KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Electrical & Electronics Engineering
(EEE)

M. Tech.
in
Power Electronics & Drives

SCHEME OF M. TECH PROGRAMME IN

POWER ELECTRONICS AND DRIVES

FIRST SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE6101	Computational Techniques	3	1	0	40	3	60	100	4
B	10EE6103	Design & Analysis of Power Electronic Systems	3	0	0	40	3	60	100	3
C	10EE6105	Advanced Machine Drives	3	0	0	40	3	60	100	3
D	10EE6107	Power Converters- I	3	0	0	40	3	60	100	3
E	10EE6xxx	Elective-I	3	0	0	40	3	60	100	3
F	10GN6001	Research Methodology	0	2	0	100	-	0	100	2
G	10EE6109	Seminar-I	0	2	0	100	-	0	100	2
H	10EE6111	Power Electronics Lab	0	0	2	100	-	0	100	1
	TOTAL		15	3	4	500		300	800	21

L-Lecture T-Tutorial P-Practical
ICA-Internal Continuous Assessment
ESE-End Semester Examination

ELECTIVE I

10EE6113 Special Machines
10EE6115 Computer Aided Design of Electrical Machines
10EE6117 Power Quality Issues and Remedial Measures
10EE6203 System Theory
10EC6105 Advanced Digital Signal Processing

Note: 8 hours/week is meant for departmental assistance by students.

SECOND SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE6102	Power Converters- II	3	1	0	40	3	60	100	4
B	10EE6104	Control Techniques in Power Electronics	3	0	0	40	3	60	100	3
C	10EE6106	Machine Analysis and Control	3	0	0	40	3	60	100	3
D	10EE61xx	Elective-II	3	0	0	40	3	60	100	3
E	10EE61xx	Elective-III	3	0	0	40	3	60	100	3
	10EE6108	Mini Project	0	0	4	100	-	0	100	2
H	10EE6112	Advanced Drives Lab	0	0	2	100	-	0	100	1
	TOTAL		15	1	6	400		300	700	19

L-Lecture T-Tutorial P-Practical
ICA-Internal Continuous Assessment
ESE- End Semester Examination

ELECTIVES

10EE6114 Industrial Control Electronics

10EE6116 Power Conversion in Renewable Energy Systems

10EE6118 Power Semiconductor Devices

10EE6122 Microcontroller Applications in Power Electronics

10EE6124 High voltage DC and AC Transmission

10EE6126 Energy Management

10EE6128 Wind Energy Conversion Systems

10EE6132 Distributed Generation and Micro grid

10ME6116 Design and Analysis of Experiments

10ME6124 Project Engineering and Management

10ME6122 Quality Management system and Reliability

Note: 8 hours/week is meant for departmental assistance by students.

THIRD SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE7xxx	Elective-IV	3	0	0	40	3	60	100	3
B	10EE7xxx	Elective-V	3	0	0	40	3	60	100	3
H	10EE7101	Seminar-II	0	2	0	100	-	0	100	2
	10EE7103	Project-Phase I	0	0	14	50	-	0	50	6
	TOTAL		**6**	**2**	**14**	**230**		**100**	**350**	**14**

L-Lecture T-Tutorial P-Practical

ICA-Internal Continuous Assessment

ESE- End Semester Examination

ELECTIVE

10EE7105 FACTS Controllers

10EE7107 Electric Vehicle Systems

10EE7109 Induction Generators

10EE7111Custom Power Devices

10EE7113 Analysis, Modelling and Control of Electric Drives

10EE7115 Advanced control of PWM inverter fed induction motors

10EC6205 Advanced Embedded Processors

10EC7507 Soft computing technique

10EC7207 Micro Electro Mechanical Systems

Note: 8 hours/week is meant for departmental assistance by students.

FOURTH SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
	10EE7104	Project –Phase II	-	-	22	70	-	30	100	12
	TOTAL		-	-	22	70		30	100	12

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment
ESE-End Semester Examination

Note: 8 hours/week is meant for departmental assistance by students.
Industrial Training (During inter semester holidays of 2nd& 3rd Semesters)

[Total Credits: 66]

SEMESTER I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6101	**COMPUTATIONAL TECHNIQUES**	**3 - 1 - 0 : 4**	**2015**

Course Prerequisites

Basic knowledge of engineering mathematics at UG level.

Course Objectives

To equip the student with mathematical techniques necessary for computing applications in engineering systems

Syllabus

Introduction to numerical techniques. Numerical/analytical solution of ordinary differential equations and partial differential equations. Stability of the numerical methods. Iterative solutions. Matrix equations. Ill conditioning and norms. Linear and unconstrained optimization. Simplex methods. Spectral methods.

Expected Outcomes

The students are expected to obtain solutions to various problems numerically.

Reference:

1. Erwin Kreyszig, Advanced Engineering Mathematics 9th Edition, Wiley International Edition Press, Numerical Recipes for scientific computing,
2. Bhaskar Dasgupta, Applied Mathematical Methods, Pearson,
3. Arfken, Weber and Harris, Mathematical Methods for Physicists, A comprehensive guide, 7th Edition, Elsevier, 2013

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Solution of equations by iterations – Newton's method – secant method – interpolation – Lagrange interpolation – Newton's divided difference, forward difference, backward difference equations – spline interpolation – numeric integration and differentiation	10	15
II	Gaussian elimination – LU factorization – Matrix inversion – Gauss-Siedel iteration – Ill conditioning and norms – least squares method – eigen value problems – power method for eigen values – Tridiagonalization and QR factorization	10	15
First Internal Examination			
III	Analytical and numerical solutions of ordinary differential equations representing physical systems – mass, spring, damper systems - RLC circuits – simple pendulum – inverted pendulum – Euler's forward difference, backward difference and symmetric methods – stability of Euler's methods – Runge Kutta methods – stability of Runge Kutta methods	8	15
IV	Elliptic PDE's: difference equations for Laplace and Poisson Equations – Dirichlet, Neumann and Mixed problems – relaxation methods Parabolic PDE's: Heat equation – analytical and numerical solutions – Crank Nicholson method Hyperbolic PDE's: Wave equation – analytical and numerical solutions – Lax Wendroff method	8	15
Second Internal Examination			

V	Unconstrained Optimization – single variable optimization – iterative methods – multivariate optimization – direct methods – steepest descent method – Newton's method – Linear programming problem – simplex method	10	20
VI	Introduction to numerical spectral methods - Matlab/Scilab Laboratory sessions: Numerical integration and differentiation. Euler's method and Runge Kutta methods for systems of linear and nonlinear differential equations. Solution of heat and wave equations for different initial and boundary conditions. Simple optimization problems.	10	20
		56	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6103	DESIGN AND ANALYSIS OF POWER ELECRONICS SYSTEMS	3 - 1 - 0 : 3	2015

Course Prerequisites

Basic knowledge of Power electronics, and Network Analysis at UG Level.

Course Objectives

To develop the design and analysis skills of Power Electronic Systems.

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Syllabus

Switched DC source with RL, RC and RLC load – half wave uncontrolled rectifier circuit analysis-power switches- half wave controlled rectifiers – rectifier fed d.c. motor drives- Choppers – d.c.motor drives -Magnetics design - AC inductor design -Thermal design

Expected Outcomes

The students are expected to design and analysis of power electronic systems.

Text books

1. Power Semiconductor circuits – S B Dewan, A Straughen John Wiley & Sons
2. Fundamentals of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
3. Power electronics Essentials and Applications – L Umanand
4. Design of Magnetic Components for Switched Mode Power supplies – L Umanand and S P Bhat – New Age International
5. Power electronics Principles and Applications-Joseph Vithayathil – Tata McGraw Hill
6. Power Electronics – Cyril W Lander – Tata McGraw Hill

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Switched DC source with RL, RC and RLC load – recovery of trapped energy – RLC load with an ac source.-Rectifier Circuit analysis-Uncontrolled Half wave Rectifier.	8	15
II	Models of power switches – Operation of thyristor-Controlled Half wave Rectifier- commutation of thyristors –types.	6	15
First Internal Examination			
III	Single phase and three phase controlled rectifiers-Rectifier fed d.c motor drive – dual converter – d.c series motor drive-numerical examples	8	15
IV	Choppers – analysis of type A, type B, four quadrant chopper-d.c motor drive	6	15
Second Internal Examination			
V	Magnetics design – transformer modeling – loss mechanism in magnetic devices – eddy currents in winding conductors – types of magnetic devices – BH loops, core and copper losses – inductor design constraints – design procedure – multiple winding magnetics design – transformer design constraints – design procedure – AC inductor design	8	20
VI	Thermal design – control of semiconductor device temperatures - various heat transfer modes, heat sink design. Numerical examples.	6	20
		56	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test	– 15 Marks
Second Internal Test	– 15 Marks
Assignments/Term Paper/Seminar	– 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE 6105	**ADVANCED MACHINE DRIVES**	**3 - 0 - 0 : 3**	**2015**

Course Prerequisites

Basic knowledge in Electrical machines and Power electronics at UG level.

Course Objectives

1. To give an idea about the dynamics and control of conventional and modern electrical drives
2. To develop power electronics based control for accurate speed control for various applications

Syllabus

Electric drive systems- Dynamics- Rating and heating of motors- DC drives- Induction motor drives- Synchronous motor drives- Drives for specific applications--Control techniques of electric drives- Transfer function and state variable representation of drive systems – Closed Loop control of drives- Microprocessors based control

Expected Outcomes

Students who complete this course will have an ability to understand the fundamental concepts of electrical drives; have a knowledge on the impact of power electronic converters and microprocessors on speed control of electric drives

Text Books:

1. Vedam Subrahmanyam, Electric Drives — Tata McGraw Hill – 2nd Edition
2. G. K. Dubey,,Fundamentals of Electric Drives –Narosa Publications-2nd Edition.

References:

1. Jingde Gao, Linzheng Zhang, Xiangheng Wang, AC Machine Systems –, Springer
2. Rik De Doncker, Duco W J Pulle, Andre Veltman, Advanced Electric Drives — Springer

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Dynamics of a drive**s: Elements of electric drives- Dynamics of a drive system –Components of load torques- Steady state stability. **Motor power rating**: Requirements of a drive motor – Power losses, Heating and Cooling of electric motor – Classes of duty and Selection of electric motor	8	15
II	**DC drives**: Phase controlled rectifier fed dc drives- Separately excited motor and Series motors drives- Single phase and three phase drives- Chopper fed drives- Reversible drives-	6	15
First Internal Examination			
III	**Induction motor drives**: Stator Voltage control- Rotor resistance control- Chopper control- Slip energy recovery schemes-V/f control- Cyclo converter fed motors- VSI & CSI fed motors- PWM drives- Field oriented control	8	15
IV	**Synchronous motor drives**: Variable frequency supply- Self control- VSI & CSI fed motors- Permanent magnet synchronous motors – Cyclo converter fed synchronous motor Drive circuits for stepper motor-switched reluctance motor drives	6	15
Second Internal Examination			
V	**Drive Applications:** Drive considerations for textile mills, steel rolling mills, cranes and hoists, cement mills, sugar mills, machine tools, paper mills, coal mines, centrifugal pumps, turbo compressors- ac & dc drives- Traction Drives.	8	20

	Basics of solar powered pump drives and electric vehicles.		
VI	**Control techniques**: Block diagram representation of drive systems – Transfer function and state variable representation of dc drive systems – Closed Loop control of drives- Torque, speed and position control schemes- **Microprocessors based control**: Application areas- Block diagram schemes for control of ac, dc drives and stepper motors – Aspects of microprocessor based control system design.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6107	**POWER CONVERTERS I**	**3 - 0- 0 : 3**	**2015**

Course Prerequisites
Basic knowledge of Power Electronic circuits and devices at UG Level.

Course Objectives
To develop solid foundation in analyzing DC-DC and AC-DC converters

Syllabus
Line frequency single phase and three phase AC-DC fully controlled rectifiers, Multi pulse AC-DC converters, DC-DC converters, Resonant converters and switching power supplies.

Expected Outcomes
The students are expected to apply the general principles of AC-DC and DC-DC converters for various industrial applications such as motor speed controllers and rectifiers.

Text books

1. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
3. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
5. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Current harmonics in rectifiers – harmonic standards – Single phase and three phase fully controlled rectifiers - power factor, Total harmonic distortion, displacement power factor- Effect of source inductance on current commutation.	8	15
II	Resonant DC-DC converters – load resonant converters – resonant switch converters – zero voltage switching, clamped voltage topologies – resonant dc link inverters with zero voltage switching – high frequency link integral half cycle converters	6	15
First Internal Examination			
III	DC- DC converters (CCM&DCM operation) : Buck converter- Boost converter- Buck boost Converter- Cuk converter – LUO converter – SEPIC converter	8	15
IV	Switching DC Power Supplies – Forward, flyback, pushpull, half bridge and full bridge converter circuit, operation, waveforms and design, small signal analysis of DC-DC converters and closed loop control – transfer function of dc-dc converters – stability analysis	6	15
Second Internal Examination			
V	PFC converters: Multiple converter – Boost PFC rectifiers- Vienna rectifiers – Third harmonic injection techniques –	8	20

	Minnesota rectifiers – Modeling and simulation of all rectifiers.		
VI	Applications: Residential and industrial applications of power electronics – induction heating, welding, electronic ballast – utility applications - back to back HVDC transmission, UPS, static var compensators and active filters.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6113	**SPECIAL MACHINES**	**3 - 0- 0 : 3**	**2015**

Course Prerequisites
Basic knowledge of Electrical Machines at UG Level.

Course Objectives
To impart knowledge about special machines

Syllabus
Stepper motor, Servomotor, Synchronous Reluctance motor, Switched reluctance motor, Permanent magnet BLDC motor & PMAC Motor, Linear Induction motor**.**

Expected Outcomes
The students are expected to apply the general principles of special machines for various industrial applications and house hold applications.

Text books

1. T.J.E. Miller, Brushless Permanent-Magnet and Reluctance Motor Drives, Clarendon Press.
2. R.Krishnan, Switched Reluctance Motor Drives-Modelling, Simulation, Analysis, Design and application, CRC press New York,2001
3. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.T.J.E. Miller, Switched Reluctance Motors And Their Control , Magna physics Publishing, Oxford.
4. T.J.E. Miller, Electronic Control of Switched Reluctance Machines, Newnes Power Engineering Series.
5. Vincent Del Toro, Electric Machines and Power Systems, Prentice Hall
6. M D Desai, Control system components, PHI
7. K Venkataratnam, Special Electrical Machines, Universities press(India) Pvt. Ltd. Hyderabad
8. R Krishnan, Electric Motor Drives, Modeling, Analysis, and control, PHI
9. Nasar S.A., Boldea I., Linear Motion Electric Machine, John Wiley & Sons.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Stepper motor:** Constructional features - Principle of operation-permanent magnet stepper motor - variable reluctance motor - hybrid motor-single and multi stack configurations - Torque equations - modes of excitations - drive circuits-microprocessor control of stepping motors - closed loop control – applications.	8	15
II	**Servomotor:** DC servomotors- construction - principle of operation-transfer function - armature control and field control - AC servomotor-construction - theory of operation - shaded pole ac servomotors –applications.	6	15
	First Internal Examination		
III	**Synchronous Reluctance motor**: Constructional features - Types - Principle of operation - Axial and radial flux motors - operating principles - variable reluctance motor - hybrid motor - voltage and torque equations – characteristics – applications.	8	15
IV	**Switched reluctance motor**: Constructional features - principle of operation - torque production - steady state performance prediction-Analytical method - Power converters and their controllers - Methods of rotor position sensing -	6	15

	Closed loop control of SRM – Characteristics – applications.		
Second Internal Examination			
V	**Permanent magnet motor:** Permanent magnet brushless DC motors - Permanent magnetic materials - Magnetic characteristics - Principle of operation -Types-Magnetic circuit analysis - Torque equations - Power controllers - Motor characteristics and control, Permanent magnet synchronous motors-Principle of operation--Torque equations-characteristics and control.	8	20
VI	**Linear Induction motor** Linear induction motor- Double sided linear induction motor from rotary type Induction motor – Scheme of LIM drive for electric traction – development of single sided LIM – Equivalent circuit- applications.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE 6115	**COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES**	**3 - 0- 0 : 3**	**2015**

Prerequisite: Knowledge about design of electrical machines

Course Objectives

To introduce the technique of Finite Element Methods in the area of electrical machines

Syllabus

Computer aided design of electrical machines - Analysis and synthesis methods - - Mathematical Formulation of Field Problems-Development of torque/force - E - Electrical Vector/Scalar potential - Stored energy in field problems – Inductances - Laplace and Poisson's Equations - Energy functional - Principle of energy conversion.Philosophy of FEM- Finite Difference method - Finite Element Method - Energy minimization - Variational method - 2D Field problems - Solution techniques.CAD Packages - Setting up solution - Postprocessing.Design Applications-Design of Solenoid Actuator - Induction Motor - Switched Reluctance Motor – Synchronous Machines.

Course Outcome

At the end of course, the student will be able to:

- Basic concept of electric machine
- Apply FEM methods for field plotting
- Design electromagnetic machines

References

1. S J Salon, "*Finite Element Analysis of Electrical Machines*", Kluwer Academic Publishers, London, 1995.
2. VladoOstovic, "*Computer Aided Analysis of Electric Machines*", PHI (UK) Ltd, 1994.
3. Silvester and Ferrari*, "Finite Elements for Electrical Engineer",* Cambridge University Press, 1983.
4. S R H Hoole, "*Computer-Aided, Analysis and Design of Electromagnetic Devices*", Elsevier1989.
5. D A Lowther, P PSilvester, "*Computer Aided Design in Magnetics*", Springer Verlag, New York.
6. M Ramamoorthy, "Computer Aided Design of Electrical Equipments", Affiliated East West Press.
7. C W Trowbridge, "*An Introduction to Computer Aided Electromagnetic Analysis*", Vector Field Ltd.
8. Chee-Mun Ong, "*Dynamic Simulations of Electric Machinery: Using MATLAB/SIMULINK",* Prentice Hall, 1998.
9. *User Manuals of Software Packages like MAGNET, ANSOFT& ANSYS.*
10. *Chee-Mun Ong, "Dynamic Simulations of Electric Machinery: Using MATLAB/SIMULINK", Prentice Hall, 1998.*

COURSE PLAN

Module	Contents	Hours	Semester Exam Marks %
I	Computer aided design of electrical machines - Conventional design procedures - Analysis and synthesis methods - Limitations - Need for field analysis based design.- Mathematical Formulation of Field Problems-Development of torque/force - Electromagnetic Field Equations - Magnetic Vector/Scalar- potential	8	15

II	Electrical Vector/Scalar potential - Stored energy in field problems – Inductances - Laplace and Poisson's Equations - Energy functional - Principle of energy conversion.	6	15
FIRST INTERNAL EXAM			
III	Philosophy of FEM- Mathematical Models - Differential/Integral equations - Finite Difference method - Finite Element Method	8	15
IV	Energy minimization - Variational method - 2D Field problems - Discretisation- Shape functions - Stiffness matrix - Solution techniques.	6	15
SECOND INTERNAL EXAM			
V	CAD Packages-Elements of a CAD System - Preprocessing - Modeling - Meshing -Material properties - Boundary Conditions - Setting up solution - Postprocessing.	8	20
VI	Design Applications-Design of Solenoid Actuator - Induction Motor - Switched Reluctance Motor – Synchronous Machines-case studies.	6	20
		42	
ESE			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6117	**POWER QUALITY ISSUES AND REMEDIAL MEASURES**	**3 - 0- 0 : 3**	**2015**

Course Prerequisites

Basic knowledge of Electrical power systems & power Electronics at UG Level.

Course Objectives

To give the Student:-

- An introduction to various power quality problems in the electrical power systems.
- Analyse the power quality problem and identify the remedial measures.
- Design and development of power electronics based solutions to power quality problems.

Syllabus

Introduction to power quality- power quality measures and standards- Important harmonic introducing devices- Harmonics and measurements-Power quality Improvement-DSTATCOM-DVR-UPQC- Active Power Factor Correction.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the power quality problems in the electrical systems ; Apply the basics of electrical engineering to identify the remedial measures to power quality problems; Design and development of power electronics based solutions to power quality problems.

REFERENCES:

1. G T Heydt, Power Quality, Star in a circle publications.
2. Dugan, Electric Power Systems Quality, Tata Mc Graw Hill.
3. K R Padiyar, FACTS controllers in Power Transmission and Distribution, New Age publications, New Delhi, 2007.
4. R Sastry Vedam, power quality VAR compensation in power systems, CRC press, NewYork, 2009.
5. A Ghosh and G Ledwich, "power quality improvement using custom power devices", IEEE Press, 2001.
6. NedMohan et al "power Electronics"

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction**-power quality-voltage quality-overview of power quality phenomena classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C message weights-flicker factor-transient phenomena-occurrence of power quality problems power acceptability curves-	8	15
II	**Important harmonic introducing devices**- SMPS-Three phase power converters – arcing devices- saturable devices-fluorescent lamps- effect of power system harmonics on equipment and loads.	6	15
First Internal Examination			
III	Balancing of source currents- Steinmetz network. **Harmonics and measurements**: Power factor reduction due to harmonics-Distortion power-distortion power factor and	8	15

	displacement power factor- Triplen harmonics. Power Quality Analysers-Voltage, Current, Power and Energy measurements		
IV	**Power quality Improvement:-DSTATCOM for** Harmonic Filtering, reactive power compensation and load balancing- d-q domain control and IRPT control of three phase DSTATCOM- Three-phase four-wire systems.	6	15
Second Internal Examination			
V	**Dynamic Voltage Restorers** for sag, swell and flicker problems – structure and control- Series active power filtering techniques for harmonic cancellation and isolation-Uninterruptible power supplies-constant voltage transformers	8	20
VI	**UPQC:** Structure and control-Left shunt UPQC-Right shunt UPQC **Active Power Factor Correction:** Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6203	**SYSTEM THEORY**	**3 - 0- 0 : 3**	**2015**

Course Prerequisites

Basic knowledge about control systems and controllers.

Course Objectives

To give the Student:-

- A foundation in the fundamentals of control system and controllers.
- To develop an application of controlles in real time.
- Optimal control design of various systems.

Syllabus

Fundamental concepts and overview; State variables ;State space analysis of discrete systems; Lyapunov's stability analysis; Krasovski's theorm; Controllability and observability in canonical form; Optimal control design using Lyapunov's method; Riccattic equations for optimal control ; Analysis and control of Robust control systems.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of control system; stability analysis of continuous and discrete systems; Use Lyapunov's method and Riccattic equations to solve optimal control design problems.

Text Books:

1. Ogata K., Modern control Engg, (second edition)Prentice Hall Inc.1990
2. Ogata K., Discrete time control systems, P.H.I.
3. Gopal M., Digital Control and state variable methods, TMH,1997

References:

4. *Ogata K., Modern control Engg, (second edition)Prentice Hall Inc.2015*
5. *Richard C. Dorf and Bishop R.T., Modern Control System, P.H.I. publisher*

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	State variable representation of system –concept of state -Equilibrium points -Stability-Solution of state equation -eigen values -eigen vectors -modes -modal decomposition -eigen value and stability- State space representation of discrete time systems -Discretization of continuous time state equation.	8	15
II	Lyapunov stability -definition of stability, asymptotic stability and instability -Lyapunov's second method -Lyapunov's stability analysis of LTI continuous time and discrete time systems-stability analysis of non linear system -Krasovski's theorem -variable gradient method.	6	15
First Internal Examination			
III	Concepts of controllability and observability -controllability and observability tests for continuous time and discrete time systems -controllability and observability studies based on canonical forms of state model -effect of state feedback on controllability and observability - pole placement by state feedback for continuous and discrete time systems .	8	15
IV	Optimal control -formulation of optimal control problem -Minimum time control problem - minimum energy	6	15

	problem -minimum fuel problem -state regulator problem - output regulator problem - tracking problem.		
Second Internal Examination			
V	Choice of performance measure -optimal control based on quadratic performance measure -optimal control system design using second method Lyapunov -solution of reduced Riccatti equation.	8	20
VI	Design of full order and reduced order observer for continuous time and discrete time systems Robust control systems -introduction -sensitivity analysis of robustness - system with uncertain parameters -design of robust PID controlled systems.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EC6105	**ADVANCED DIGITAL SIGNAL PROCESSING**	**3 – 0 - 0 : 3**	**2015**

Course Prerequisites
(1) Basic knowledge in signals and systems at UG level;
(2) Basic knowledge in transforms at UG level.

Course Objectives
(1) To attain a good analytical ability in digital filter design;
(2) To investigate the applications of digital signal processing.

Syllabus
Review of transforms, Z-Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT), LTI systems as frequency selective filters, Invertibility of LTI systems, Design of digital filters by placement of poles and zeros, FIR filter structures, IIR filter structures, Design of FIR filters, Linear Phase Systems, Window method, Frequency sampling method, Finite word length effects, Design of IIR filters, Pole zero placement, Impulse invariance, Bilinear Z transformation, Finite word length effects, Adaptive Digital Filters, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Power Spectrum Estimation, Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.

Expected Outcomes
The students are expected to :
(1) Attain a good analytical ability in digital filter design;
(2) Know various applications of digital signal processing.

References:
1. Proakis and Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications,* 4/e, Pearson Education.
2. Ifeachor and Jervis, *Digital Signal Processing, A practical Approach,* 2/e, Pearson Education.
3. Johnny R. Johnson, *Introduction to Digital Signal Processing,* PHI, 1992.
4. Ashok Ambardar, *Digital Signal Processing: A Modern Introduction,* Thomson, IE, 2007.
5. Douglas F. Elliott*, Handbook of Digital Signal Processing- Engineering Application,* Academic Press.
6. Robert J. Schilling and Sandra L. Harris, *Fundamentals of Digital Signal Processing using MATLAB,* Thomson, 2005.
7. Ingle and J. G. Proakis, *Digital Signal Processing Using MATLAB,* Thomson, 1/e.

Course plan

Module	Content	Hours	Semester Exam Marks
I	**Review of transforms** : Z-Transform, ROC, Poles & Zeros, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), DFT as a linear transformation, Frequency analysis of signals and systems using DFT, Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT). **LTI systems as filters** : Invertibility of LTI systems, Minimum phase, Maximum phase and mixed phase systems, All-pass filters, Design of digital filters by placement of poles and zeros, Linear filtering methods based on DFT.	8	15
II	**Digital Filter Structures** : Generalized input-output relationship, IIR Transfer Function, FIR Transfer Function, Signal Flow Graphs, FIR filter structures, Direct Form-I, Direct Form-II, Frequency Sampling, Cascade, Lattice, IIR filter structures, Direct Form-I, Transposed, Direct Form-II, Canonical, Parallel, Cascade, Lattice-Ladder structures.	6	15
First Internal Examination			

III	**Design of FIR filters** : Linear Phase Systems, Specifications, Coefficient calculation methods, Desired impulse responses, Window method, Frequency sampling method, Comparison of methods, Filter realization, Finite word length effects, Implementation examples, FIR filter design using Octave/ MATLAB.	8	15
IV	**Design of IIR filters** : Specifications, Coefficient calculation method, Pole zero placement, Transformation rules, Impulse invariance, Bilinear Z transformation (BZT), Buttorworth and Chebyschev approximations, Filter realization, Finite word length effects, Implementation examples, IIR filter design using Octave/ MATLAB.	6	15
Second Internal Examination			
V	**Adaptive Digital Filters** : Concepts, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Lattice Ladder filters, Application of Adaptive filters.	8	20
VI	**Power Spectrum Estimation** : Estimation of spectra from finite duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation	6	20
	TOTAL	42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	RESEARCH METHODOLOGY	0 - 2 - 0 : 2	2015

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.
As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India,

New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology**: Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

10EE 6109	SEMINAR-I	0-2-0:2	2015

Course Objectives

The basic objective of this course is to improve the oral communication skill of the students.

Syllabus

Individual students are required to choose a topic of their interest in consultation with faculty and present for about 30 minutes. They will be guided about sound modulation, sequence of presentation, eye contact and writing on the black board.

Students have to submit a report on the topic in the prescribed format.

Internal Continuous Assessment: 50 marks

Internal continuous assessment is for the presentation and the report. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

Presentation	– 25 Marks
report	– 25 Marks
Total	– 50 Marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6111	POWER ELECTRONICS LAB	0 - 0 - 2 : 2	2015

Course Prerequisites
Basic knowledge of Power Electronics at UG Level.

Course Objectives
To design and develop power electronic converters.

Syllabus
- AC-DC Converters
- DC-DC Converters
- DC-AC Converters
- AC-AC converters

Expected Outcomes
The students are expected to design and analysis of power electronic converters.

References

1. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
3. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
5. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Course Plan

Sl. No.	Experiments
1	Study the performance of a single-phase half wave and full wave AC-DC phase controlled converter. Record AC supply voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor for various loads.
2	Study the performance of a three-phase bridge rectifier.
3	Study the performance of 12-pulse and 24-pulse uncontrolled three-phase bridge rectifiers.
4	Study the performance DC- DC step down Chopper in the open loop and record the DC supply voltage, supply current, load voltage and load current, device voltage and current in Resistive load and DC motor load.
5	Study the performance DC- DC buck converter in CCM and DCM mode.
6	Study the performance DC- DC boost converter in CCM and DCM mode.
7	Study the performance DC- DC buck-boost converter in CCM and DCM mode.
8	Study the performance of a DC-AC single-phase inverter with triangular carrier PWM Control. AC voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, input DC current average value and waveform in DC-AC single-phase inverter.
9	Study the performance of a DC-AC three-phase inverter with 120 degree and 180 degree conduction. AC supply voltage and current waveform, Harmonic spectrum, THD, crest factor, rmsvalue, distortion factor, displacement factor and power factor, input DC current average value and waveform.
10	Study the performance of a DC-AC three-phase inverter with PWM control.
11	Study the performance of single-phase AC voltage controllers with (i) resistive (R), (ii) resistive-inductive (R-L) and (iii) single-phase motor loads at two firing angles. AC supply voltage, load voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor, active power, reactive power and apparent power and power factor for R and R-L loads

12	Study the performance of step up and step down cycloconverter.
13	Control of dc-dc converters (Buck, Boost and Buck-Boost converter) using discrete ICs like TL494/SG3525/UC3842, Power loss computation, Selection of heatsinks and PCB design.
14	Study of harmonic pollution by power electronics loads using power quality analyser
	(Out of the above, a minimum of SIX hardware experiments and SIX simulation studies are to be conducted. Simulation can be done using any of the software packages like MATLAB/SIMULINK, ORCAD, PSCAD etc.)
End Semester Examination	

Internal Continuous Assessment: 50 marks

i) Practical Records /outputs: 20

ii) Regular Class Viva-Voce: 10

iii) Final Test (Objective): 20

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand& Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech.Degree Program with effect from Academic Year 2015 - 2016

Electrical & Electronics Engineering
(EEE)

M. Tech.
in
Power Systems and Power Electronics

SCHEME OF M. TECH PROGRAMME IN
POWER SYSTEMS AND POWER ELECTRONICS
FIRST SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE6101	Computational Techniques	3	1	0	40	3	60	100	4
B	10EE6303	Power System Dynamics	3	0	0	40	3	60	100	3
C	10EE6305	Advanced Power System Analysis	3	0	0	40	3	60	100	3
D	10EE6107	Power Converters- I	3	0	0	40	3	60	100	3
E	10EE6xxx	Elective-I	3	0	0	40	3	60	100	3
F	10GN6001	Research Methodology	0	2	0	100	-	0	100	2
G	10EE6309	Seminar-I	0	2	0	100	-	0	100	2
H	10EE6311	Power Electronics Lab	0	0	2	100	-	0	100	1
	TOTAL		15	3	4	500		300	800	21

L-Lecture T-Tutorial P-Practical

ICA-Internal Continuous Assessment

ESE-End Semester Examination

ELECTIVE I

10EE6103Design and Analysis of Power Electronic System

10EE6105Advanced Machine Drives

10EE6117 Power Quality Issues and Remedial Measures

10EE6203 System Theory

10EE6313Power System Security

Note: 8 hours/week is meant for departmental assistance by students.

SECOND SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE6102	Power Converters- II	3	1	0	40	3	60	100	4
B	10EE6104	Control Techniques in Power Electronics	3	0	0	40	3	60	100	3
C	10EE6306	Power System Operation and Control	3	0	0	40	3	60	100	3
D	10EE6xxx	Elective-II	3	0	0	40	3	60	100	3
E	10EE6xxx	Elective-III	3	0	0	40	3	60	100	3
	10EE6308	Mini Project	0	0	4	100	-	0	100	2
H	10EE6312	Power System Lab	0	0	2	100	-	0	100	1
	TOTAL		15	1	6	400		300	700	19

L-Lecture T-Tutorial P-Practical
ICA-Internal Continuous Assessment
ESE- End Semester Examination

ELECTIVES

10EE6106 Machine Analysis and Control

10EE6114 Industrial Control Electronics

10EE6116 Power Conversion in Renewable Energy Systems

10EE6118 Power Semiconductor Devices

10EE6122 Microcontroller Applications in Power Electronics

10EE6124 High voltage DC and AC Transmission

10EE6126 Energy Management

10EE6128 Wind Energy Conversion Systems

10EE6132 Distributed Generation and Micro grid

10EE6314Power System Planning and Reliability

10ME6116 Design and Analysis of Experiments

10ME6124 Project Engineering and Management

Note: 8 hours/week is meant for departmental assistance by students.

THIRD SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE7xxx	Elective-IV	3	0	0	40	3	60	100	3
B	10EE7xxx	Elective-V	3	0	0	40	3	60	100	3
H	10EE7301	Seminar-II	0	2	0	100	-	0	100	2
	10EE7303	Project-Phase I	0	0	14	50	-	0	50	6
	TOTAL		**6**	**2**	**14**	**230**		**100**	**350**	**14**

L-Lecture T-Tutorial P-Practical

ICA-Internal Continuous Assessment

ESE- End Semester Examination

ELECTIVES

10EE7105 FACTS Controllers

10EE7107 Electric Vehicle Systems

10EE7109 Induction Generators

10EE7111Custom Power Devices

10EE7305 Digital Protection of Power System

10EE7307Power Distribution System

10EE7309 Computer Control of Power System

10EC7507 Soft computing techniques

Note: 8 hours/week is meant for departmental assistance by students.

FOURTH SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
	10EE7304	Project –Phase II	-	-	22	70	-	30	100	12
	TOTAL		-	-	**22**	**70**		**30**	**100**	**12**

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment
ESE-End Semester Examination

Note: 8 hours/week is meant for departmental assistance by students.
Industrial Training (During inter semester holidays of 2^{nd}& 3^{rd} Semesters)

[Total Credits: 66]

SEMESTER - I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6101	COMPUTATIONAL TECHNIQUES	3 - 1 - 0 : 4	2015

Course Prerequisites

Basic knowledge of engineering mathematics at UG level.

Course Objectives

To equip the student with mathematical techniques necessary for computing applications in engineering systems

Syllabus

Introduction to numerical techniques. Numerical/analytical solution of ordinary differential equations and partial differential equations. Stability of the numerical methods. Iterative solutions. Matrix equations. Ill conditioning and norms. Linear and unconstrained optimization. Simplex methods. Spectral methods.

Expected Outcomes

The students are expected to obtain solutions to various problems numerically.

Reference:

1. Erwin Kreyszig, Advanced Engineering Mathematics 9th Edition, Wiley International Edition Press, Numerical Recipes for scientific computing,
2. BhaskarDasgupta, Applied Mathematical Methods, Pearson,
3. Arfken, Weber and Harris, Mathematical Methods for Physicists, A comprehensive guide, 7th Edition, Elsevier, 2013

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Solution of equations by iterations – Newton's method – secant method – interpolation – Lagrange interpolation – Newton's divided difference, forward difference, backward difference equations – spline interpolation – numeric integration and differentiation	10	15
II	Gaussian elimination – LU factorization – Matrix inversion – Gauss-Siedel iteration – Ill conditioning and norms – least squares method – eigen value problems – power method for eigen values – Tridiagonalization and QR factorization	10	15
First Internal Examination			
III	Analytical and numerical solutions of ordinary differential equations representing physical systems – mass, spring, damper systems - RLC circuits – simple pendulum – inverted pendulum – Euler's forward difference, backward difference and symmetric methods – stability of Euler's methods – RungeKutta methods – stability of RungeKutta methods	8	15
IV	Elliptic PDE's: difference equations for Laplace and Poisson Equations – Dirichlet, Neumann and Mixed problems – relaxation methods	8	15

	Parabolic PDE's: Heat equation – analytical and numerical solutions – Crank Nicholson method Hyperbolic PDE's: Wave equation – analytical and numerical solutions – Lax Wendroff method		
Second Internal Examination			
V	Unconstrained Optimization – single variable optimization – iterative methods – multivariate optimization – direct methods – steepest descent method – Newton's method – Linear programming problem – simplex method	10	20
VI	Introduction to numerical spectral methods - Matlab/Scilab Laboratory sessions: Numerical integration and differentiation. Euler's method and RungeKutta methods for systems of linear and nonlinear differential equations. Solution of heat and wave equations for different initial and boundary conditions. Simple optimization problems.	10	20
	TOTAL	56	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6303	POWER SYSTEM DYNAMICS	3-0-0:3	2015

Course Prerequisites

Numerical Methods , Electrical Machines, Power System Analysis

Course Objectives

This course aims to give basic knowledge about the dynamic mechanisms behind angle and voltage stability problems in electric power systems, including physical phenomena and modelling issues.

Syllabus

Power system stability considerations, synchronous machine representation, stability of dynamic systems, d-q transformation, state space representation concept, transient stability, numerical integration method, voltage stability

Expected Outcomes

At the end of this course, students will be able to analyse and understand the electromagnetic and electromechanical phenomena taking place around the synchronous generator.

Text books

1 Power System Stability and Control: –P. Kundur – McGraw Hill publications
2.Power System Dynamics: Stability and Control: – K.R.PADIYAR, II Edition, B.S.Publications
3.Power system control and stability P.M. Anderson and A.A. Fouad, John Wiley & sons
4.Computer modelling of Electric Power Systems, J. Arrillaga and N. R. Watson, John Wiley & sons, 2001

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Power system stability considerations – definitions-classification of stability-rotor angle and voltage stability-synchronous machine representation –classical model-load modelling concepts-modelling of excitation systems-modelling of prime movers.	6	15
II	Stability of Dynamic systems, Synchronous machine theory and modelling- armature and field structure, parks transformation, machine with multiple pole pairs-mathematical description, d-q transformation, per unit representation, equivalent circuit for d-q axes, steady state analysis- voltage-current and flux linkage, phasor representation, rotor angle – steady state equivalent circuit	8	15
First Internal Examination			
III	State space representation concept, Eigen properties of the state vectors, analysis of stability- small signal stability of a single machine connected to infinite bus system, classical representation of generator, small signal stability of a multi machine connected to infinite bus system. Characteristics of small - signal stability problems	8	15
IV	Transient stability:- Concept of transient stability, response to a step change in mechanical power input, Swing equation- multi-	6	15

	machine analysis, factors influencing transient stability		
Second Internal Examination			
V	Numerical integration methods – Euler method – R-K method (4th order), critical clearing time and angle- methods for improving transient stability.	8	20
VI	Voltage stability**:-** Basic concept, transmission system characteristics, generator characteristics, load characteristics, PV curve, QV curve and PQ curve, characteristics of reactive power compensating devices. Voltage collapse and prevention of voltage collapse.	6	20
	TOTAL	42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6305	**ADVANCED POWER SYSTEM ANALYSIS**	**3-0-0:3**	**2015**

Course Prerequisites
A basic knowledge on the subjects viz., Power System analysis, Matrix manipulations, Alternating machines and network analysis

Course Objectives
To perform steady state analysis and fault studies for a power system of any size and also to explore the nuances of estimation of different states of a power system.

Syllabus
Physical interpretation of bus admittance and impedance matrices, AC Load Flow, DC power flow, fault studies, system optimization, state estimation

Expected Outcomes
On completion of the course, the students will be able to investigate the state of a power system of any size and be in a position to analyse a practical system both under steady state and fault conditions. Also the students would be able to determine the operating condition of a system according to the demand without violating the technical and economic constraints.

Text books
1. Grainger, J.J. and Stevenson, W.D. 'Power System Analysis' Tata McGraw hill, New Delhi, 2003.
2. Arrillaga, J and Arnold, C.P., 'Computer analysis of power systems' John Wiley and Sons, New York, 1997
3. Pai, M.A., 'Computer Techniques in Power System Analysis', Tata McGraw hill, New Delhi, 2006

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Physical interpretation of bus admittance and impedance matrices-Introduction to admittance matrix formulation-Formation of admittance matrix due to inclusion of regulating transformer- Development of admittance matrix using singular transformation-Modification of admittance matrix for branch addition/ deletion.	8	15
II	AC Load Flow - Network modeling – Conditioning of Y Matrix – Load flow-Newton Raphson method- Decoupled – Fast decoupled Load flow -three-phase load flow	6	15
First Internal Examination			
III	DC power flow –Single phase and three phase -AC-DC load flow - DC system model –Sequential Solution Techniques – Extension to Multiple and or Multi-terminal DC systems –DC convergence tolerance – Test System and results.	8	15
IV	Fault Studies -Analysis of balanced and unbalanced three phase faults – fault calculations –Short circuit faults – open circuit	6	15

	faults		
Second Internal Examination			
V	System optimization - strategy for two generator system – generalized strategies – effect of Transmission losses - Sensitivity of the objective function- Formulation of optimal power flow-solution by Gradient method-Newton's method	8	20
VI	State Estimation – method of least squares – statistics – errors – estimates – test for bad data– Structure and formation of Hessian matrix – power system state estimation.	6	20
	TOTAL	42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6107	**POWER CONVERTERS I**	**3-0-0:3**	**2015**

Course Prerequisites
Basic knowledge of Power Electronic circuits and devices at UG Level.

Course Objectives
To develop solid foundation in analyzing DC-DC and AC-DC converters

Syllabus
Line frequency single phase and three phase AC-DC fully controlled rectifiers, Multi pulse AC-DC converters, DC-DC converters, Resonant converters and switching power supplies.

Expected Outcomes
The students are expected to apply the general principles of AC-DC and DC-DC converters for various industrial applications such as motor speed controllers and rectifiers.

Text books

1. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
3. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
5. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Current harmonics in rectifiers – harmonic standards – Single phase and three phase fully controlled rectifiers - power factor, Total harmonic distortion, displacement power factor- Effect of source inductance on current commutation.	8	15
II	Resonant DC-DC converters – load resonant converters – resonant switch converters – zero voltage switching, clamped voltage topologies – resonant dc link inverters with zero voltage switching – high frequency link integral half cycle converters	6	15
First Internal Examination			
III	DC- DC converters (CCM&DCM operation) : Buck converter- Boost converter- Buck boost Converter- Cuk converter – LUO converter – SEPIC converter	8	15
IV	Switching DC Power Supplies – Forward, flyback, pushpull, half bridge and full bridge converter circuit, operation, waveforms and design, small signal analysis of DC-DC converters and closed loop control – transfer function of dc-dc converters – stability analysis	6	15
Second Internal Examination			

V	PFC converters: Multiple converter – Boost PFC rectifiers- Vienna rectifiers – Third harmonic injection techniques – Minnesota rectifiers – Modeling and simulation of all rectifiers.	8	20
VI	Applications: Residential and industrial applications of power electronics – induction heating, welding, electronic ballast – utility applications - back to back HVDC transmission, UPS, static var compensators and active filters.	6	20
	TOTAL	42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

ELECTIVE-I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6103	DESIGN AND ANALYSIS OF POWER ELECRONICS SYSTEMS	3 - 0- 0:3	2015

Course Prerequisites

Basic knowledge of Power electronics, and Network Analysis at UG Level.

Course Objectives

To develop the design and analysis skills of Power Electronic Systems

.

Syllabus

Switched DC source with RL, RC and RLC load – half wave uncontrolled rectifier circuit analysis-power switches- half wave controlled rectifiers – rectifier fed d.c. motor drives- Choppers – d.c.motor drives -Magnetics design - AC inductor design -Thermal design

Expected Outcomes

The students are expected to design and analysis of power electronic systems.

Text books

1. Power Semiconductor circuits – S B Dewan, A Straughen John Wiley & Sons
2. Fundamentals of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
3. Power electronics Essentials and Applications – L Umanand
4. Design of Magnetic Components for Switched Mode Power supplies – L Umanand and S P Bhat – New Age International
5. Power electronics Principles and Applications-Joseph Vithayathil – Tata McGraw Hill
6. Power Electronics – Cyril W Lander – Tata McGraw Hill

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Switched DC source with RL, RC and RLC load – recovery of trapped energy – RLC load with an ac source.-Rectifier Circuit analysis-Uncontrolled Half wave Rectifier	8	15
II	Models of power switches – Operation of thyristor-Controlled Half wave Rectifier- commutation of thyristors –types.	6	15
First Internal Examination			
III	Single phase and three phase controlled rectifiers-Rectifier fed d.c motor drive –dual converter –d.c series motor drive-numerical examples	8	15
IV	Choppers – analysis of type A,typeB,four quadrant chopper-d.c motor drive	6	15
Second Internal Examination			
V	Magnetics design – transformer modeling – loss mechanism in magnetic devices – eddy currents in winding conductors – types of magnetic devices – BH loops, core and copper losses – inductor design constraints – design procedure – multiple winding magnetics design – transformer design constraints – design	8	20

	procedure – AC inductor design		
VI	Thermal design – control of semiconductor device temperatures - various heat transfer modes, heat sink design. Numerical examples.	6	20
	TOTAL	42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE 6105	**ADVANCED MACHINE DRIVES**	**3 - 0 - 0 : 3**	**2015**

Course Prerequisites

Basic knowledge in Electrical machines and Power electronics at UG level.

Course Objectives

1. To give an idea about the dynamics and control of conventional and modern electrical drives
2. To develop power electronics based control for accurate speed control for various applications

Syllabus

Electric drive systems- Dynamics- Rating and heating of motors- DC drives- Induction motor drives- Synchronous motor drives- Drives for specific applications--Control techniques of electric drives- Transfer function and state variable representation of drive systems – Closed Loop control of drives- Microprocessors based control

Expected Outcomes

Students who complete this course will have an ability to understand the fundamental concepts of electrical drives; have a knowledge on the impact of power electronic converters and microprocessors on speed control of electric drives

Text Books:

1. VedamSubrahmanyam, Electric Drives — Tata McGraw Hill – 2nd Edition
2. G. K. Dubey,,Fundamentals of Electric Drives –Narosa Publications-2nd Edition.

References:

1. Jingde Gao, Linzheng Zhang, Xiangheng Wang, AC Machine Systems –, Springer
2. Rik De Doncker, Duco W J Pulle, Andre Veltman, Advanced Electric Drives — Springer

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Dynamics of a drives**: Elements of electric drives- Dynamics of a drive system –Components of load torques- Steady state stability. **Motor power rating**: Requirements of a drive motor – Power losses, Heating and Cooling of electric motor – Classes of duty and Selection of electric motor	8	15
II	**DC drives**: Phase controlled rectifier fed dc drives- Separately excited motor and Series motors drives- Single phase and three phase drives- Chopper fed drives- Reversible drives-	6	15
First Internal Examination			
III	**Induction motor drives**: Stator Voltage control- Rotor resistance control- Chopper control- Slip energy recovery schemes-V/f control- Cyclo converter fed motors- VSI & CSI fed motors- PWM drives- Field oriented control	8	15
IV	**Synchronous motor drives**: Variable frequency supply- Self control- VSI & CSI fed motors- Permanent magnet synchronous motors – Cyclo converter fed synchronous motor Drive circuits for stepper motor-switched reluctance motor drives	6	15
Second Internal Examination			

V	**Drive Applications:** Drive considerations for textile mills, steel rolling mills, cranes and hoists, cement mills, sugar mills, machine tools, paper mills, coal mines, centrifugal pumps, turbo compressors- ac & dc drives- Traction Drives. Basics of solar powered pump drives and electric vehicles.	8	20
VI	**Control techniques**: Block diagram representation of drive systems – Transfer function and state variable representation of dc drive systems – Closed Loop control of drives- Torque, speed and position control schemes- **Microprocessors based control**: Application areas- Block diagram schemes for control of ac, dc drives and stepper motors – Aspects of microprocessor based control system design.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6117	**POWER QUALITY ISSUES AND REMEDIAL MEASURES**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge of Electrical power systems & power Electronics at UG Level.

Course Objectives

To give the Student:-

- An introduction to various power quality problems in the electrical power systems.
- Analyze the power quality problem and identify the remedial measures.
- Design and development of power electronics based solutions to power quality problems.

Syllabus

Introduction to power quality- power quality measures and standards- Important harmonic introducing devices- Harmonics and measurements-Power quality Improvement-DSTATCOM-DVR-UPQC- Active Power Factor Correction.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the power quality problems in the electrical systems; Apply the basics of electrical engineering to identify the remedial measures to power quality problems; Design and development of power electronics based solutions to power quality problems.

REFERENCES:

1. G T Heydt, Power Quality, Star in a circle publications.
2. Dugan, Electric Power Systems Quality, Tata Mc Graw Hill.
3. K R Padiyar, FACTS controllers in Power Transmission and Distribution, New Age publications, New Delhi, 2007.
4. R SastryVedam, power quality VAR compensation in power systems, CRC press, NewYork, 2009.
5. A Ghosh and G Ledwich, “power quality improvement using custom power devices”, IEEE Press, 2001.
6. NedMohan et al “power Electronics”

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction**-power quality-voltage quality-overview of power quality phenomena classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C message weights-flicker factor-transient phenomena-occurrence of power quality problems power acceptability curves-	8	15
II	**Important harmonic introducing devices**- SMPS-Three phase power converters – arcing devices- saturable devices-fluorescent lamps- effect of power system harmonics on equipment and loads.	6	15
First Internal Examination			

III	Balancing of source currents- Steinmetz network. **Harmonics and measurements**: Power factor reduction due to harmonics-Distortion power-distortion power factor and displacement power factor-Triplen harmonics. Power Quality Analysers-Voltage, Current, Power and Energy measurements	8	15
IV	**Power quality Improvement:-DSTATCOM for** Harmonic Filtering, reactive power compensation and load balancing- d-q domain control and IRPT control of three phase DSTATCOM-Three-phase four-wire systems.	6	15
Second Internal Examination			
V	**Dynamic Voltage Restorers** for sag, swell and flicker problems – structure and control- Series active power filtering techniques for harmonic cancellation and isolation-Uninterruptible power supplies-constant voltage transformers	8	20
VI	**UPQC:** Structure and control-Left shunt UPQC-Right shunt UPQC **Active Power Factor Correction:** Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6203	**SYSTEM THEORY**	**3-0-0:3**	**2015**

Course Prerequisites
Basic knowledge about control systems and controllers.

Course Objectives
The course is designed to give the student:-

- A foundation in the fundamentals of control system and controllers.
- To develop an application of controllres in real time.
- Optimal control design of various systems.

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Syllabus
Fundamental concepts and overview; State variables ;State space analysis of discrete systems; Lyapunov's stability analysis; Krasovski'stheorm; Controllability and observability in canonical form; Optimal control design using Lyapunov's method; Riccattic equations for optimal control ; Analysis and control of Robust control systems.

Expected Outcomes
Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of control system; stability analysis of continuous and discrete systems; Use Lyapunov's method and Riccattic equations to solve optimal control design problems.

References

1. Ogata K., Modern control Engg, (second edition)Prentice Hall Inc.1990
2. Ogata K., Discrete time control systems, P.H.I.
3. Gopal M., Digital Control and state variable methods, TMH,1997
4. Ogata K., Modern control Engg, (second edition)Prentice Hall Inc.2015
5. Richard C. Dorf and Bishop R.T., Modern Control System, P.H.I. publisher

Module	Content	Hours	Semester Exam Marks (%)
I	**State variable representation of system** –concept of state - Equilibrium points -Stability-Solution of state equation -eigen values -eigen vectors -modes -modal decomposition - eigen value and stability	4	15
	State space representation of discrete time systems - Discretization of continuous time state equation.	3	
II	**Lyapunov stability** -definition of stability, asymptotic stability and instability -Lyapunov's second method -Lyapunov's stability analysis of LTI continuous time and discrete time systems	5	15
	Stability Analysis of non linear system -Krasovski's theorem - variable gradient method	3	
First Internal Examination			
III	**Concepts of controllability and observability** -controllability and observability tests for continuous time and discrete time systems.	3	15
	Controllability and observability studies based on canonical forms of state model -effect of state feedback on controllability and observability - pole placement by state feedback for continuous	4	

	and discrete time systems		
IV	**Optimal control -**formulation of optimal control problem - Minimum time control problem - minimum energy problem	3	15
	Minimum fuel problem -state regulator problem - output regulator problem - tracking problem	4	
Second Internal Examination			
V	**Choice of performance measure** -optimal control based on quadratic performance measure	3	20
	Optimal control system design using second method Lyapunov -solution of reduced Riccatti equation.	4	
VI	Design of full order and reduced order observer for continuous time and discrete time systems	2	20
	Robust control systems -introduction -sensitivity analysis of robustness -system with uncertain parameters	2	
	Design of robust PID controlled systems.	2	
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6313	POWER SYSTEM SECURITY	3-0-0:3	2015

Course Prerequisites

Basic Knowledge on power system at UG level

Course Objectives

To give the Student:-

- To understand about power system state estimation.
- To be familiar with the power system security issues and contingency studies.

Syllabus

Power system stability-security-observability and reliability **;** Power system state estimation; Power system security assessment; Basis of evolutionary optimization techniques; Security in Deregulated Environment, Contingency analysis

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of power system security and to adopt contingency analysis and selection methods to improve system security

Text books

1. Wood and Wollenberg, "Power generation, operation and control, John Wiley & Sons, 2000.

2.K.Bhattacharya, M.H.J Bollen and J.E. Daaider, "Operation of restructured power system" Kluwer Power Electronics and Power System series (2001)

3.N.S.Rau,"Optimization Principles: Practical Applications to the operation and Markets of the Electric Power Industry".

4.Sally Hunt, "Making competition work in Electricity", John Wiley, 2002

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Basic concepts: Power system stability-security-observability and reliability, deregulation, factors affecting power system security, decomposition and multilevel approach, state estimation, system monitoring, security assessment, static and dynamic – online and offline, security enhancement.	8	15
II	Power system state estimation: DC and AC network, orthogonal decomposition algorithm, detection identification of bad measurements, network observability and pseudo measurements, application of power system state estimation, introduction to supervisory control and data acquisition.	6	15
First Internal Examination			
III	State space representation concept, Eigen properties of the state vectors, analysis of stability- small signal stability of a single machine	8	15

	connected to infinite bus system, classical representation of generator, small signal stability of a multi machine connected to infinite bus system. Characteristics of small - signal stability problems		
IV	Basis of evolutionary optimization techniques, preventive, emergency and restorative controls though non- linear programming (NLP) and linear programming(LP)methods.	6	15
Second Internal Examination			
V	Security in Deregulated Environment: Need and conditions for deregulation, electricity sector structure model, power wheeling transactions, congestion management methods, available transfer capability (ATC), system security in deregulation.	8	20
VI	Contingency analysis – linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	RESEARCH METHODOLOGY	0 - 2 - 0 : 2	2015

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;

(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;

(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :

(1) Be motivated for research through the attainment of a perspective of research methodology;

(2) Analyze and evaluate research works and to formulate a research problem to pursue research;

(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co

12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction,	4	20

	sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.		

10EE 6309	SEMINAR-I	0-2-0-2	2015
Course Objectives			

The basic objective of this course is to improve the oral communication skill of the students.
Syllabus Individual students are required to choose a technical topic of their interest in consultation with faculty and present for about 30 minutes. They will be guided about sound modulation, sequence of presentation, eye contact and writing on the black board. Students have to submit a report on the topic in the prescribed format. **Internal Continuous Assessment: 50 marks** Internal continuous assessment is for the presentation and the report. The assessment details are to be announced to students' right at the beginning of the semester by the teacher. Presentation – 25 Marks report – 25 Marks Total – 50 Marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction

10EE6311	POWER ELECTRONICS LAB	0 - 0 - 2 – 1	2015

Course Prerequisites

Basic knowledge of Power Electronics at UG Level.

Course Objectives

To design and develop power electronic converters.

Syllabus

- AC-DC Converters
- DC-DC Converters
- DC-AC Converters
- AC-AC converters

Expected Outcomes

The students are expected to design and analysis of power electronic converters.

References

6. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
7. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
8. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
9. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
10. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Course plan

Sl. No.	Experiments
1	Study the performance of a single-phase half wave and full wave AC-DC phase controlled converter. Record AC supply voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor for various loads.
2	Study the performance of a three-phase bridge rectifier.
3	Study the performance of 12-pulse and 24-pulse uncontrolled three-phase bridge rectifiers.
4	Study the performance DC- DC step down Chopper in the open loop and record the DC supply voltage, supply current, load voltage and load current, device voltage and current in Resistive load and DC motor load.
5	Study the performance DC- DC buck converter in CCM and DCM mode.
6	Study the performance DC- DC boost converter in CCM and DCM mode.
7	Study the performance DC- DC buck-boost converter in CCM and DCM mode.
8	Study the performance of a DC-AC single-phase inverter with triangular carrier PWM Control. AC voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, input DC current average value and waveform in DC-AC single-phase inverter.
9	Study the performance of a DC-AC three-phase inverter with 120 degree and 180 degree conduction. AC supply voltage and current waveform, Harmonic spectrum, THD, crest factor, rmsvalue, distortion factor, displacement factor and power factor, input DC current average value and waveform.
10	Study the performance of a DC-AC three-phase inverter with PWM control.
11	Study the performance of single-phase AC voltage controllers with (i) resistive (R), (ii) resistive-inductive (R-L) and (iii) single-phase motor loads at two firing angles. AC supply voltage, load voltage and current waveform, harmonic spectrum, THD, crest

	factor, rms value, distortion factor, displacement factor, active power, reactive power and apparent power and power factor for R and R-L loads
12	Study the performance of step up and step down cycloconverter.
13	Control of dc-dc converters (Buck, Boost and Buck-Boost converter) using discrete ICs like TL494/SG3525/UC3842, Power loss computation, Selection of heatsinks and PCB design.
14	Study of harmonic pollution by power electronics loads using power quality analyser
	(Out of the above, a minimum of SIX hardware experiments and SIX simulation studies are to be conducted. Simulation can be done using any of the software packages like MATLAB/SIMULINK, ORCAD, PSCAD etc.)
End Semester Examination	

Internal Continuous Assessment: 50 marks

i) Practical Records /outputs: 20

ii) Regular Class Viva-Voce: 10

iii) Final Test (Objective): 20

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Electrical & Electronics Engineering

(EEE)

M. Tech.

in

Power Electronics

Scheme of M. Tech Programme in
POWER ELECTRONICS

FIRST SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE6101	Computational Techniques	3	1	0	40	3	60	100	4
B	10EE6203	System Theory	3	0	0	40	3	60	100	3
C	10EE6105	Advanced Machine Drives	3	0	0	40	3	60	100	3
D	10EE6107	Power Converters- I	3	0	0	40	3	60	100	3
E	10EE6xxx	Elective-I	3	0	0	40	3	60	100	3
F	10GN6001	Research Methodology	0	2	0	100	-	0	100	2
G	10EE6209	Seminar-I	0	2	0	100	-	0	100	2
H	10EE6211	Power Electronics Lab	0	0	2	100	-	0	100	1
	TOTAL		15	3	4	500		300	800	21

L-Lecture T-Tutorial P-Practical

ICA-Internal Continuous Assessment

ESE-End Semester Examination

ELECTIVE I

10EE6213 Electric Systems in Wind Energy

10EE6215 Distribution Systems Management and Automation

10EE6217 Process Control and Automation

10EE6113 Special Machines

10EE6117 Power Quality Issues and Remedial Measures

Note: 8 hours/week is meant for departmental assistance by students.

SECOND SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10EE6102	Power Converters- II	3	1	0	40	3	60	100	4
B	10EE6204	Switched Mode Power Converters	3	0	0	40	3	60	100	3
C	10EE6106	Machine Analysis and Control	3	0	0	40	3	60	100	3
D	10EE6xxx	Elective-II	3	0	0	40	3	60	100	3
E	10EE6xxx	Elective-III	3	0	0	40	3	60	100	3
	10EE6208	Mini Project	0	0	4	100	-	0	100	2
H	10EE6212	Control and Drives Lab	0	0	2	100	-	0	100	1
	TOTAL		15	1	6	400		300	700	19

L-Lecture T-Tutorial P-Practical
ICA-Internal Continuous Assessment
ESE- End Semester Examination

ELECTIVES

10EE6214 Data Acquisition and Signal Control

10EE6216 Power System Restructuring and Pricing

10EE6114 Industrial Control Electronics

10EE6116 Power Conversion in Renewable Energy Systems

10EE6118 Power Semiconductor Devices

10EE6122 Microcontroller Applications in Power Electronics

10EE6124 High voltage DC and AC Transmission

10EE6126 Energy Management

10EE6132 Distributed Generation and Micro- Grid

10ME6116 Design and Analysis of Experiments

Note: 8 hours/week is meant for departmental assistance by students.

THIRD SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
A	10E7xxx	Elective-IV	3	0	0	40	3	60	100	3
B	10E7xxx	Elective-V	3	0	0	40	3	60	100	3
H	10EE7201	Seminar-II	0	2	0	100	-	0	100	2
	10EE7203	Project-Phase I	0	0	14	50	-	0	50	6
	TOTAL		**6**	**2**	**14**	**230**		**100**	**350**	**14**

L-Lecture T-Tutorial P-Practical

ICA-Internal Continuous Assessment

ESE- End Semester Examination

ELECTIVES

10EE7205 Smart Grid Technologies

10EE7209 Energy Storage Systems

10EE7105 FACTS Controllers

10EE7107 Electric Vehicles

10EE7109 Induction Generators

10EE7111 Custom Power Devices

10EC7207 Micro Electro Mechanical Systems

10EC6105 Advanced Digital Signal Processing

10EC6205 Advanced Embedded Processors

10EC7507 Soft computing technique

Note: 8hours/week is meant for departmental assistance by students.

FOURTH SEMESTER

Slot	Code	Subject	Hours/Week			ICA	ESE		Total	Credit
			L	T	P		Hrs	Marks		
	10EE7204	Project –Phase II	-	-	22	70	-	30	100	12
	TOTAL		-	-	22	70		30	100	12

L-Lecture T-Tutorial P-Practical
ICA-Internal Continuous Assessment
ESE-End Semester Examination

Note: 8 hours/week is meant for departmental assistance by students.

Industrial Training (During inter semester holidays of 2nd& 3rd Semesters)

[Total Credits: 66]

SEMESTER 1

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6101	COMPUTATIONAL TECHNIQUES	3-1-0:4	2015

Course Prerequisites

Basic knowledge of engineering mathematics at UG level.

Course Objectives

To equip the student with mathematical techniques necessary for computing applications in engineering systems

Syllabus

Introduction to numerical techniques. Numerical/analytical solution of ordinary differential equations and partial differential equations. Stability of the numerical methods. Iterative solutions. Matrix equations. Ill conditioning and norms. Linear and unconstrained optimization. Simplex methods. Spectral methods.

Expected Outcomes

The students are expected to obtain solutions to various problems numerically.

Reference:

1. Erwin Kreyszig, Advanced Engineering Mathematics 9th Edition, Wiley International Edition Press, Numerical Recipes for scientific computing,
2. Bhaskar Dasgupta, Applied Mathematical Methods, Pearson,
3. Arfken, Weber and Harris, Mathematical Methods for Physicists, A comprehensive guide, 7th Edition, Elsevier, 2013

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Solution of equations by iterations – Newton's method – secant method – interpolation – Lagrange interpolation – Newton's divided difference, forward difference, backward difference equations – spline interpolation – numeric integration and differentiation	10	15
II	Gaussian elimination – LU factorization – Matrix inversion – Gauss-Siedel iteration – Ill conditioning and norms – least squares method – eigen value problems – power method for eigen values – Tridiagonalization and QR factorization	10	15
First Internal Examination			
III	Analytical and numerical solutions of ordinary differential equations representing physical systems – mass, spring, damper systems - RLC circuits – simple pendulum – inverted pendulum – Euler's forward difference, backward difference and symmetric methods – stability of Euler's methods – Runge Kutta methods – stability of Runge Kutta methods	8	15
IV	Elliptic PDE's: difference equations for Laplace and Poisson Equations – Dirichlet, Neumann and Mixed problems – relaxation methods	8	15

	Parabolic PDE's: Heat equation – analytical and numerical solutions – Crank Nicholson method Hyperbolic PDE's: Wave equation – analytical and numerical solutions – Lax Wendroff method		
Second Internal Examination			
V	Unconstrained Optimization – single variable optimization – iterative methods – multivariate optimization – direct methods – steepest descent method – Newton's method – Linear programming problem – simplex method	10	20
VI	Introduction to numerical spectral methods - Matlab/Scilab Laboratory sessions: Numerical integration and differentiation. Euler's method and Runge Kutta methods for systems of linear and nonlinear differential equations. Solution of heat and wave equations for different initial and boundary conditions. Simple optimization problems.	10	20
		56	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6203	**SYSTEM THEORY**	**3 - 0- 0 : 3**	**2015**

Course Prerequisites

Basic knowledge about control systems and controllers.

Course Objectives

To give the Student:-

- A foundation in the fundamentals of control system and controllers.
- To develop an application of controlles in real time.
- Optimal control design of various systems.

Syllabus

Fundamental concepts and overview; State variables ;State space analysis of discrete systems; Lyapunov's stability analysis; Krasovski's theorm; Controllability and observability in canonical form; Optimal control design using Lyapunov's method; Riccattic equations for optimal control ; Analysis and control of Robust control systems.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of control system; stability analysis of continuous and discrete systems; Use Lyapunov's method and Riccattic equations to solve optimal control design problems.

Text Books:

1. Ogata K., Modern control Engg, (second edition)Prentice Hall Inc.1990
2. Ogata K., Discrete time control systems, P.H.I.
3. Gopal M., Digital Control and state variable methods, TMH,1997

References:

4. *Ogata K., Modern control Engg, (second edition)Prentice Hall Inc.2015*
5. *Richard C. Dorf and Bishop R.T., Modern Control System, P.H.I. publisher*

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	State variable representation of system –concept of state - Equilibrium points -Stability-Solution of state equation - eigen values -eigen vectors -modes -modal decomposition -eigen value and stability- State space representation of discrete time systems -Discretization of continuous time state equation.	8	15
II	Lyapunov stability -definition of stability, asymptotic stability and instability -Lyapunov's second method - Lyapunov's stability analysis of LTI continuous time and discrete time systems-stability analysis of non linear system -Krasovski's theorem -variable gradient method.	6	15
First Internal Examination			
III	Concepts of controllability and observability - controllability and observability tests for continuous time and discrete time systems -controllability and observability studies based on canonical forms of state model -effect of state feedback on controllability and observability - pole placement by state feedback for continuous and discrete	8	15

	time systems .		
IV	Optimal control -formulation of optimal control problem -Minimum time control problem - minimum energy problem -minimum fuel problem -state regulator problem -output regulator problem - tracking problem.	6	15
Second Internal Examination			
V	Choice of performance measure -optimal control based on quadratic performance measure -optimal control system design using second method Lyapunov -solution of reduced Riccatti equation.	8	20
VI	Design of full order and reduced order observer for continuous time and discrete time systems Robust control systems -introduction -sensitivity analysis of robustness -system with uncertain parameters -design of robust PID controlled systems.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE 6105	ADVANCED MACHINE DRIVES	3 - 0 - 0 : 3	2015

Course Prerequisites

Basic knowledge in Electrical machines and Power electronics at UG level.

Course Objectives

1. To give an idea about the dynamics and control of conventional and modern electrical drives
2. To develop power electronics based control for accurate speed control for various applications

Syllabus

Electric drive systems- Dynamics- Rating and heating of motors- DC drives- Induction motor drives- Synchronous motor drives- Drives for specific applications--Control techniques of electric drives- Transfer function and state variable representation of drive systems – Closed Loop control of drives- Microprocessors based control

Expected Outcomes

Students who complete this course will have an ability to understand the fundamental concepts of electrical drives; have a knowledge on the impact of power electronic converters and microprocessors on speed control of electric drives

Text Books:

1. Vedam Subrahmanyam, Electric Drives — Tata McGraw Hill – 2^{nd} Edition
2. G. K. Dubey,,Fundamentals of Electric Drives –Narosa Publications-2^{nd} Edition.

References:

1. Jingde Gao, Linzheng Zhang, Xiangheng Wang, AC Machine Systems –, Springer
2. Rik De Doncker, Duco W J Pulle, Andre Veltman, Advanced Electric Drives — Springer

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Dynamics of a drives**: Elements of electric drives- Dynamics of a drive system –Components of load torques- Steady state stability. **Motor power rating**: Requirements of a drive motor – Power losses, Heating and Cooling of electric motor – Classes of duty and Selection of electric motor	8	15
II	**DC drives**: Phase controlled rectifier fed dc drives- Separately excited motor and Series motors drives- Single phase and three phase drives- Chopper fed drives- Reversible drives-	6	15
First Internal Examination			
III	**Induction motor drives**: Stator Voltage control- Rotor resistance control- Chopper control- Slip energy recovery schemes-V/f control- Cyclo converter fed motors- VSI & CSI fed motors- PWM drives- Field oriented control	8	15
IV	**Synchronous motor drives**: Variable frequency supply- Self control- VSI & CSI fed motors- Permanent magnet synchronous motors – Cyclo converter fed synchronous motor Drive circuits for stepper motor-switched reluctance motor drives	6	15
Second Internal Examination			

V	**Drive Applications:** Drive considerations for textile mills, steel rolling mills, cranes and hoists, cement mills, sugar mills, machine tools, paper mills, coal mines, centrifugal pumps, turbo compressors- ac & dc drives- Traction Drives. Basics of solar powered pump drives and electric vehicles.	8	20
VI	**Control techniques**: Block diagram representation of drive systems – Transfer function and state variable representation of dc drive systems – Closed Loop control of drives- Torque, speed and position control schemes- **Microprocessors based control**: Application areas- Block diagram schemes for control of ac, dc drives and stepper motors – Aspects of microprocessor based control system design.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6107	**POWER CONVERTERS I**	**3-0-0:3**	**2015**

Course Prerequisites
Basic knowledge of Power Electronic circuits and devices at UG Level.

Course Objectives
To develop solid foundation in analyzing DC-DC and AC-DC converters

Syllabus
Line frequency single phase and three phase AC-DC fully controlled rectifiers, Multi pulse AC-DC converters, DC-DC converters, Resonant converters and switching power supplies.

Expected Outcomes
The students are expected to apply the general principles of AC-DC and DC-DC converters for various industrial applications such as motor speed controllers and rectifiers.

Text books

1. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
3. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
5. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Current harmonics in rectifiers – harmonic standards – Single phase and three phase fully controlled rectifiers - power factor, Total harmonic distortion, displacement power factor- Effect of source inductance on current commutation.	8	15
II	Resonant DC-DC converters – load resonant converters – resonant switch converters – zero voltage switching, clamped voltage topologies – resonant dc link inverters with zero voltage switching – high frequency link integral half cycle converters	6	15
First Internal Examination			
III	DC- DC converters (CCM&DCM operation) : Buck converter- Boost converter- Buck boost Converter- Cuk converter – LUO converter – SEPIC converter	8	15
IV	Switching DC Power Supplies – Forward, flyback, pushpull, half bridge and full bridge converter circuit, operation, waveforms and design, small signal analysis of DC-DC converters and closed loop control – transfer function of dc-dc converters – stability analysis	6	15
Second Internal Examination			
V	PFC converters: Multiple converter – Boost PFC rectifiers-	8	20

	Vienna rectifiers – Third harmonic injection techniques – Minnesota rectifiers – Modeling and simulation of all rectifiers.		
VI	Applications: Residential and industrial applications of power electronics – induction heating, welding, electronic ballast – utility applications - back to back HVDC transmission, UPS, static var compensators and active filters.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

ELECTIVE-I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6213	**ELECTRIC SYSTEMS IN WIND ENERGY**	**3-0-0:3**	**2015**

Course Prerequisites

Basics of Electrical Machines and Power Electronics.

Course Objectives

The course is designed to give the student:-

- An introduction of the various electrical generators and appropriate power electronic controllers employed in wind energy systems.
- An understanding of SEIC and GCIGs.
- Knowledge about the analysis of DFIG and PMSGs.

Syllabus

Introduction to the operation and characteristics of GCIGs; analysis of SEIG; power electronic controllers used in standalone systems; typical configurations for the single-phase operation of three-phase GCIGs and SEIGs; performance analysis of DFIG for standalone applications; operation of DFIGs with different power electronic configurations for standalone and grid connected operation; operation, analysis of and characteristics of PMSGs.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of the operation and analysis of SEIG, DFIG, GCIG and PMSG; familiarised with the operation of PMSGs and DFIGs with different power electronic configurations for standalone and grid-connected operation.

References

1. Marcelo Godoy Simões and Felix A. Farret, 'Renewable Energy Systems: Design and Analysis with Induction Generators', CRC Press, ISBN 0849320313, 2004.
2. Siegfried Heier, Rachel Waddington, 'Grid Integration of Wind Energy Conversion Systems, 2nd Edition', Wiley, June 2006, ISBN: 978-0-470-86899-7.
3. Freries LL , 'Wind Energy Conversion Systems', Prentice Hall, U.K., 1990.
4. Ion Boldea, 'Variable speed Generators', CRC Press, ISBN 0849357152, 2006.
5. S.N. Bhadra, D.Kastha and S.Banerje, 'Wind Electrical Systems', Oxford University Press, 2005.

Module	Content	Hours	Semester Exam Marks (%)
I	Principle of operation – Wind turbine characteristics.	2	15
	Types of Grid connected systems.	4	
II	Steady-state analysis-characteristics of GCIGs.	4	15
	Operation of GCIGs with different power electronic configurations	3	
First Internal Examination			
III	Process of self-excitation – steady-state equivalent circuit of SEIG and its analysis - performance equations - widening the operating	4	15

	speed-range of SEIGs by changing the stator winding connection with suitable solid state switching schemes.		
	Power electronic controllers used in standalone systems.	4	
IV	Need for single-phase operation –typical configurations for the single-phase operation of three-phase GCIGs and SEIGs.	4	15
	Steady state equivalent circuit and analysis using symmetrical components	4	
Second Internal Examination			
V	Different operating modes- steady-state equivalent circuit-performance analysis- DFIG for standalone applications.	3	20
	Operation of DFIGs with different power electronic configurations for standalone and grid-connected operation.	4	
VI	Operation of PMSGs- steady-state analysis- performance characteristics.	3	20
	Operation of PMSGs with different power electronic configurations for standalone and grid-connected operation.	3	
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6215	DISTRIBUTION SYSTEMS MANAGEMENT AND AUTOMATION	3-0-0:3	2015

Course Prerequisites

Basic Knowledge on Power System.

Course Objectives

The course is designed to give the student:-

- To develop deep understanding of various aspects of power distribution and control.
- An introduction to power quality and custom power devices
- Study of DA communication protocols and deregulated systems.

Syllabus

Fundamental concepts of distribution management system functions; integration of distributed generation and custom power components; electrical system design and safety measures; study of DA communication protocols; wired and wireless communication; concept and application of power quality and custom power devices; deregulated systems.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of power distribution; Apply the concepts of power quality and power devices; develop an idea about electrical system design and safety measures; concepts of deregulated systems.

References

1.James, J.O. Brien "Construction inspection handbook – Quality assurance and quality control" – Van Nostrand, New York, 1989

2.Kwaku A., and Jose M. Guevera. " Fundamental of Construction Management and Organization", Prentice Hall of India. 1995

3. Juran Frank, J.M. and Gryna, F.M. " quality planning and analysis "., tata McGraw Hill, 1982.

4. Steven McCabe, "Quality Improvement Techniques in Construction", Addition Wesley Longman Ltd., England,2006.

Module	Content	Hours	Semester Exam Marks (%)
I	**Distribution Automation System** : Necessity, System Control Hierarchy- Basic Architecture and implementation	4	15
	Strategies for DA- Basic Distribution Management System Functions- Outage management	3	
II	Integration of Distributed Generation and Custom Power components in distribution systems	4	15
	Distribution system Performance and reliability calculations	3	
First Internal Examination			
III	**Electrical System Design:** Distribution System Design-Electrical Design Aspects of Industrial	3	15
	Commercials Buildings- Electrical Safety and Earthing Practices at	3	

	various voltage levels		
IV	IS Codes Communication Systems for Control and Automation-Wireless and wired Communications	4	15
	DA Communication Protocols, Architectures and user interface-Case Studies.	4	
Second Internal Examination			
V	Power Quality and Custom Power: Concept	3	20
	Custom Power Devices - Operation and Applications	4	
VI	**Deregulated Systems:** Reconfiguring Power systems	3	20
	Unbundling of Electric Utilities Competition and Direct access	4	
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6217	**PROCESS CONTROL AND AUTOMATION**	**3-0-0:3**	**2015**

Course Prerequisites

Basic knowledge about Control systems and controllers.

Course Objectives

The course is designed to give the student:-

- An understanding of automation in industrial applications.
- An introduction to fuzzy logic in process control.
- An idea about different types of control.

Syllabus

An introduction to process control and instrumentation; transfer function, state space models and time series model; Development of empirical models from process data; feedback and feedforward control; LQR problem; Pole placement; simulation using softwares; advanced process control; decoupling controls; real time optimization; model predicitive control; plant wide control and monitoring; introduction to fuzzy logic in process control; introduction to OPC; comparision of performance of different types of control.

Expected Outcomes

Students who successfully complete this course have demonstrated an ability to understand the fundamental concepts of process control and instrumentation; to do simulation using softwares; get familiarized with different types of control.

References

1. Sebrog D.E, T.F. Edgar and D.F. Mellichamp, Process Dynamics and control, John Wiley,2004
2. Johnson D Curtis, Instrumentation Technology (7th edition),Prentice Hall India, 2002
3. Bob Connel, Process instrumentation applications manual, McGrawHill,1996
4. K. Krishnaswamy, Process control, New Age International, 2007
5. B. Wayne Bequette, Process control: modelling design and simulation Prentice Hall PTR, 2006

Module	Content	Hours	Semester Exam Marks (%)
I	**Process Modeling**- Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models.	3	15
	Development of empirical models from process data-chemical reactor modeling.	3	
II	Feedback & Feedforward Control- Feedback controllers-PID design, tuning, trouble shooting-Cascade control- Selective control loops-Ratio control	4	15
	Control system design based on Frequency response Analysis-Direct digital design-Feedforward and ratio control-State feedback control- LQR problem- Pole placement.	4	

First Internal Examination			
III	Simulation using softwares-Control system instrumentation.	3	15
	Control valves- Codes and standards- Preparation of P& I Diagrams.	4	
IV	**Advanced process control**-Multi-loop and multivariable control-Process Interactions-Singular value analysis-tuning of multi loop	3	15
	PID control systems-decoupling control-strategies for reducing control loop interactions-Real-time optimization	4	
Second Internal Examination			
V	Model predictive control-Batch Process control-Plant-wide control & monitoring- Plant wide control design.	3	20
	Instrumentation for process monitoring-Statistical process control-Introduction to Fuzzy Logic in Process Control.	4	
VI	Introduction to OPC-Introduction to environmental issues and sustainable development relating to process industries.	4	20
	Comparison of performance with different types of control.	3	
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6113	**SPECIAL MACHINES**	**3-0-0:3**	**2015**

Course Prerequisites

Basic knowledge of Electrical Machines at UG Level.

Course Objectives

To impart knowledge about special machines

Syllabus

Stepper motor, Servomotor, Synchronous Reluctance motor, Switched reluctance motor, Permanent magnet BLDC motor & PMAC Motor, Linear Induction motor.

Expected Outcomes

The students are expected to apply the general principles of special machines for various industrial applications and house hold applications.

Text books

1. T.J.E. Miller, Brushless Permanent-Magnet and Reluctance Motor Drives, Clarendon Press.
2. R.Krishnan, Switched Reluctance Motor Drives-Modelling, Simulation, Analysis, Design and application, CRC press New York,2001
3. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.T.J.E. Miller, Switched Reluctance Motors And Their Control , Magna physics Publishing, Oxford.
4. T.J.E. Miller, Electronic Control of Switched Reluctance Machines, Newnes Power Engineering Series.
5. Vincent Del Toro, Electric Machines and Power Systems, Prentice Hall
6. M D Desai, Control system components, PHI
7. K Venkataratnam, Special Electrical Machines, Universities press(India) Pvt. Ltd. Hyderabad
8. R Krishnan, Electric Motor Drives, Modeling, Analysis, and control, PHI
9. Nasar S.A., Boldea I., Linear Motion Electric Machine, John Wiley & Sons.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Stepper motor:** Constructional features - Principle of operation-permanent magnet stepper motor - variable reluctance motor - hybrid motor-single and multi stack configurations - Torque equations - modes of excitations - drive circuits-microprocessor control of stepping motors - closed loop control – applications.	8	15
II	**Servomotor:** DC servomotors- construction - principle of operation-transfer function - armature control and field control - AC servomotor-construction - theory of operation - shaded pole ac servomotors –applications.	6	15
First Internal Examination			
III	**Synchronous Reluctance motor**: Constructional features - Types - Principle of operation - Axial and radial flux motors - operating principles - variable reluctance motor - hybrid motor - voltage and torque equations – characteristics – applications.	8	15
IV	**Switched reluctance motor**: Constructional features - principle of	6	15

	operation - torque production - steady state performance prediction-Analytical method - Power converters and their controllers - Methods of rotor position sensing - Closed loop control of SRM – Characteristics – applications.		
Second Internal Examination			
V	**Permanent magnet motor:** Permanent magnet brushless DC motors - Permanent magnetic materials - Magnetic characteristics - Principle of operation -Types-Magnetic circuit analysis - Torque equations - Power controllers - Motor characteristics and control, Permanent magnet synchronous motors-Principle of operation-- Torque equations-characteristics and control.	8	20
VI	**Linear Induction motor** Linear induction motor- Double sided linear induction motor from rotary type Induction motor – Scheme of LIM drive for electric traction – development of single sided LIM – Equivalent circuit- applications.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6117	**POWER QUALITY ISSUES AND REMEDIAL MEASURES**	**3-0-0:3**	**2015**

Course Prerequisites

Basic knowledge of Electrical power systems & power Electronics at UG Level.

Course Objectives

To give the Student:-

- An introduction to various power quality problems in the electrical power systems.
- Analyse the power quality problem and identify the remedial measures.
- Design and development of power electronics based solutions to power quality problems.

Syllabus

Introduction to power quality- power quality measures and standards- Important harmonic introducing devices- Harmonics and measurements-Power quality Improvement-DSTATCOM-DVR-UPQC- Active Power Factor Correction.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the power quality problems in the electrical systems ; Apply the basics of electrical engineering to identify the remedial measures to power quality problems; Design and development of power electronics based solutions to power quality problems.

REFERENCES:

1. G T Heydt, Power Quality, Star in a circle publications.
2. Dugan, Electric Power Systems Quality, Tata Mc Graw Hill.
3. K R Padiyar, FACTS controllers in Power Transmission and Distribution, New Age publications, New Delhi, 2007.
4. R Sastry Vedam, power quality VAR compensation in power systems, CRC press, NewYork, 2009.
5. A Ghosh and G Ledwich, “power quality improvement using custom power devices”, IEEE Press, 2001.
6. NedMohan et al “power Electronics”

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction**-power quality-voltage quality-overview of power quality phenomena classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C message weights-flicker factor-transient phenomena-occurrence of power quality problems power acceptability curves-	8	15
II	**Important harmonic introducing devices**- SMPS-Three phase power converters – arcing devices- saturable devices- fluorescent lamps- effect of power system harmonics on equipment and loads.	6	15
First Internal Examination			

III	Balancing of source currents- Steinmetz network. **Harmonics and measurements**: Power factor reduction due to harmonics-Distortion power-distortion power factor and displacement power factor- Triplen harmonics. Power Quality Analysers-Voltage, Current, Power and Energy measurements	8	15
IV	**Power quality Improvement:-DSTATCOM for** Harmonic Filtering, reactive power compensation and load balancing- d-q domain control and IRPT control of three phase DSTATCOM-Three-phase four-wire systems.	6	15
Second Internal Examination			
V	**Dynamic Voltage Restorers** for sag, swell and flicker problems – structure and control- Series active power filtering techniques for harmonic cancellation and isolation-Uninterruptible power supplies-constant voltage transformers	8	20
VI	**UPQC:** Structure and control-Left shunt UPQC-Right shunt UPQC **Active Power Factor Correction:** Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques.	6	20
		42	100
Cluster Level End Semester Examination			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co

12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction,	4	20

	sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE 6209	**SEMINAR-I**	**0-2-0:2**	**2015**

Course Objectives

The basic objective of this course is to improve the oral communication skill of the students.

Syllabus

Individual students are required to choose a topic of their interest in consultation with faculty and present for about 30 minutes. They will be guided about sound modulation, sequence of presentation, eye contact and writing on the black board.

Students have to submit a report on the topic in the prescribed format.

Internal Continuous Assessment: 50 marks

Internal continuous assessment is for the presentation and the report. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

Presentation	– 25 Marks
Report	– 25 Marks
Total	– 50 Marks

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6211	**POWER ELECTRONICS LAB**	**0-0-2-2**	**2015**

Course Prerequisites

Basic knowledge of Power Electronics at UG Level.

Course Objectives

To design and develop power electronic converters.

Syllabus

- AC-DC Converters
- DC-DC Converters
- DC-AC Converters
- AC-AC converters

Expected Outcomes

The students are expected to design and analysis of power electronic converters.

References

1. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
3. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
5. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Course plan

Sl. No.	Experiments
1	Study the performance of a single-phase half wave and full wave AC-DC phase controlled converter. Record AC supply voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor for various loads.
2	Study the performance of a three-phase bridge rectifier.
3	Study the performance of 12-pulse and 24-pulse uncontrolled three-phase bridge rectifiers.
4	Study the performance DC- DC step down Chopper in the open loop and record the DC supply voltage, supply current, load voltage and load current, device voltage and current in Resistive load and DC motor load.
5	Study the performance DC- DC buck converter in CCM and DCM mode.
6	Study the performance DC- DC boost converter in CCM and DCM mode.
7	Study the performance DC- DC buck-boost converter in CCM and DCM mode.
8	Study the performance of a DC-AC single-phase inverter with triangular carrier PWM Control. AC voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, input DC current average value and waveform in DC-AC single-phase inverter.
9	Study the performance of a DC-AC three-phase inverter with 120 degree and 180 degree conduction. AC supply voltage and current waveform, Harmonic spectrum, THD, crest factor, rmsvalue, distortion factor, displacement factor and power factor, input DC current average value and waveform.
10	Study the performance of a DC-AC three-phase inverter with PWM control.
11	Study the performance of single-phase AC voltage controllers with (i) resistive (R),

	(ii) resistive-inductive (R-L) and (iii) single-phase motor loads at two firing angles. AC supply voltage, load voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor, active power, reactive power and apparent power and power factor for R and R-L loads
12	Study the performance of step up and step down cycloconverter.
13	Control of dc-dc converters (Buck, Boost and Buck-Boost converter) using discrete ICs like TL494/SG3525/UC3842, Power loss computation, Selection of heatsinks and PCB design.
14	Study of harmonic pollution by power electronics loads using power quality analyser
	(Out of the above, a minimum of SIX hardware experiments and SIX simulation studies are to be conducted. Simulation can be done using any of the software packages like MATLAB/SIMULINK, ORCAD, PSCAD etc.)
End Semester Examination	

Internal Continuous Assessment: 50 marks

i) Practical Records /outputs: 20

ii) Regular Class Viva-Voce: 10

iii) Final Test (Objective): 20

KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*10*
Branch	**:**	*Mechanical Engineering*
Stream	**:**	**Advanced Manufacturing and Mechanical Systems Design**
Year	**:**	*2015*
No. of Credits	**:**	*66*

FIRST SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME6101	Computational Methods	3	1	-	40	3	60	100	4
10ME6103	Principles of Machining and Manufacturing Systems	3	-	-	40	3	60	100	3
10ME6105	Discrete Event System Simulation	3	-	-	40	3	60	100	3
10ME6107	Production Automation and Trends in Manufacturing	3	-	-	40	3	60	100	3
10ME61XX	Elective-I	3	-	-	40	3	60	100	3
10GN6001	Research Methodology	0	2	-	100	-	0	100	2
10ME6109	Seminar	-	-	2	100	-	0	100	2
10ME6111	Engineering Software Lab	-	-	2	100	-	0	100	1
		15	**3**	**4**	**500**		**300**	**800**	**21**

ELECTIVE-I

10ME6113 Vibration Analysis and Control

10ME6115 Fracture Mechanics and Fatigue

10ME6117 Mechanics of Composites

10ME6119 Advanced Mechanics of Solids

SECOND SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME6202	Modeling and Analysis of Manufacturing Systems	3	-	-	40	3	60	100	4
10ME6104	Intelligent Manufacturing	3	-	-	40	3	60	100	3
10ME6106	Micro and Nano Machining	3	-	-	40	3	60	100	3
10ME61XX	Elective-II	3	-	-	40	3	60	100	3
10ME61XX	Elective-III	3	-	-	40	3	60	100	3
10ME6108	Mini Project	-	-	4	100	-	0	100	2
10ME6112	Advanced Manufacturing Lab	-	-	2	100	-	0	100	1
TOTAL		**15**	**-**	**6**	**400**		**300**	**700**	**19**

ELECTIVE II

10ME6114 Soft Computing Techniques
10ME6116 Design of Experiments
10ME6118 Management Information System

10ME6122 Quality and Reliability Engineering
10ME6124 Project Engineering and Management
10ME6126 Industrial Automation and Robotics
10ME6128 Mechatronics
10ME6132 Finite Element Methods and Applications
10ME6134 Metrology and Computer Aided Inspection

THIRD SEMESTER

ELECTIVE-IV

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME71XX	Elective-IV	3	-	-	40	3	60	100	3
10ME71XX	Elective-V	3	-	-	40	3	60	100	3
10ME7101	Seminar 2	-	-	2	100	-	0	100	2
10ME7103	Project - Phase 1	-	-	8	50	-	0	50	6
TOTAL		**6**	**-**	**10**	**230**		**120**	**350**	**14**

10ME7105 Industrial Tribology
10ME7107 Energy Management
10ME7209 Sensors and Controls in Manufacturing
10ME7211 Process Planning and Cost Estimation
10ME7113 Concurrent Engineering and Product Life Cycle Management
10ME7215 Expert System and Artificial Intelligence in Manufacturing
10ME7117 Machine Tool Design
10ME7119 Material Selection in Mechanical Design

FOURTH SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME7104	Project - Phase 2	-	-	22	70		30	100	12
TOTAL		**-**	**-**	**22**	**70**		**30**	**12**	**12**

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6101	COMPUTATIONAL METHODS	3-1-0-4	2015

Prerequisite:
Basic knowledge in mathematical methods at UG level

Objective:
1. To be capable of developing a thorough knowledge in computational techniques to aid in the modeling and analysis of manufacturing processes, systems.
2. To lay a sound computational foundation for further independent research in manufacturing engineering

Syllabus:
First order differential equations, Second order differential equations, Non homogenous differential equations, Laplace transforms, Systems of differential equations, Series solutions, Higher order differential equations, Boundary value problems and fourier series, Partial differential equations, Probability, distributions, Moments, Estimation Theory, Correlation, Regression, optimization, Unconstrained optimization Nonlinear programming.

Reference Books:

1.Erwin Kreyzig Advanced Engineering Mathematics, John Wiley 2006.
2. Shepley L Ross,Differential Equations, JohnWiley&Sons, Third Edition, 2004.
3. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi 2001
4. Kalyanmoy Deb,.Optimisation for Engineering Design-Algorithms and Examples., Prentice Hall India- 1998
5. S.S.Rao, .Engineering Optimization., 3rd Ed.,New Age International (P) Ltd,New Delhi, 2007

COURSE PLAN

Module	Contents	Contact hours	Sem.Exam Marks;%
I	First order differential equations, modeling with first order equations, equilibrium solutions, euler's method, Second order differential equations, fundamental sets of solutions, wronskian method, Non homogenous differential equations, mechanical vibrations, Laplace transforms, inverse laplace transforms, step function, solving IVP's with laplace transforms, dirac delta function, convolution integral.	6	15
II	Systems of differential equations, solutions to systems, phase plane, solution involving real, complex, repeated eigen values and laplace transforms, solving non homogenous differential equations, Modeling using systems of differential equations,	8	15

	Series solutions, series solution about an ordinary point, solutions to euler differential equations.		
	FIRST INTERNAL TEST		
III	Higher order differential equations, linear homogenous differential equations, solution using undetermined coefficients, variation of parameters and laplace transforms, systems of differential equations, series solution, Boundary value problems and fourier series, eigen values and eigen functions in BVP, periodic functions and orthogonal functions, fourier sine, cosine and full series, convergence of fourier series, Partial differential equations, heat equation, wave equation, solution of heat equation with non zero temperature boundaries, laplace equation, vibrating string.	10	15
IV	Probability, Random variables, Binomial, Poisson, Geometric, Uniform, Normal, Exponential distributions, Moments, Moments generating functions and their properties, Functions of Random variables. Estimation Theory, Correlation, Regression, Partial and Multiple correlations, Partial and Multiple regression, Estimation of parameters using maximum likelihood estimator and method of moments.	6	15
	SECOND INTERNAL TEST		
V	Concepts of optimization: Engineering applications-Statement of optimization problem-Classification - type and size of the problem. Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity - formulation of LP problems - simplex method and algorithm -Matrix form- two phase method. Duality- dual simplex method- LU Decomposition. Sensitivity analysis .Artificial variables	6	20
VI	Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear programming - gradient and Hessian. Unconstrained optimization: First & Second order necessary conditions-Minimisation & Maximisation Local & Global convergence-Speed of convergence. Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method-Lagrange multiplier method - Kuhn-tucker conditions . Quasi-Newton method- separable convex programming - Frank and Wolfe method.	12	20

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6103	PRINCIPLES OF MACHINING AND MANUFACTURING SYSTEMS	2 - 1 - 0 - 3	2015

Course Prerequisites

Basic Understanding of Manufacturing Processes at UG level

Course Objectives

To get the competencies to work well in international factory environments and to be effective written and oral communicators, for communicating ideas to Industrial people and promote them in world class level.

The ability to recognize the importance of, FMS and engage in life-long learning through study

Syllabus

Principles of Machining- Tool Geometry and Reference Systems-Mechanism of Chip Formation by Single Point Tools-Types and Characteristics of Chips-Cutting Force Measurements-Cutting Tools – Failures-Wear-Tool Life- Economics of Machining-Performance Evaluation of Manufacturing Systems-Virtual Organizations

REFERENCES:

1.HMT ,Production Technology , Tata Mc Graw Hill
2. Ghosh & Mallik ,Manufacturing Science , affiliated –West Press
3. Sharma P C , A Text book of Production Engineering
4. Askin R G and Gold berg J B "Design and Analysis of Production systems " , John Wieley and sons Inc .. 2003
5. ASTME ,Fundamentals of Tool Design , Prentice Hall of India
6. Bhattacharya A Metal cutting : Theory and Practice , Central Book Publishers

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Machining, definition and objectives. Geometry of cutting tools; turning, milling and drilling - indifferent reference systems like machine reference system, tool reference system and work reference system. Sharpening and resharpening of cutting tools.	8	15
II	Mechanism of chip formation by single point tools, drills and milling cutters. Types of chips and their characteristics. Effective rake. Mechanics of machining, theoretical estimation and experimental determination of cutting forces and power consumption.	8	15

First Internal Examination			
III	Cutting tools; methods of failure, mechanics of tool wear, essential properties, assessment of tool life cutting tool materials and cutting fluids.	8	15
IV	Flexible Manufacturing Systems (FMS), architecture of FMS,Evaluation of performance measures of FMS, Bottleneck Model, FMS Operation parameters, Extended Bottleneck Model, Sizing of FMS,performance evaluation problems	8	15
Second Internal Examination			
V	Performance evaluation of manufacturing systems –Lean manufacturing assessment ,Lean Tools, Value stream Mapping ,OEE ,and six sigma on advanced manufacturing systems DMAIC Methodology,	8	20
VI	Virtual Organization –Introduction to virtual Manufacturing and its applications	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6105	DISCRETE EVENT SYSTEM SIMULATION	2-1-0-3	2015

Course Prerequisites

Basic knowledge of probability and statistics

Course Objectives

To understand how computer simulation can be used as an effective tool to model and analyze complex systems

Syllabus

System Modeling and Analysis – Monte Carlo Simulation – Random Number Generation – Analysis of Simulation Data-Simulation Languages and Packages- Simulation using Spreadsheets- Simulation of Manufacturing and Material Handling Systems

REFERENCES:

1. Jerry Banks and John S, Carson II "Discrete Event system Simulation", Prentice Hall.
2. Kelton, W. David, and Averill M. Law. "Simulation modeling and analysis". McGraw Hill.
3. Francis Neelamkovil, "Computer Simulation and Modelling", John Willey and sons.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction to systems and modeling - Discrete and continuous system - areas of application –Limitations- Monte Carlo simulation	6	10
II	Discrete event simulation and their applications- Queuing and inventory problems- Simulation as a decision making tool	10	20
First Internal Examination			
III	Random numbers-Techniques for generating random numbers- Linear congruential method-Test for random numbers- Frequency and run tests- Tests for autocorrelation- Random variate generation- Inverse transformation technique.	8	15
IV	Analysis of simulation data. - Data collection- Identifying the distribution with data-Goodness of fit tests-Verification and validation of simulation models	8	15
Second Internal Examination			
V	Simlation languages and packages – Simulation using spreadsheets –	6	15

	Simulation optimization		
VI	Simulation of manufacturing and material handling systems- Performance analysis of flow shop and job shopsystems- Modelling of supply chains- Case studies.	10	25
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6107	PRODUCTION AUTOMATION AND TRENDS IN MANUFACTURING	2 - 1 - 0 - 3	2015

Course Prerequisites

Fundamental knowledge in Manufacturing systems

Course Objectives

To learn the concepts of automation , Discrete Control systems, advanced manufacturing processes, Computerized Numerical Control technology.

Syllabus

Concept and scope of industrial automation- Industrial Robots-Discrete Control, PLC, CNC systems, Part Programming, APT programming, Latest trends in Manufacturing.

REFERENCES:

1. Serope Kalpakjian,, "Manufacturing processes for Engineering Materials", Addision Wesley
2. Serope Kalpakjian , Steven R Schmid.,"Manufacturing Engineering and Technology", Prentice Hall
3. Radhakrishnan, P., "Computer Numerical Control Machines", New Central Book Agencies
4. Mikell P. Groover., " Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Concept and scope of industrial automation – Sensors, Actuators and other control system components.	8	15
II	Industrial Robotics- Robot anatomy-Robot control systems-Sensors in robotics. Concepts of discrete control, Programmable Logic Controllers.	8	15
First Internal Examination			
III	Concepts, features, fundamentals, components , classification, Design consideration of NC machine tools –Tooling, Maintenance of CNC machines.	8	15
IV	Controls and System devices - Control loops of NC system , Reference pulse and sampled data techniques – CNC adaptive control – ACO and ACC systems.	8	15
Second Internal Examination			
V	Fundamentals of part programming. Manual part programming, Computer aided part programming - APT programming	8	20
VI	Concepts of GT, FMS, CIM. Latest trends in Manufacturing, Additive manufacturing concepts, Green sustainable manufacturing	8	20

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6113	**THEORY OF VIBRATION**	**2 - 1 - 0 - 3**	**2015**

Course Prerequisites

Engineering Mechanics-Statics and dynamics (basics), Strength of materials (basics).

Course Objectives

To help the students fully understand and appreciate the importance of mechanical vibrations.

To enable them acquire the skill to develop mathematical models and analyse the vibration of mechanical systems.

Syllabus

Single degree-of-freedom systems-Undamped and damped free vibration problems, Forced response of undamped and damped systems, Vibration isolation and base excitation cases, Duhamel's integral and transient response, periodic excitation inputs, Instrumentation for vibration measurements.

Two degree-of-freedom systems-Vibration absorber. Multi degree-of-freedom systems, coordinate transformation, definition of normal modes and modal coordinates, modal superposition based free and forced vibration responses, proportional and non-proportional damping. Continuous systems-Axial, bending and torsional vibration of bars and beams.

REFERENCES:

1. Elements of vibration analysis, Leonard Meirovitch, Tata McGraw-Hill Publishing Company Ltd., 2007
2. Theory of vibration with applications, William T Thomson, Marie Dillon Dahleh , Pearson Education, Inc., 1998.
3. Mechanical Vibrations, Singiresu S. Rao, Pearson Education, Inc., 2011
4. Principles of vibration control, Mallik A.K., East-West Press Pvt. Ltd., New Delhi, 1990.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Single degree-of-freedom systems- Undamped and damped free vibration problems, Forced response of undamped and damped systems	8	15

II	Vibration isolation and base excitation cases, Duhamel's integral and transient response, Periodic excitation inputs,	8	15
First Internal Examination			
III	Instrumentation for vibration measurements, Two degree-of-freedom systems-Vibration absorber	8	15
IV	Multi degree-of-freedom systems, coordinate transformation, definition of normal modes and modal coordinates	8	15
Second Internal Examination			
V	Modal superposition based free and forced vibration responses, proportional and non-proportional damping	8	20
VI	Continuous systems-axial, bending and torsional vibration of bars and beams.	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6115	**FRACTURE MECHANICS AND FATIGUE**	**2 - 1 - 0 - 3**	**2015**

Course Prerequisites

A course on Mechanics of Solids at the UG level

Course Objectives

To impart the basic knowledge on fracture mechanics and to facilitate the incorporation of cracks and fatigue in engineering design

Syllabus

Micro and Macro Cracks – Fracture Criterion – Stress Analysis – Plastic zone – Elastic-Plastic Fracture Mechanics – Fatigue and Fatigue Crack Growth - Linear static fracture Mechanics Design- Dynamic Fracture – Experimental Determination of dynamic Stress Intensity Factor

REFERENCES:

1. S.A. Maguid,, "Engineering Fracture Mechanics", Elsevier, 1996
2. David Broke., "Elementary Engineering Fracture Mechanics", Noordhoff, 1995.
3. Karen Hellan, "Introduction to Fracture Mechanics", Mc Graw Hill, 1982.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction -sources of micro and macro cracks - fracture criterion based on stress concentration and theoretical strength Griffith's energy - various approaches - Stress Analysis for Members with Cracks.	8	15
II	Crack tip Plastic Zone: Plastic zone estimation - yielding fracture mechanics.	8	15
First Internal Examination			
III	Elastic–Plastic Fracture Mechanics - Path-independent integrals, J-integral , J-integral fracture criterion, crack opening displacement(COD), experimental determination of J integral and COD - Fatigue and Fatigue crack growth rate.	8	15
IV	Linear static fracture Mechanics Design Concepts - Introduction, the stress criterion, strain energy density, 2-D linear elastic crack problems.	8	15
Second Internal Examination			
V	Dynamic Fracture: Mohr's model, strain energy release rates, crack branching, practical applications of crack arresting techniques.	8	20
VI	Experimental determination of dynamic SIF. -NDT and Fracture Mechanics	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
AMD 105C	MECHANICS OF COMPOSITES	2 - 1 - 0 - 3	2015

Course Prerequisites

The student must have basic knowledge on mechanical engineering at UG level

Course Objectives

Introduces knowledge on advanced material and its properties and method of fabrication and analysis.

Syllabus

Definition of composites- Micromechanics of composites- Ply mechanics- Static and dynamic analysis of laminated composite structures- Analysis of impact on laminates- Analysis of smart composite structures.

REFERENCES:

Robert M. Jones, Mechanics of composite materials, Scripta Book Company.
Ronald F. Gibson, Principles of Composite Material Mechanics, Second Edition .

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Definition of composites; Classification and Applications	8	15
II	Micromechanics of composites: effective properties of long and short fiber reinforced composites, effective strength of composites, effective properties of piezoelectric fiber reinforced composites;	8	15
First Internal Examination			
III	Ply mechanics; Macrobehaviour of laminate- classical lamination theory –Stress distribution through the thickness; Macromechanics of laminated composite structures: description of laminates, laminate moduli,	8	15
IV	Static and dynamic analysis of laminated composite structures (beams, plates and shells) using shear deformation theories, failure theories,	8	15
Second Internal Examination			
V	Analysis of impact on laminates	8	20
VI	Analysis of smart composite structures.	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6119	ADVANCED MECHANICS OF SOLIDS	2 - 1 - 0 - 3	2015

Course Prerequisites

Basic knowledge of mechanics of solids at the UG level

Course Objectives

To enable the students to understand the complex theories and practices related to advanced mechanics and solids which shall help them in engineering design

Syllabus

Theory of stresses and strains- linear elasticity – solutions- energy methods – finite deformation – application to thick cylinders, curved beams on elastic foundation – torsion of non circular shafts

REFERENCES:

.1. Durelli, Philips and Tsao, Introduction to the Theoretical and Experimental Analysis of Stress and Strain, McGraw Hill; New York.
2. Timoshenko S and Goodier J N, Theory of Elasticity, McGraw Hill.
3. Fung Y.C., Foundations of Solid Mechanics, Prentice Hall of India.
4. Boresi A.P. Schmidt R J and Sidebottom O M, Advanced Mechanics of Materials, John Wiley.
5. Fenner R T, Engineering Elasticity Application of Numerical and Analysis Techniques, Ellis Hordwood Ltd

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Theory of stresses and strains. Introduction of tensors. Constitutive modeling.	8	15
II	Linear elasticity. Solutions of plane problems. Solutions using polynomials.	8	15
First Internal Examination			
III	Energy methods. Introduction to finite deformation, plasticity, stability, vibration, and wave propagation.	8	15
IV	Application to thick cylinders, rotating discs, curved beams, beams on elastic foundations,	8	15
Second Internal Examination			
V	Torsion of non-circular cross-sections, stress concentration problems, Hertzian contact stresses.	8	20
VI	Theories of failures. Static failure theories. Fatigue failure theories. Case studies, Design for fatigue	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6109	**SEMINAR - 1**	**0 - 0 - 2 - 2**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;
(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :
(1) Be motivated in reading which enhances the literature review required for doing project work;
(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EI6111	ENGINEERING SOFTWARE LAB	0 - 0 - 2 - 1	2015

Course Prerequisites

Basic knowledge of simulation design and analysis software at UG level

Course Objectives

To get the students acquainted with the state of the art software for data analysis, optimization and modeling and analysis of mechanical engineering problems.

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List of Experiments

1. Simulation of engineering and manufacturing systems using tools like ARENA, WITNESS etc

2. Modeling and optimization of linear and non-linear engineering problems using tools like LINGO,LINDO etc

3. Design and modeling of engineering components and systems using high end software like Pro/E, CATIA,UNIGRAPHICS, SolidWorks etc

4. Engineering analysis of components and systems using high end software like ANSYS, ABAQUS, Pro/E, CATIA,UNIGRAPHICS, SolidWorks etc

5. Using project management tools like Primavera, MSProject etc

6. Using software like MATLAB, LabVIEW etc for special problems in Mechanical Engineering

7) Data analysis using SPSS, MINITAB etc

KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*10*
Branch	**:**	*Mechanical Engineering*
Stream	**:**	**Manufacturing Systems Management**
Year	**:**	*2015*
No. of Credits	**:**	*66*

FIRST SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME6101	Computational Methods	3	1	-	40	3	60	100	4
10ME6203	Design of Manufacturing Processes	3	-	-	40	3	60	100	3
10ME6105	Discrete Event System Simulation	3	-	-	40	3	60	100	3
10ME6207	Inventory and Supply Chain Management	3	-	-	40	3	60	100	3
10ME6XXX	Elective-I	3	-	-	40	3	60	100	3
10GN6001	Research Methodology	0	2	-	100	-	0	100	2
10ME6209	Seminar	-	-	2	100	-	0	100	2
10ME6211	Advanced Manufacturing Systems Lab	-	-	2	100	-	0	100	1
		15	**3**	**4**	**500**		**300**	**800**	**21**

ELECTIVE-I

10ME6213 Lean Production Management
10ME6215 Industrial Marketing and Marketing Research
10ME6217 Production Planning and Control
10ME6219 Industrial Energy Management

SECOND SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME6202	Modeling and Analysis of Manufacturing Systems	3	-	-	40	3	60	100	4
10ME6204	Enterprise Resource Planning	3	-	-	40	3	60	100	3
10ME6206	Management Accounting and Financial Management	3	-	-	40	3	60	100	3
10ME6XXX	Elective-II	3	-	-	40	3	60	100	3
10ME6XXX	Elective-III	3	-	-	40	3	60	100	3
10ME6208	Mini Project	-	-	4	100	-	0	100	2
10ME6212	Manufacturing Systems Management Lab	-	-	2	100	-	0	100	1
TOTAL		**15**	**-**	**6**	**400**		**300**	**900**	**19**

ELECTIVE II

10ME6114 Soft Computing Techniques
10ME6116 Design of Experiments
10ME6118 Management Information System

10ME6122 Quality and Reliability Engineering
10ME6124 Project Engineering and Management
10ME6126 Industrial Automation and Robotics
10ME6128 Mechatronics
10ME6132 Finite Element Methods and Applications
10ME6234 Microfabrication

THIRD SEMESTER

ELECTIVE-IV

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME72XX	Elective-IV	3	-	-	40	3	60	100	3
10ME72XX	Elective-V	3	-	-	40	3	60	100	3
10ME7201	Seminar 2	-	-	2	100	-	0	100	2
10ME7203	Project - Phase 1	-	-	8	50	-	0	50	6
TOTAL		**6**	**-**	**10**	**230**		**120**	**350**	**14**

10ME7205 Managerial Economics
10ME7207 Energy Management
10ME7209 Sensors and Controls in Manufacturing
10ME7211 Process Planning and Cost Estimation
10ME7113 Technical Entrepreneurship
10ME7215 Expert System and Artificial Intelligence in Manufacturing
10ME7117 Industrial Machine Vision
10ME7119 Modern Machining Processes

FOURTH SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Total Marks	Credit
		L	T	P		Hrs	Marks		
10ME7204	Project - Phase 2	-	-	22	70		30	100	12
TOTAL		**-**	**-**	**22**	**70**		**30**	**12**	**12**

TOTAL CREDITS : 66

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME6101	COMPUTATIONAL METHODS	3-1-0-4	2015

Prerequisite:
Basic knowledge in mathematical methods at UG level

Objective:
1. To be capable of developing a thorough knowledge in computational techniques to aid in the modeling and analysis of manufacturing processes, systems.
2. To lay a sound computational foundation for further independent research in manufacturing engineering

Syllabus:
First order differential equations, Second order differential equations, Non homogenous differential equations, Laplace transforms, Systems of differential equations, Series solutions, Higher order differential equations, Boundary value problems and fourier series, Partial differential equations, Probability, distributions, Moments, Estimation Theory, Correlation, Regression, optimization, Unconstrained optimization Nonlinear programming.

Reference Books:

1.Erwin Kreyzig Advanced Engineering Mathematics, John Wiley 2006.
2. Shepley L Ross,Differential Equations, JohnWiley&Sons, Third Edition, 2004.
3. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi 2001
4. Kalyanmoy Deb,.Optimisation for Engineering Design-Algorithms and Examples., Prentice Hall India- 1998
5. S.S.Rao, .Engineering Optimization., 3rd Ed.,New Age International (P) Ltd,New Delhi, 2007

COURSE PLAN

Module	Contents	Contact hours	Sem.Exam Marks;%
I	First order differential equations, modeling with first order equations, equilibrium solutions, euler's method, Second order differential equations, fundamental sets of solutions, wronskian method, Non homogenous differential equations, mechanical vibrations, Laplace transforms, inverse laplace transforms, step function, solving IVP's with laplace transforms, dirac delta function, convolution integral.	6	15
II	Systems of differential equations, solutions to systems, phase plane, solution involving real, complex, repeated eigen values and laplace transforms, solving non homogenous differential equations, Modeling using systems of differential equations, Series solutions, series solution about an ordinary point,	8	15

	solutions to euler differential equations.		
	FIRST INTERNAL TEST		
III	Higher order differential equations, linear homogenous differential equations, solution using undetermined coefficients, variation of parameters and laplace transforms, systems of differential equations, series solution, Boundary value problems and fourier series, eigen values and eigen functions in BVP, periodic functions and orthogonal functions, fourier sine, cosine and full series, convergence of fourier series, Partial differential equations, heat equation, wave equation, solution of heat equation with non zero temperature boundaries, laplace equation, vibrating string.	10	15
IV	Probability, Random variables, Binomial, Poisson, Geometric, Uniform, Normal, Exponential distributions, Moments, Moments generating functions and their properties, Functions of Random variables. Estimation Theory, Correlation, Regression, Partial and Multiple correlations, Partial and Multiple regression, Estimation of parameters using maximum likelihood estimator and method of moments.	6	15
	SECOND INTERNAL TEST		
V	Concepts of optimization: Engineering applications-Statement of optimization problem-Classification - type and size of the problem. Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity - formulation of LP problems - simplex method and algorithm -Matrix form- two phase method. Duality- dual simplex method- LU Decomposition. Sensitivity analysis .Artificial variables	6	20
VI	Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear programming - gradient and Hessian. Unconstrained optimization: First & Second order necessary conditions-Minimisation & Maximisation Local & Global convergence-Speed of convergence. Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method-Lagrange multiplier method - Kuhn-tucker conditions . Quasi-Newton method- separable convex programming - Frank and Wolfe method.	12	20

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME62013	DESIGN OF MANUFACTURING PROCESSES	3-0-0-3	2015

Prerequisite: *Basic knowledge in manufacturing processes at UG level*

Objective: *To be capable of developing a thorough knowledge in manufacturing processes and modeling and analysis of manufacturing processes.*

Syllabus:

Properties and structure of materials; Mechanical properties of materials; Different Casting processes and their Analysis and modeling; Plastic deformation and forming processes; Metal machining processes; Analysis and modeling of welding/joining processes; Unconventional machining processes.

Reference books:

1. R Venkata Rao, Advanced Modeling and Optimization of Manufacturing Processes – International Research and Development, Springer Verlag 2011
2. Amitabha Ghosh and Asok Kumar Mallik Manufacturing Science Affiliated East-West Press Pvt. Ltd.
3. ScheyJ.A. Introduction to Manufacturing Processes McGraw Hill.
4. Dieter G.E. Mechanical Metallurgy McGraw Hill.
5. Juneja B.L. Nitin Seth Fundamentals of Metal Cutting and Machine Tools New Age International.

COURSE PLAN

Module	Content	Hours	Sem.Exam Marks;%
I	Introduction manufacturing properties of materials structure of matter metals and alloys deformation and mechanical properties of materials control of material properties.	6	15
II	Introduction to casting processes pattern and mould melting gating design cooling and solidification defects in castings an overview of various casting processes inspection of castings numerical problems on modeling and analysis of casting processes.	8	15
	FIRST INTERNAL TEST		
III	Introduction to forming processes plastic deformation and yield criteria relationship between tensile and shear yield stresses operation and mechanics of forming processes advantages and disadvantages of hot and cold forming friction and lubrication in metal forming defects in metal forming numerical problems in modeling and analysis of forming processes.	10	15

IV	Introduction to machining processes mechanics of basic machining operation an overview of various machining processes abrasive machining and finishing operations surface finish optimization of cutting parameters for minimum cost maximum production and maximum efficiency numerical problems in modeling and analysis of machining processes	6	15
	SECOND INTERNAL TEST		
V	Introduction to joining processes principles of solid phase welding principles of fusion welding principles of solid/liquid state joining an overview of various joining processes weld defects and inspection numerical problems in modeling and analysis of joining processes.	6	20
VI	Introduction to unconventional machining processes abrasive jet machining ultrasonic machining electrochemical machining electric discharge machining electron beam machining laser beam machining plasma arc machining numerical problems in modeling and analysis unconventional machining processes introduction to recent trends in manufacturing an overview on micro manufacturing diamond micromachining high resolution lithography LIGA process generative manufacturing processes self assembly numerical problems in modeling and analysis of modern machining processes	12	20

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6105	**DISCRETE EVENT SYSTEM SIMULATION**	**2-1-0-3**	**2015**

Course Prerequisites

Basic knowledge of probability and statistics

Course Objectives

To understand how computer simulation can be used as an effective tool to model and analyze complex systems

Syllabus

System Modeling and Analysis – Monte Carlo Simulation – Random Number Generation – Analysis of Simulation Data- Simulation Languages and Packages- Simulation using Spreadsheets- Simulation of Manufacturing and Material Handling Systems

REFERENCES:

1. Jerry Banks and John S, Carson II "Discrete Event system Simulation", Prentice Hall.
2. Kelton, W. David, and Averill M. Law. "Simulation modeling and analysis". McGraw Hill.
3. Francis Neelamkovil, "Computer Simulation and Modelling", John Willey and sons.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction to systems and modeling - Discrete and continuous system - areas of application –Limitations- Monte Carlo simulation	6	10
II	Discrete event simulation and their applications- Queuing and inventory problems- Simulation as a decision making tool	10	20
First Internal Examination			
III	Random numbers-Techniques for generating random numbers- Linear congruential method-Test for random numbers- Frequency and run tests- Tests for autocorrelation- Random variate generation- Inverse transformation technique.	8	15
IV	Analysis of simulation data. - Data collection- Identifying the distribution with data-Goodness of fit tests-Verification and validation of simulation models	8	15
Second Internal Examination			
V	Simlation languages and packages – Simulation using spreadsheets – Simulation optimization	6	15
VI	Simulation ofmanufacturing and material handling systems- Performance analysis of flow shop and job shopsystems- Modelling of supply chains- Case studies.	10	25
Cluster Level End Semester Examination			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME62017	INVENTORY AND SUPPLY CHAIN MANAGEMENT	3-0-0-3	2015

Prerequisite: *Basic knowledge in industrial engineering and materials management at UG level*

Objective: *To be capable of modeling, simulating and analyzing an inventory/supply chain system*

Syllabus:

Introduction to supply chain management; Supply chain strategies; Evaluating supplier suppy contracts; Computer based stores management; Inventory management and control techniques; Make or buy decisions; Optimal policy curves; Demand systems; Stock out cost and service levels managing.

Reference Books

1. Chopra S. and Meindl P. *Supply chain Management: Strategy Planning and Operations* Pearson Education (Singapore) Pvt. Ltd.
2. Simchi-Levi D. Kaminsky P. and Simchi-Levi E. *Designing & Managing the Supply Chain: Concepts Strategies & Case studies* Tata McGraw-Hill Edition.
3. Doebler D.W. and Burt D.N. *Purchasing and Supply Chain Management: Text and Cases* McGraw-Hill Publishing Company Limited New Delhi.
4. Tersine R.J. *Principles of Inventory and Materials Management* Prentice-Hall Inc. New Jersey.
5. Christopher M. *Logistics and Supply Chain Management* Pitman Publishing Company London.

COURSE PLAN

Module	MODULE	Contract hours	Sem-exam marks %
I	Introduction to supply chain management (SCM) concept of logistics management concept of supply management and SCM core competency value chain elements of supply chain efficiency flow in supply chains key issues in supply chain management decision phases in supply chain supply chain integration process view of a supply chain competitive strategy and supply chain strategies uncertainties in supply chain supply chain drivers.	10	15
II	Sourcing and procurement outsourcing benefit importance of suppliers evaluating a potential supplier supply contracts competitive bidding and negotiation e-procurement purchasing objectives relations with other departments centralized and decentralized purchasing procedure.	5	15
	FIRST INTERNAL TEST		
III	Types of orders tender buying purchasing department records computer based systems/EDI stores management: functions storage methods receiving inspection issues inventory valuation.	5	15
IV	Introduction to inventory management: selective control techniques MUSIC-3D systems various costs independent	8	15

	demand systems deterministic models quantity discounts all units incremental price sensitivity make-or-buy decisions.		
	SECOND INTERNAL TEST		
V	Multi-item joint replenishment: economic production quantity for multiple items inventory system constraints exchange curve (optimal policy curve) working capital restrictions storage space restrictions.	8	20
VI	Independent demand systems (probabilistic models) single order quantities payoff matrix expected value criterion lost sales case mathematical formulation of discrete and continuous cases dynamic order quantities Q- system P- system mathematical modeling under known stock out costs and service levels managing inventory in supply chain bullwhip effect information and supply chain trade-offs.	12	20

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME6213	LEAN PRODUCTION MANAGEMENT	3-0-0-3	2015

Prerequisite: *Basic knowledge in production/manufacturing engineering at UG level*

Objective: *To develop a thorough knowledge on lean production management system*

Syllabus:

Small lot production; Setup time and setup methodologies; Pull production systems; Cellular manufacturing; Master production scheduling; Decentralized planning and control systems.

Reference Books

1. Harold J. Steudel and Paul Desruelle. *Manufacturing in the Nineties - How to Become a Lean, World-Class Competitor*, Van Norstrand Reinhold, New York
2. John Nicholas. *Competitive Manufacturing Management - Continuos Improvement, Lean Production, and Customer-Focused Qualities*, McGraw-Hill International Editions.

COURSE PLAN

Module	Content	Contract hours	Sem-exam marks %
I	Small-lot production, lot-size basics, lot sizing, lot-size reduction, facilitating small lot size.	8	15
II	Setup time reduction, setup reduction methodology, techniques for setup reduction, setup reduction projects.	8	15
	FIRST INTERNAL TEST		
III	Pull production systems, pull systems and push systems, conditions for pull production systems, how to achieve pull production, mechanisms for signal and control.	5	15
IV	Work cells and cellular manufacturing, cell layout and capacity measures, design of work cells, worker assignment, implementation issues.	5	15
	SECOND INTERNAL TEST		
V	Scheduling for smooth flow, production leveling, level scheduling in pull production, master production scheduling, synchronizing and balancing process, synchronization, bottleneck scheduling, balancing, adapting to schedule changes.	10	20
VI	Planning and control in pull production centralized planning and control system, decentralized planning and control system, adapting MRP based production planning and control system to pull production, maintaining and improving equipment, equipment maintenance, equipment effectiveness, total productive maintenance.	12	20

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME6215	**INDUSTRIAL MARKETING AND MARKETING RESEARCH**	3-0-0-3	2015

Prerequisite: *Basic knowledge in industrial engineering at UG level*

Objective: *To develop a thorough knowledge on industrial marketing and marketing research and solve related industrial problems.*

Syllabus:

Marketing management concepts; Marketing planning; Target markets; Market segmentation process; New product development process; Pricing strategy; Marketing channel; Retailing and wholesale system.

Text / Reference Books:

1. Philip Kotler. *Marketing Management Analysis Planning Implementation and Control* Prentice Hall of India Pvt. Ltd.
2. Rajan Saxena *Marketing Management* Tata McGraw Hill Publication Co.

COURSE PLAN

Module	Content	Contract hours	Sem-exam marks %
I	Introduction to marketing management core concepts marketing concept selling concept and marketing process marketing mix analyzing market opportunities designing marketing strategies planning marketing programs organizing implementing and controlling the marketing effort marketing planning current marketing situation opportunity and issue analysis action programs profit and loss statement numeric problems/simulation exercises.	8	15
II	Researching and selecting target markets concepts in demand measurement estimating future demand market segmentation general approach to segmenting a market patterns of market segmentation market segmentation procedures base for segmenting customer markets and industrial markets market targeting evaluating the market segments selecting the market segments numeric problems/simulation exercises.	10	15
	FIRST INTERNAL TEST		
III	Product design new product development effective organizational arrangements idea generation idea screening concept development and testing product development market testing commercialization consumer adoption process product life cycle introductory stage growth stage maturity	8	15

	stage and decline stage numerical problems/simulation exercises.		
IV	Managing product lines brands and packaging product mix decisions product line decisions brand decisions packaging and labeling decisions managing service businesses and ancillary services classification of services marketing strategies for service firms managing product support services	8	15
	SECOND INTERNAL TEST		
V	Pricing strategies and programs setting the price adapting the price initiating and responding to price changes numerical problems/simulation exercises. Market placing and promotion strategies nature of marketing channels channel design decision channel management decisions channel dynamics channel co-operation conflict and competition.	8	20
VI	Retailing wholesaling and distribution systems nature and importance of retailing types of retailers wholesaling physical distribution communication process steps in developing effective communication measuring promotion results managing the sales force designing the sales force principles of personal selling numerical problems/simulation exercises.	6	20

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME6217	PRODUCTION PLANNING AND CONTROL	3-0-0-3	2015

Prerequisite: *Basic knowledge in Production Engineering at UG level*

Objective: *To develop a thorough knowledge on production planning and control and solve related industrial problems.*

Syllabus:

Production planning and control; Introduction to forecasting; Aggregate planning; Capacity management; Scheduling strategy; Lot sizing rules; Scheduling decisions; Sequencing rules; Production planning and control systems; Integrated production planning system.

Reference Books:

1. Mukhopadhyay S.K. *Production Planning and Control:Text and Cases* Prentice Hall of India.
2. Samuel Eilon *Elements of Production Planning and Control* Universal Publishing Corporation
3. G.F.Simmons *Topology and Modern Analysis* McGraw Hill.
4. Frazier Michael W. *An Introduction to Wavelets through Linear Algebra* Springer Publications.
5. Strang G *Linear Algebra and its Applications* 3rd edition Saunders 1988.

COURSE PLAN

Module	Content	Contract hours	Sem-exam marks %
I	**Module: 1** General introduction to production planning and control introduction to facilities location and layout plant location facility location facilities layout CRAFT ALDEP CORELAP introduction to forecasting simple averaging method moving averages exponential smoothing holt's linear and holt-winter's method box-jenkins method numerical problems/simulation exercises.	8	15
II	**Module: 2:** Introduction to aggregate planning linear decision rules graphical approach mathematical programming model introduction to disaggregation MPS BOM MRP introduction to capacity management load capacity expansion strategy capacity management RRP RCCP CRP scheduling strategies infinite versus finite loading comparison of the strategies numerical problems/simulation exercises.	10	15

	FIRST INTERNAL TEST		
III	Introduction to lot sizing rules FOQ EOQ LFL FPR POQ LUC LTC PPB W-W algorithm analysis of lot sizing heuristics such as EOQ W-W GR SM and freeland-colley analysis of the entire data set numerical problems/simulation exercises	8	15
IV	Introduction to scheduling decision rules scheduling approaches types of decisions single machine sequencing shop floor control input-output control infinite and finite loading forward and backward scheduling flow shop sequencing techniques critical ratio least changeover cost non-quantifiable sequencing rules two and three machine scheduling problem job shop scheduling common rule for job shop scheduling problem minimizing make span in job shop line of balance technique run out technique optimize production technology numerical problems/simulation exercises.	12	15
	SECOND INTERNAL TEST		
V	Design of PPC systems basic concepts MRP II -JIT -Kanban design of continuous flow manufacturing system multi-agent manufacturing planning and control system implementation of kanban.	5	20
VI	Design and implementation of an integrated production planning system design of forecasting models using SAP APO multi-product multi-stage lot sizing numerical problems/simulation exercises.	5	20

Course Code	Course Name	L-T-P-Credits	Year of Introduction
10ME6219	INDUSTRIAL ENERGY MANAGEMENT	3-0-0-3	2015

Prerequisite:
Basic knowledge in Thermal Engineering and Basic Electrical Engineering at UG level

Objective:
To develop a thorough knowledge on industrial energy management and solve related industrial problems.

Syllabus:
Introduction to energy engineering world; Energy conservation schemes; Electrical system optimization; Waste heat recovery energy management maintenance management; Energy auditing and accounting; Energy and environment; Utilization public health issues related to environmental pollution; Solid waste management; Environmental auditing.

Reference books:

1. A.P.E.Thumann *Fundamentals of Energy* Engineering Prentice Hall.
2. A.P.E.Thumann *Plant Engineers and Managers Guide to Energy Conservation* UNR
3. W.F.Kenney *Energy Conservation in the Process Industries* Academic press.
4. M.H.Chiyogioji *Industrial Energy Conservation* Marcel Dekker
5. C.B. Smith *Energy Management Principles* Pergamon Press.

Module	Content	Contract hours	Sem-exam marks %
I	Introduction to energy engineering world energy outlook application of non-conventional and renewable energy systems use of energy efficient technologies solar energy solar energy collectors and energy storage applications of solar energy wind energy basic components of a wind energy conversion system performance of wind machines applications of wind energy energy from biomass biomass conversion technologies types of biogas plants Energy conservation schemes case studies numerical problems/simulation exercises.	8	15
II	Electrical system optimization importance of power factor power factor correction energy efficient motors lighting basics energy efficient light sources domestic commercial and industrial lighting energy conservation in lighting schemes case studies numerical problems/simulation exercises.	8	15
	FIRST INTERNAL TEST		
III	Energy conservation in HVAC systems energy conservation by co-generation scheme boiler efficiency improvement waste heat recovery energy management	10	15

	maintenance management preventive maintenance schedule energy management organization case studies numerical problems/simulation exercises.		
IV	Energy economics payback analysis energy auditing and accounting types energy use profiles the energy survey sankey diagram for energy audit energy audit instruments thermal energy efficiency and audits electrical energy efficiency audits case studies numerical problems/simulation exercises.	10	15
	SECOND INTERNAL TEST		
V	Energy and environment environmental aspects of energy utilization public health issues related to environmental pollution methods to measure pollution in industries air pollution & water pollution.	6	20
VI	Compliance with standards international environmental policy energy recovery by solid waste management environmental auditing case studies numerical problems/simulation exercises.	6	20

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To understand the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.
As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning,	5	15

	objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.		
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10ME6209	SEMINAR - 1	0 - 0 - 2 - 2	2015

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;
(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :
(1) Be motivated in reading which enhances the literature review required for doing project work;
(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10ME6211	**ADVANCED MANUFACTING SYSTEMS LAB**	**0-0-2-1**	**2015**

Course Prerequisites

Basic knowledge in AUTOCAD, Modeling softwares at UG level

Course Objectives

To develop a thorough knowledge on Designing mechanical parts using CAD software's and learning PLC programming

.

List of Experiments

- Solid modeling exercises on commercial software like PTC Creo, CATIA, Siemens NX, Autodesk Inventor Series, Solid Edge, Solid Works etc.
- CNC part programming exercises on Mastercam, ESPRIT CAM, Predator CNC Editor, etc. Exercises on finite element analysis using ANSYS and ABAQUS software etc.
- Modeling and fabricating components using RP Programming exercises on Robots and FMS system.
- Pneumatic circuit design and implementation using pneumatic simulator. PLC programming and testing.
- Measurement exercises using CMM. 2 20
- Study and demonstration of PCB milling machine. 2 20

KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	:	*10*
Branch	:	*Mechanical Engineering*
Stream	:	**Thermal and Fluids Engineering**
Year	:	*2015*
No. of Credits	:	*66*

SEMESTER 1

Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
A	10ME6301	Advanced Engineering Mathematics	3-1-0	40	60	3	100	4
B	10ME6303	Advanced Engineering Fluid Dynamics	3-0-0	40	60	3	100	3
C	10ME6305	Advanced Heat Transfer	3-0-0	40	60	3	100	3
D	10ME6307	Advanced Thermodynamics and Combustion	3-0-0	40	60	3	100	3
E	10ME6XXX	Elective I	3-0-0	40	60	3	100	3
F	10GN6001	Research Methodology	0-2-0	100			100	2
G	10ME6309	Seminar I	0-0-2	100			100	2
H	10ME6311	Thermal Sciences Laboratory	0-0-2	100			100	1
		TOTAL	**15-3-4**	**500**	**300**	**-**	**800**	**22**

Elective I

10ME6313 Refrigeration Engineering

10ME6415 Hydraulic, Pneumatic And Fluid Controls

10ME6317 Thermal Environmental Engineering

10ME6319 Solar Thermal Engineering

10ME6321 Boundary layer and turbulence

SEMESTER 2

<table>
<tr><th rowspan="2">Examination Slot</th><th rowspan="2">Course Number</th><th rowspan="2">Name</th><th rowspan="2">L-T-P</th><th rowspan="2">Internal Marks</th><th colspan="2">End Semester Examination</th><th rowspan="2">Total Marks</th><th rowspan="2">Credits</th></tr>
<tr><th>Marks</th><th>Duration (hours)</th></tr>
<tr><td>A</td><td>10ME6302</td><td>Internal Combustion Engine, Combustion & Pollution</td><td>3-1-0</td><td>40</td><td>60</td><td>4</td><td>100</td><td>4</td></tr>
<tr><td>B</td><td>10ME6304</td><td>Advanced Power plant Engineering</td><td>3-0-0</td><td>40</td><td>60</td><td>3</td><td>100</td><td>3</td></tr>
<tr><td>C</td><td>10ME6306</td><td>Measurements In Thermal Engineering</td><td>3-0-0</td><td>40</td><td>60</td><td>3</td><td>100</td><td>3</td></tr>
<tr><td>D</td><td>10ME6XXX</td><td>Elective II</td><td>3-0-0</td><td>40</td><td>60</td><td>3</td><td>100</td><td>3</td></tr>
<tr><td>E</td><td>10ME6XXX</td><td>Elective III</td><td>3-0-0</td><td>40</td><td>60</td><td>3</td><td>100</td><td>3</td></tr>
<tr><td></td><td></td><td>Mini Project</td><td>0-0-4</td><td>100</td><td></td><td></td><td>100</td><td>2</td></tr>
<tr><td>H</td><td></td><td>Advanced Heat Transfer Lab</td><td>0-0-2</td><td>100</td><td></td><td></td><td>100</td><td>1</td></tr>
<tr><td></td><td></td><td>TOTAL</td><td>15-0-6</td><td>400</td><td>300</td><td>-</td><td>700</td><td>19</td></tr>
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</table>

Elective II

10ME6114 Soft Computing Techniques
10ME6116 Design of Experiments
10ME6118 Management Information System
10ME6122 Quality and Reliability Engineering
10ME6124 Project Engineering and Management
10ME6326 Design of Heat Transfer Equipment
10ME6328 Renewable Energy Systems
10ME6432 Industrial refrigeration system
10ME6434 Computational fluid flow & heat transfer
10ME6336 Advanced Gas Dynamics

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total	Credits
					Marks	Duration (hours)		
A	10ME7XXX	Elective IV	3-0-0	40	60	3	1	3
B	10ME7XXX	Elective V	3-0-0	40	60	3	40	3
G	10ME7301	Seminar II	0-0-2	100			100	2
	10ME7303	Project (Phase 1)	0-0-12	50			50	6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**230**	**14**

Elective IV

10ME7305	Cryogenic engineering
10ME7307	Design and analysis of turbo machines
10ME7309	Convection and Two-phase Flow
10ME7411	Gas Turbines
10ME7313	Cogeneration and Waste Heat Recovery Systems
10ME7315	Modern Energy Conversion Systems
10ME7417	Steam turbines
10ME7419	Air conditioning & Ventilation
10ME7421	Finite element analysis for heat transfer
10ME7323	Energy Conversion and Heat Recovery Systems

SEMESTER 4

Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credit
					Marks	Duration (hours)		
	10ME7304	Project (Phase 2)	0-0-23	70	30			12
		TOTAL	**0-0-23**	**70**	**30**	**-**		**12**

TOTAL NUMBER OF CREDITS: 66

	Course Name	L-T-P-Credits	Year of Introduction
10ME6301	**ADVANCED ENGINEERING MATHEMATICS**	**3-1-0- 4**	**2015**

Course Prerequisites

Basic knowledge of advanced calculus including methods for solving ODEs and basics of PDEs

Course objectives

The course is designed to teach students various techniques to solve PDEs including boundary value problems and introduce them to the important mathematical tool of Calculus of Variations and its methods.

Syllabus

Methods of solutions of First Order PDEs and important second order PDEs viz. Heat, Wave and Laplace equations.Fourier Transform Methods, Schwarz-Christoffel Transformation, Calculus of Variation, Numerical Methods for PDEs,Finite Difference in polar coordinates etc.

Expected Outcomes

The students are expected to develop knowledge about a variety of techniques for solving mathematical models in the form of PDEs.

References

1. Mitchel A.R and Griffith D.F .The Finite Difference Method in Partial Differential Equations,John Wiley and sons ,New York (1980)
2. Gupta.A.S . Calculus of Variations with Applications.PHI Pvt. Ltd New Delhi (1997)
3. Introduction to PDE –K..Sankara Rao-PHI
4. Advanced Engineering Mathematics-Erwin Kreizig . .
5. Introductory Methods of Numerical Analysis-S.S Sastry PHI
6. Tychonov.A.N and Samarskii.A.A. Partial Differential Equations of Mathematical Physics.Holden-Day,1964
7. Partial Differential Equations-Sneddon.

Module	Content	Hours	Semester Exam Marks (%)
I	First order PDEs .Linear Equations, Lagrange method, Cauchy method, Charpits' method, Jacobian method. Second order PDEs, Classifications, Formulations and method of solutions Wave equation, Heat equations and Laplace equation.	9	20
II	Fourier Transform method for solving PDEs, relevant formulae for transform of partial derivatives, one dimensional heat conduction problems in infinite and semi infinite rod, Laplace equation, Poisson Equation.	9	20
First Internal Examination			
III	Concept of variation and its properties, Euler's equation, Functionals dependent on first and higher order derivatives, Functionals dependent on functions of several independent variables, Problems with moving boundaries, Direct methods, Ritz and Kantorovich methods.	9	15
IV	Schwarz-Christoffel Transformation, Transformation of boundaries in parametric form, Physical applications, Fluid flow problems, Heat flow problems.	7	15

Second Internal Examination			
V	Numerical methods for one dimensional parabolic equation, Explicit and Crank-Nicolson Schemes, Thomas Algorithm, Weighted average approximation, Dirichlet and Neumann conditions, Two dimensional parabolic equations, ADI method.	9	15
	L		
VI	Solutions of Laplace and Poisson equations in rectangular region, Finite difference in polar coordinates, Formule for derivatives near curved boundary while using a square mesh.	7	15
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6303	ADVANCED ENGINEERING FLUID DYNAMICS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of **Fluid Mechanics and Vector calculus** at UG Level

Course Objectives

To understand the basic concept and principles of modeling and analysing thermo-fluid systems, and the applications of the same.

Syllabus

Introduction to fluid dynamics, Differential and integral forms of conservation equations, Navier-Stokes equations, Non-dimensionalisation of N-S equations and order of magnitude analysis, Exact solutions of N-S equations, Boundary layer theory, Prandtl boundary layer equations, von-Karman momentum integral equations, Introduction to turbulent flow, Reynolds stresses, boundary layer equations, Turbulence modelling, Turbulent flow through pipes and ducts, Turbulent jets and wakes.

Expected Outcomes

The students are expected to have a sound understanding of the concept of fluid dynamic principles and capability of applying this in the modeling and analyzing of various thermo-fluid systems in engineering.

References:

1. White, F. M., Viscous Fluid Flow, Third Edition, McGraw-Hill, 2006
2. H. Schlitchting, K.Gersten, Boundary Layer Theory, 8th Edition, Springer, 2004.
3. Papanastasiou, T. C., Georgiou, G. C., and Alexandrou, A. N., Viscous Fluid Flow, CRC Press, 2000.
4. Muralidhar, K. and Biswas, G., Advanced Engineering Fluid Mechanics, Second Edition, Narosa Publishing House, 2005.
5. John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, Lynne B. Jack, Fluid Mechanics, Pearson Education 2009
6. Yunus A. Cengel, John M. Cimbala, Fluid Mechanics, 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., 2010.
7. Pijush K. Kundu, Ira M. Cohen, Fluid Mechanics, Academic Press, 2004.

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to fluid dynamics:** Review of fundamental concepts, Reynolds transport equation, Stokes hypothesis, Integral and differential forms of continuity, momentum, and energy equations.	10	20
II	Navier-Stokes equations and boundary conditions, Non-		15

	dimensionalisation of N-S equations and order of magnitude analysis, dimensionless parameters and their significance.	7	
First Internal Examination			
III	**Exact solutions of incompressible Navier-Stokes equations**: Couette flow, flow between rotating cylinders, Stokes first problem, fully developed flow through ducts, Low Reynolds number flows.	8	15
IV	**Boundary layer theory:** Prandtl boundary layer equations, Blasius solution and other similarity solutions of the laminar boundary layer, Karman momentum integral equations, prediction of boundary layer separations.	9	20
Second Internal Examination			
V	**Introduction to turbulent flow**: Mean motion and fluctuation, time averaged turbulent flow equations, Reynolds stresses, boundary layer equations, boundary conditions	8	15
VI	**Turbulence modelling:** Shear stress models, mixing length hypothesis, k-Ɛ model, universal velocity distribution laws, flow through pipes and ducts, turbulent jets and wakes	9	15
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6305	**ADVANCED HEAT TRANSFER**	**3-0-0- 3**	**2015**

Course Prerequisites

A knowledge of first and second law of thermodynamics, basic heat transfer of conduction, convection, and radiation, as well as fluid mechanics such as external and internal flow. An ability to analytically and numerically solve ordinary and partial differential equations.

Course Objectives

Apply scientific and engineering principles to analyze thermofluid aspects of engineering systems; use appropriate analytical and numerical tools to investigate heat transfer phenomena; both competent and confident in interpreting results of investigations related to heat transfer ; recognize the broad technological context of heat transfer.

Syllabus

Heat transfer characteristics of Fins. Steady state conduction in one and two dimensional systems. Unsteady state conduction. Forced convection equations. Approximate and exact analysis of boundary layers. Free convection. Radiative properties of materials . Radiative exchange between two surfaces. Radiation exchange in an enclosure. Solar and gas radiation

Expected Outcomes

Deepens and broadens the understanding of heat transfer.

References:

1. Yunus A Cengel, Heat and Mass Transfer, A practical approach, Tata McGraw-Hill, 2007.
2. Holman, J. P., Heat Transfer, Ninth Edition, Tata McGraw-Hill, 2002.
3. D. Poulikakos: Conduction Heat Transfer, Prentice Hall, 1994.
4. Fundamentals of Heat and Mass Transfer- Incropera F P and Dewitt D P
5. V.S. Arpaci: Conduction Heat Transfer, Addision Wesly, 1996
6. H.S. Carslaw and J.C. Jaeger: Conduction of Heat in Solids, Oxford University Press, 1959.
7. Bejan: Convection Heat Transfer, J. Wiley, 2007
8. M.F. Modest: Radiative Heat Transfer, McGraw Hill, 1993
9. Siegel and Howell, Thermal radiation Heat transfer, McGraw Hill,
10. Kays and Crawfard., Convective heat and mass transfer, Mc-Graw Hil Nations Industrial Development Organization, Vienna.Yoder and Witczak, 'Principles of Pavement Design', John Wiley,1975

Module	Content	Hours	Semester Exam Marks (%)
I	Heat transfer characteristics of straight, annular, and pin fins of uniform and non-uniform cross sections. Steady state conduction with uniform internal heat generation-temperature distribution and heat flux for regular solids with uniform heat generation-temperature dependent and location dependent heat generation	4	15

	steady state conduction in two dimensional systems. Analytical and numerical methods.	4	
II	Unsteady state conduction: unsteady state heating or cooling-Newtonian heating or cooling- Heating or cooling of finite and semi-infinite slabs with negligible surface resistance for different boundary conditions	6	20
	Solutions of heating or cooling of regular solids with comparable internal and external resistance by simple analytical methods and use of charts-periodic variation of surface temperature of infinitely thick walls neglecting and considering surface resistances.	4	
First Internal Examination			
III	Forced convection: Equations of motion of a viscous fluid. General equation of energy transport - 2D boundary layer equation for momentum and energy transport. Laminar flow heat transfer: Exact solutions of the 2D boundary layer momentum and energy equations.	4	15
IV	Approximate calculations of the boundary layer by the momentum and energy integral equations. Turbulent flow heat transfer: Analog methods- Reynolds, Prandtl and von Karman.	6	20
Second Internal Examination			
V	Free convection: Solutions of the boundary layer equations for a vertical plate and a horizontal cylinder – approximate solutions-free convection with a turbulent boundary layer.	4	15
	Radiation: Radiative properties of real materials Radiative properties of metals and opaque non-metals-modifications of spectral characteristics. Exchange of radiant energy between black isothermal surfaces. Radiative exchange between two surfaces-	5	
VI	methods for evaluating configuration factors –radiation in a black enclosure, Radiation exchange in an enclosure composed of diffuse-gray surfaces Radiation between finite areas-radiation between infinitesimal areas,	4	15
	Solar and gas radiation.	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6307	ADVANCED THERMODYNAMICSAND COMBUSTION	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of thermodynamics at UG Level.

Course Objectives

To understand the principles of combustion and to get broad knowledge in thermodynamics.

Syllabus

Introduction to thermodynamics, Second law of thermodynamics and concept of chemical equilibrium,Chemistry of Combustion,Physics of Combustion,Premixed Flame,Diffusion Flame, Combustion and Environment.

Expected Outcomes

The students are expected to Have a sound understanding of the principles of combustion and uderstand the complexities of industrial combustion processes

References

1. Thermodynamics – An Engineering Approach, YunusCengel and Michael Boles,7th Ed., Tata McGraw Hill
2. Modern Engineering Thermodynamics, Robert Balmer, Elseveir.
3. Advanced Thermodynamics for Engineers, Winterbone, John Wiley
4. Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw Hill
5. Fundamentals of Engineering Thermodynamics, Michael Moran, Howard Shapiro, John Wiley
6. Fundamental s of Combust ion, D. P. Mishra, Prentice Hall of India, New Del hi, 2008.
7. Principles of Combustion,Kuo K. K., John Wiley and Sons.

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to thermodynamics:** Thermodynamics-equation of state, properties of gas mixtures, First law analysis of reacting systems, enthalpy of formation and heat of reaction, stoichometric and equivalence ratio, adiabatic flame temperature.	7	15
II	Second law of thermodynamics and concept of chemical equilibrium, Gibbs free energy and the equilibrium constant of a chemical reaction (VantHofts equation). Calculation of equilibrium Composition of a chemical reaction.	8	15
First Internal Examination			
III	**Chemistry of Combustion:** Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.	5	15

	Physics of Combustion: Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.	5	
IV	**Premixed Flame:** One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.	8	15
Second Internal Examination			
V	**Diffusion Flame:** Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion.	7	20
VI	**Combustion and Environment:** Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.	6	20
Cluster Level End Semester Examination			

ELECTIVE- I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6313	**REFRIGERATION ENGINEERING**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of principles of refrigeration, basic thermodynamics, at UG Level.

Course Objectives

The course is designed to provide a strong background in the concept of refrigeration. Sound knowledge in vapour compression and vapour absorption system and operations

Syllabus

Vapour Compression refrigeration systems, multi stage refrigeration systems, Cascade systems, Sorption refrigeration, Classification of sorption systems, Absorption and adsorption systems, Dry and wet types; Working principles of sorption refrigeration system, Low temperature refrigeration systems, Air cycle refrigeration, Other methods of refrigeration, Refrigerants, Environmental impact of refrigerants

Expected Outcomes

The students are expected to gain knowledge of advanced refrigeration, sorption refrigeration, and environmentally benign refrigerants. .`

References

1. Stocker W.F. and Jones J.W., *Refrigeration and Air Conditioning*, McGraw-Hill Publishing

Company.
2. W. B. Gosney, Principles of Refrigeration, Cambridge University Press, 1982
3. Dossat R.J., *Principle of Refrigeration*, Wiley.
4. K. E. Herold, R. Radermacher and S. A. Klein, Absorption Chillers and Heat Pumps, CRC Press, 1996
5. Arora C.P., *Refrigeration and Air Conditioning*, McGraw-Hill.

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction: Recapitulation of Thermodynamics, Thermodynamics process pertaining to refrigeration and air conditioning. First and Second law applied to refrigerating machines, Carnot principles, COP, EER	4	15
	Physical, thermodynamic, properties of refrigerants (packages, like REFPROP), Environmental impact of Refrigerants Global warming, Ozone depletion, Alternate refrigerants, future refrigerants.	4	
II	Different methods of refrigeration, advanced vapour compression systems, multi pressure systems, Flash gas removal, Two evaporator and one compressor systems.	6	25
	One evaporator and two compressor systems, other combinations of compressors, evaporators and condensers, Low temperature refrigeration, cascade systems.	6	
First Internal Examination			
III	Introduction: Classification of sorption systems, Absorption and adsorption systems, Dry and wet types; Working principles of sorption refrigeration system, heat pump and heat transformer.	6	15
	Wet absorption systems; Refrigerant absorbent combination: LiBr-H2O and NH3-H2O solution thermodynamics, Pressure - concentration - temperature / enthalpy relations and charts.	6	15
Second Internal Examination			
IV	Vapour absorption refrigeration systems, principles of operation, Vapour absorption refrigeration systems, principles of operation, description of components and their constructional features refrigerant, absorber combinations.	8	15
	Criteria for selection, performance analysis, Working principle of three fluid absorption systems; Introduction to dry absorption / adsorption systems.	6	
V	Air Refrigeration Systems: Thermodynamic processes, priority criteria and suitability of air refrigeration system. Types of Air refrigeration system.	4	15
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6415	HYDRAULIC, PNEUMATIC AND FLUID CONTROLS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of hydraulics, pneumatics and various fluid control devices in UG level.

Course Objectives

By completing this module, the student should be able to:

- Understand the main components of the hydraulic and pneumatic systems
- Design and understand the electro-hydraulic and electro-pneumatic circuits.
- Design hydraulic and pneumatic circuits.
- Classify various fluidic devices and their area of application.

Syllabus

Introduction to hydraulic/pneumatic devices-Types of hydraulic motors and their characteristics-Hydraulic valves:-JIC symbols of hydraulic/pneumatic components-Typical hydraulic circuits-Design of hydraulic/pneumatic equipment/circuit- Drawing the circuit using standard symbols-Fluidics: Introduction to fluidic devices

Expected Outcomes:

Students will be able to:

Define various concepts of hydraulics. Classify the accessories use in hydraulic system. Identify various valves and auxiliaries. Rectify the problems; Describe the constructional details of pumps and motors. Classify the hydraulic circuits. Develop Hydraulic Circuits. Identify various components of pneumatic system. Differentiate pneumatic and hydraulic system. Ability to identify or predict the flow regime in a given engineering system based on consideration of the governing groups.
References 1. Pippenger , John J &Koff Richard M: Fluid Power Controls 2. Pippenger , John J &Hicks,Tyler G: Industrial Hydraulics 3. Kirshner, Joseph M: Fluid Amplifiers 4. Kirshner, Joseph M & Silas Katz: Design Theory of Fluidic components 5. Dr. Heinz Zoebl, Techn: Fundamentals of Hydraulic circuitry

Module	**Content**	**Hour s**	**Semester Exam Marks (%)**
I	**Introduction :** Introduction to hydraulic/pneumatic devices, their applications and characteristics, comparison of electric, hydraulic and pneumatic devices. Pumps and motors: principles of working, range of displacement and pressures. Fixed and variable discharge pumps, gear pumps, internal gear pump, serotor pump, vane pump/piston pump, axial piston pump, swash plate pump, bent-axis pump.	12	20
II	**Hydraulic devices and their accessories:** Types of hydraulic motors and their characteristics. Accessories: Hydraulic accumulators, intensifiers, filters, heater, cooler, tank.	6	15
First Internal Examination			
III	**Types of hydraulic valves and their operation:** Hydraulic valves: Stop valve, non-return valve, relief valve, sequence valve, counter balance valve, pressure reducing valve, flow control valves, direction control valves, their principles of operations and applications. JIC symbols of hydraulic/pneumatic components. Properties of commonly used hydraulic fluids	8	15
IV	**Typical hydraulic circuits**: Examples of practical circuits like those used in machine tools, riveter, pneumatic hammer, hydraulic pressure, power steering.	6	15
Second Internal Examination			
V	**Designing parameters:** Design of hydraulic/pneumatic equipment/circuit to fulfil a given set of requirements like a sequence of operations, load conditions, speed of operation etc. Specifying the components and their rating. Drawing the circuit using standard symbols.	6	15

VI	**Introduction to fluidics:** Introduction to fluidic devices, principle of working of common fluidic devices like wall attachment devices, proportional amplifiers, turbulent amplifiers, fluidic logic devices. Examples of applications of fluidic devices like edge control of steel plate in rolling mills, tension control.	10	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6317	**THERMAL ENVIRONMENTAL ENGINEERING**	**3-1-0- 4**	**2015**

Course Prerequisites

Basic knowledge of Thermodynamics, Refrigeration, Heat transfer at UG/PG Level.

Course Objectives

The course is designed to provide students a strong background in the Air conditioning practices, theory ,basic principles and design of air conditioning systems.

Syllabus

Air conditioning -Properties of air- Applied psychrometry- Estimation of Air Conditioning Load- Summer Air Conditioning Processes- Winter Air Conditioning Processes-Air Distribution-Air duct design- Air Handling Equipments- Air Conditioning Systems.

Expected Outcomes

This course will provide a gist of the theory behind the Air conditioning and will emphasize direct applications of theory to design of an Air conditioning system. The students are expected to apply the general principles of psychrometry and applied psychometrics in Air conditioning with a knowledge of load estimation,equipment selection, duct design etc.

References

1. Threlkeld, J. L., Thermal Environmental Engineering, Second Edition, Prentice Hall, 1970.
2. Norman C. Harris, N. C., Modern Air Conditioning Practice, Third edition, McGraw-Hill, 1985.
3. Levenhagen, J. L., Spethmann, D. H., Heating Ventilating and Air conditioning Controls and Systems, McGraw Hill1993.

Module	Content	Hours	Semester Exam Marks (%)
I	**Air conditioning:** Introduction-physiological basis for air conditioning-classification of air conditioning systems-Air conditioning system components.	3	15
	Properties of air: Applied psychrometry - Psychrometric chart-Thermal comfort, effective temperature, comfort chart – Inside design condition, ventilation standards	5	
II	**Estimation of Air Conditioning Loads:** Summer and Winter air conditioning load-load classification- heating and cooling; heat gain/loss through glass, heat gain/loss through structures, internal load, ventilation load, and infiltration load.	8	15
First Internal Examination			
III	**Summer Air Conditioning Processes:** Room sensible factor, coil sensible factor-ADP-Summer Air Conditioning process.	8	15
IV	**Winter Air Conditioning Processes.**	8	15
Second Internal Examination			
V	**Air Distribution:** Room air distribution, air diffusion equipments, friction losses and dynamic loss in ducts	4	20
	Air duct design: Ducts-types-fittings-methods of sizing.	5	
VI	**Air Handling Equipments:** Fans – types, performance, and selection; air conditioning apparatus, cooling dehumidifying, humidifying heating and cleaning equipments.	4	20
	Air Conditioning Systems: DX system, all water system, all air system, air water system, central and unitary systems, fan coil system; automatic controls of air conditioning systems, thermostats, dampers, and damper motors; automatic valves piping design- water piping, refrigerant piping, steam piping.	5	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6319	SOLAR THERMAL ENGINEERING	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of solar energy, thermal engineering at UG/PG Level.

Course Objectives

The course is designed to provide students a strong background in the concept of solar engineering, solar energy and alternative energy

Syllabus

Introduction, sun and its energy, solar radiation and its measurement, collection of solar energy, solar ait heater, thermal energy storage, passive solar house, energy storage, latent heat storage.

Expected Outcomes

The students are expected to apply the general principles of solar thermal engineering to design solar energy harnessing devices and make professionals in power and energy industry fields

References

1. F Kreith and J F Kreider: Principles of Solar thermal Engg.
2. J A Diffie and W A Beckman: Solar Engineering of Thermal processes
3. A B Meinel and F P Meinel: Applied Solar Engineering
4. S P Sukhatme: Solar Energy

5. Tiwari, G.N. and SayestaSuneja., Solar Thermal engineering Systems, Narosa Publishing House.
6. Duffie and Backuran, Solar Thermal Engineering.
7. H.P. Gupta.,Solar Engineering

Module	Content	Hours	Semester Exam Marks (%)
I	**Sun and it's Energy**: Solar spectrum, solar constant & solar radiations, Sun earth angles, solar hourly radiations-Radiations on Horizontal and inclined surfaces.,	12	20
II	**Solar radiation**- solar radiation data, solar radiation geometry, empirical equations for predicting solar radiation, solar radiation on tilted surfaces, Measurement of Solar Radiation: Pyrheliometer, Pyranometer, Sunshine- Recorder.	8	15
First Internal Examination			
III	**Collection of Solar Energy** : Flat plate collectors, classification, construction, heat transfer coefficients, optimisation of heat losses - Analysis of flat plate collectors, testing of collectors	6	15
IV	**Solar Air Heater** : Description & classification, conventional air heater, air heater above the collector surface air heaters with flow on both sides of absorbers to pan air heater, air heater with finned absorbers, porous absorber	6	15
Second Internal Examination			
V	**Thermal energy storage**- sensible heat storage, latent heat storage , thermochemical storage. Solar Water heater: Collection cum storage water heater, Natural circulation & forced circulation water heater, shallow solar ponds. Solar Concentrators: Classification, characteristic parameters, types of concentrators materials in concentrators.	6	15
VI	**Passive Solar House**: Thermal gain, Thermal cooling, Ventilation. **Energy Storage**: Sensible heat storage, Liquid, Solid, packed bed, **Latent heat storage**. Solar Distillation, Solar Cookers, Solar Refrigeration	10	20
Cluster Level End Semester Examination			

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6321	BOUNDARY LAYER THEORY AND TURBULENCE	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of fluid mechanics, boundary layer at UG/PG Level.

Course Objectives

- To impart knowledge on the governing equations of boundary layer flow.
- To impart knowledge on the Laminar and turbulence flow Boundary Layer Equations
- To understand the theory of turbulent flow and its modeling, structure types and a detailed insight about turbulence..

Syllabus

Fundamentals Boundary layer theory, Laminar and turbulent boundary layers, boundary layer separation, turbulence and turbulence models, Statistical Theory of Turbulence, Turbulent flows

Expected Outcomes

On successful completion of this course the student will be able to apply the fundamental concepts related to viscous flows in general, and to boundary layer flows ,apply the concepts of boundarylayer theory and turbulence.

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References

1. G. Biswas and E. Eswaran, Turbulent Flows, Fundamentals, Experiments and Modelling, Narosa Publishing House, 2002.
2. H. Schlichting and Klaus Gersten, Boundary Layer Theory, Springer 2000.
3. R.J. Garde, Turbulent Flow, New Age International (p) Limited, Publishers, 2000.

Module	Content	Hours	Semester Exam Marks (%)
I	**Fundamentals Boundary layer theory**-Boundary Layer Concept, Laminar Boundary Layer on a Flat Plate at zero incidences, Turbulent Boundary Layer on a Flat plate at zero incidence,Fully Developed Turbulent Flow in a pipe, Boundary Layer on an airfoil,	10	20
II	**Boundary Layer separation.**	4	10
	First Internal Examination		
III	**Turbulent Boundary layers**Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Law of the wall – Friction law – Fully developed Internal flows – Chennel Flow, Couettee – Poiseuille flows, Pipe Flow	8	20
IV	**Turbulence and Turbulence Models:** Nature of turbulence –	8	20

	Averaging Procedures – Characteristics of Turbulent Flows – Types of Turbulent Flows – Scales of Turbulence, Prandtl's Mixing length, Two-Equation Models, Low – Reynolds – Number Models, Large – Eddy Simulation.		
Second Internal Examination			
V	**Statistical Theory of Turbulence**: Ensemble Average – Isotropic Turbulence and Homogeneous Turbulence – Kinematics of Isotropic Turbulence – Taylor's Hypothesis – Dynamics of Isotropic Turbulence – Grid Turbulence and decay – Turbulence in Stirred Tanks.	8	15
VI	**Turbulent flows** Wall Turbulent shear flows – Structure of wall flow – Turbulence characteristics of Boundary layer – Free Turbulence shear flows – Jets and wakes – Plane and axi - symmetric flows.	8	15
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;

(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To understand the methodology of doing research;

(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals -

research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :

(1) Be motivated for research through the attainment of a perspective of research methodology;

(2) Analyze and evaluate research works and to formulate a research problem to pursue research;

(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task,	5	15

	literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.		
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6309	**SEMINAR - 1**	**0 - 0 - 2 - 2**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;
(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :
(1) Be motivated in reading which enhances the literature review required for doing project work;
(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6311	**Thermal Sciences Laboratory**	0-0-2- 1	2015

Course Prerequisites: None

Course Objectives

- To understand the need for experimental investigation in thermal and Fluids Engineering.
- To know how to plan and design experiments, select required measuring instruments.
- To learn how to make experimental set up and validate and calibrate
- To know about experimental data collection, data processing and analysis
- To know about presenting the experimental results and deriving inferences and arriving at conclusions

Student shall design their own experiment by setting an experimental facility or suitably modifying one of the existing experimental set ups in any of the laboratories of Thermal Engineering, Heat transfer, Fluid Mechanics, Fluid Machinery, Instrumentation etc., related to Thermal and Fluids stream under the supervision of Faculty-in-Charge of the Class and Staff-in-Charge, concerned Laboratory. They shall conduct the planned experiment and submit a detailed report on the experimental results obtained. The report shall also contain the detailed study carried out prior to designing the experiment. Marks will be awarded on the basis of the quality of the experiment conducted, the final report submitted, and oral examination conducted towards the end of the semester.

Expected Outcomes. After completion if this course

- Student will be able to identify, plan, design, procure and build an experimental facility.
- Students will become skilled in conducting experiments and data collection and alaysis.
- Students will know how to present the results and derive conclusions.

Assessment :

i) Practical Records /outputs 40%

ii) Regular Class Viva-Voce 20%

iii) Final Test (Objective) 40%

KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	:	*10*
Branch	:	*Mechanical Engineering*
Stream	:	**Thermal Engineering**
Year	:	*2015*
No. of Credits	:	*66*

SEMESTER 1

Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
A	10ME6301	Advanced Engineering Mathematics	3-1-0	40	60	3	100	4
B	10ME6303	Advanced Engineering Fluid Dynamics	3-0-0	40	60	3	100	3
C	10ME6305	Advanced Heat Transfer	3-0-0	40	60	3	100	3
D	10ME6307	Advanced Thermodynamics and Combustion	3-0-0	40	60	3	100	3
E	10ME6XXX	Elective I	3-0-0	40	60	3	100	3
F	10GN6001	Research Methodology	0-2-0	100			100	2
G	10ME6409	Seminar I	0-0-2	100			100	2
H	10ME6411	Engineering Software Laboratory	0-0-2	100			100	1
		TOTAL	**15-3-4**	**500**	**300**	**-**	**800**	**21**

Elective I

10ME6313 Refrigeration Engineering

10ME6415 Hydraulic, Pneumatic And Fluid Controls

10ME6317 Thermal Environmental Engineering

10ME6319 Solar Thermal Engineering

10ME6321 Boundary layer and turbulence

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
A	10ME6302	Internal Combustion Engine, Combustion & Pollution	3-1-0	40	60	4	100	4
B	10ME6304	Advanced Power plant Engineering	3-0-0	40	60	3	100	3
C	10ME6306	Measurements In Thermal Engineering	3-0-0	40	60	3	100	3
D	10ME6XXX	Elective II	3-0-0	40	60	3	100	3
E	10ME6XXX	Elective III	3-0-0	40	60	3	100	3
		Mini Project	0-0-4	100			100	2
H		Advanced Heat Transfer Lab	0-0-2	100			100	1
		TOTAL	**15-0-6**	**400**	**300**	**-**	**700**	**19**

Elective II

10ME6114 Soft Computing Techniques
10ME6116 Design of Experiments
10ME6118 Management Information System
10ME6122 Quality and Reliability Engineering
10ME6124 Project Engineering and Management
10ME6326 Design of Heat Transfer Equipment
10ME6328 Renewable Energy Systems
10ME6432 Industrial refrigeration system
10ME6434 Computational fluid flow & heat transfer
10ME6336 Advanced Gas Dynamics

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total	Credits
					Marks	Duration (hours)		
A	10ME7XXX	Elective IV	3-0-0	40	60	3	1	3
B	10ME7XXX	Elective V	3-0-0	40	60	3	40	3
G	10ME7301	Seminar II	0-0-2	100			100	2
	10ME7303	Project (Phase 1)	0-0-12	50			50	6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**230**	**14**

Elective IV

10ME7305 Cryogenic engineering
10ME7307 Design and analysis of turbo machines
10ME7309 Convection and Two-phase Flow
10ME7411 Gas Turbines
10ME7313 Cogeneration and Waste Heat Recovery Systems
10ME7315 Modern Energy Conversion Systems
10ME7417 Steam turbines
10ME7419 Air conditioning & Ventilation
10ME7421 Finite element analysis for heat transfer
10ME7323 Energy Conversion and Heat Recovery Systems

SEMESTER 4

Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credit
					Marks	Duration (hours)		
	10ME7304	Project (Phase 2)	0-0-23	70	30		100	12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**100**	**12**

TOTAL NUMBER OF CREDITS: 66

	Course Name	L-T-P-Credits	Year of Introduction
10ME6301	**ADVANCED ENGINEERING MATHEMATICS**	**3-1-0- 4**	**2015**

Course Prerequisites

Basic knowledge of advanced calculus including methods for solving ODEs and basics of PDEs

Course objectives

The course is designed to teach students various techniques to solve PDEs including boundary value problems and introduce them to the important mathematical tool of Calculus of Variations and its methods.

Syllabus

Methods of solutions of First Order PDEs and important second order PDEs viz. Heat, Wave and Laplace equations.Fourier Transform Methods, Schwarz-Christoffel Transformation, Calculus of Variation, Numerical Methods for PDEs,Finite Difference in polar coordinates etc.

Expected Outcomes

The students are expected to develop knowledge about a variety of techniques for solving mathematical models in the form of PDEs.

References

1. Mitchel A.R and Griffith D.F .The Finite Difference Method in Partial Differential Equations,John Wiley and sons ,New York (1980)
2. Gupta.A.S . Calculus of Variations with Applications.PHI Pvt. Ltd New Delhi (1997)
3. Introduction to PDE –K..Sankara Rao-PHI
4. Advanced Engineering Mathematics-Erwin Kreizig . .
5. Introductory Methods of Numerical Analysis-S.S Sastry PHI
6. Tychonov.A.N and Samarskii.A.A. Partial Differential Equations of Mathematical Physics.Holden-Day,1964
7. Partial Differential Equations-Sneddon.

Module	Content	Hours	Semester Exam Marks (%)
I	First order PDEs .Linear Equations, Lagrange method, Cauchy method, Charpits' method, Jacobian method. Second order PDEs, Classifications, Formulations and method of solutions Wave equation, Heat equations and Laplace equation.	9	20
II	Fourier Transform method for solving PDEs, relevant formulae for transform of partial derivatives, one dimensional heat conduction problems in infinite and semi infinite rod, Laplace equation, Poisson Equation.	9	20
	First Internal Examination		
III	Concept of variation and its properties, Euler's equation, Functionals dependent on first and higher order derivatives, Functionals dependent on functions of several independent variables, Problems with moving boundaries, Direct methods, Ritz and Kantorovich methods.	9	15
IV	Schwarz-Christoffel Transformation, Transformation of boundaries in parametric form, Physical applications, Fluid flow problems, Heat flow problems.	7	15

Second Internal Examination			
V	Numerical methods for one dimensional parabolic equation, Explicit and Crank-Nicolson Schemes, Thomas Algorithm, Weighted average approximation, Dirichlet and Neumann conditions, Two dimensional parabolic equations, ADI method.	9	15
	L		
VI	Solutions of Laplace and Poisson equations in rectangular region, Finite difference in polar coordinates, Formule for derivatives near curved boundary while using a square mesh.	7	15
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6303	ADVANCED ENGINEERING FLUID DYNAMICS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of **Fluid Mechanics and Vector calculus** at UG Level

Course Objectives

To understand the basic concept and principles of modeling and analysing thermo-fluid systems, and the applications of the same.

Syllabus

Introduction to fluid dynamics, Differential and integral forms of conservation equations, Navier-Stokes equations, Non-dimensionalisation of N-S equations and order of magnitude analysis, Exact solutions of N-S equations, Boundary layer theory, Prandtl boundary layer equations, von-Karman momentum integral equations, Introduction to turbulent flow, Reynolds stresses, boundary layer equations, Turbulence modelling, Turbulent flow through pipes and ducts, Turbulent jets and wakes.

Expected Outcomes

The students are expected to have a sound understanding of the concept of fluid dynamic principles and capability of applying this in the modeling and analyzing of various thermo-fluid systems in engineering.

References:

1. White, F. M., Viscous Fluid Flow, Third Edition, McGraw-Hill, 2006
2. H. Schlitchting, K.Gersten, Boundary Layer Theory, 8^{th} Edition, Springer, 2004.
3. Papanastasiou, T. C., Georgiou, G. C., and Alexandrou, A. N., Viscous Fluid Flow, CRC Press, 2000.
4. Muralidhar, K. and Biswas, G., Advanced Engineering Fluid Mechanics, Second Edition, Narosa Publishing House, 2005.
5. John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, Lynne B. Jack, Fluid Mechanics, Pearson Education 2009
6. Yunus A. Cengel, John M. Cimbala, Fluid Mechanics, 2^{nd} Edition, Tata McGraw Hill Education Pvt. Ltd., 2010.
7. Pijush K. Kundu, Ira M. Cohen, Fluid Mechanics, Academic Press, 2004.

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to fluid dynamics:** Review of fundamental concepts, Reynolds transport equation, Stokes hypothesis, Integral and differential forms of continuity, momentum, and energy equations.	10	20
II	Navier-Stokes equations and boundary conditions, Non-		15

	dimensionalisation of N-S equations and order of magnitude analysis, dimensionless parameters and their significance.	7	
First Internal Examination			
III	**Exact solutions of incompressible Navier-Stokes equations**: Couette flow, flow between rotating cylinders, Stokes first problem, fully developed flow through ducts, Low Reynolds number flows.	8	15
IV	**Boundary layer theory:** Prandtl boundary layer equations, Blasius solution and other similarity solutions of the laminar boundary layer, Karman momentum integral equations, prediction of boundary layer separations.	9	20
Second Internal Examination			
V	**Introduction to turbulent flow**: Mean motion and fluctuation, time averaged turbulent flow equations, Reynolds stresses, boundary layer equations, boundary conditions	8	15
VI	**Turbulence modelling:** Shear stress models, mixing length hypothesis, k-Ɛ model, universal velocity distribution laws, flow through pipes and ducts, turbulent jets and wakes	9	15
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6305	**ADVANCED HEAT TRANSFER**	**3-0-0- 3**	**2015**

Course Prerequisites

A knowledge of first and second law of thermodynamics, basic heat transfer of conduction, convection, and radiation, as well as fluid mechanics such as external and internal flow. An ability to analytically and numerically solve ordinary and partial differential equations.

Course Objectives

Apply scientific and engineering principles to analyze thermofluid aspects of engineering systems; use appropriate analytical and numerical tools to investigate heat transfer phenomena; both competent and confident in interpreting results of investigations related to heat transfer ; recognize the broad technological context of heat transfer.

Syllabus

Heat transfer characteristics of Fins. Steady state conduction in one and two dimensional systems. Unsteady state conduction. Forced convection equations. Approximate and exact analysis of boundary layers. Free convection. Radiative properties of materials . Radiative exchange between two surfaces. Radiation exchange in an enclosure. Solar and gas radiation

Expected Outcomes

Deepens and broadens the understanding of heat transfer.

References:

1. Yunus A Cengel, Heat and Mass Transfer, A practical approach, Tata McGraw-Hill, 2007.
2. Holman, J. P., Heat Transfer, Ninth Edition, Tata McGraw-Hill, 2002.
3. D. Poulikakos: Conduction Heat Transfer, Prentice Hall, 1994.
4. Fundamentals of Heat and Mass Transfer- Incropera F P and Dewitt D P
5. V.S. Arpaci: Conduction Heat Transfer, Addision Wesly, 1996
6. H.S. Carslaw and J.C. Jaeger: Conduction of Heat in Solids, Oxford University Press, 1959.
7. Bejan: Convection Heat Transfer, J. Wiley, 2007
8. M.F. Modest: Radiative Heat Transfer, McGraw Hill, 1993
9. Siegel and Howell, Thermal radiation Heat transfer, McGraw Hill,
10. Kays and Crawfard., Convective heat and mass transfer, Mc-Graw Hil Nations Industrial Development Organization, Vienna.Yoder and Witczak, 'Principles of Pavement Design', John Wiley,1975

Module	Content	Hours	Semester Exam Marks (%)
I	Heat transfer characteristics of straight, annular, and pin fins of uniform and non-uniform cross sections. Steady state conduction with uniform internal heat generation-temperature distribution and heat flux for regular solids with uniform heat generation-temperature dependent and location dependent heat generation	4	15

	steady state conduction in two dimensional systems. Analytical and numerical methods.	4	
II	Unsteady state conduction: unsteady state heating or cooling- Newtonian heating or cooling- Heating or cooling of finite and semi-infinite slabs with negligible surface resistance for different boundary conditions	6	20
	Solutions of heating or cooling of regular solids with comparable internal and external resistance by simple analytical methods and use of charts-periodic variation of surface temperature of infinitely thick walls neglecting and considering surface resistances.	4	
First Internal Examination			
III	Forced convection: Equations of motion of a viscous fluid. General equation of energy transport - 2D boundary layer equation for momentum and energy transport. Laminar flow heat transfer: Exact solutions of the 2D boundary layer momentum and energy equations.	4	15
IV	Approximate calculations of the boundary layer by the momentum and energy integral equations. Turbulent flow heat transfer: Analog methods- Reynolds, Prandtl and von Karman.	6	20
Second Internal Examination			
V	Free convection: Solutions of the boundary layer equations for a vertical plate and a horizontal cylinder – approximate solutions- free convection with a turbulent boundary layer.	4	15
	Radiation: Radiative properties of real materials Radiative properties of metals and opaque non-metals-modifications of spectral characteristics. Exchange of radiant energy between black isothermal surfaces. Radiative exchange between two surfaces-	5	
VI	methods for evaluating configuration factors –radiation in a black enclosure, Radiation exchange in an enclosure composed of diffuse-gray surfaces Radiation between finite areas-radiation between infinitesimal areas,	4	15
	Solar and gas radiation.	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6307	**ADVANCED THERMODYNAMICSAND COMBUSTION**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of thermodynamics at UG Level.

Course Objectives

To understand the principles of combustion and to get broad knowledge in thermodynamics.

Syllabus

Introduction to thermodynamics, Second law of thermodynamics and concept of chemical equilibrium,Chemistry of Combustion,Physics of Combustion,Premixed Flame,Diffusion Flame, Combustion and Environment.

Expected Outcomes

The students are expected to Have a sound understanding of the principles of combustion and uderstand the complexities of industrial combustion processes

References

1. Thermodynamics – An Engineering Approach, YunusCengel and Michael Boles,7th Ed., Tata McGraw Hill
2. Modern Engineering Thermodynamics, Robert Balmer, Elseveir.
3. Advanced Thermodynamics for Engineers, Winterbone, John Wiley
4. Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw Hill
5. Fundamentals of Engineering Thermodynamics, Michael Moran, Howard Shapiro, John Wiley
6. Fundamental s of Combust ion, D. P. Mishra, Prentice Hall of India, New Del hi, 2008.
7. Principles of Combustion,Kuo K. K., John Wiley and Sons.

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to thermodynamics:** Thermodynamics-equation of state, properties of gas mixtures, First law analysis of reacting systems, enthalpy of formation and heat of reaction, stoichometric and equivalence ratio, adiabatic flame temperature.	7	15
II	Second law of thermodynamics and concept of chemical equilibrium, Gibbs free energy and the equilibrium constant of a chemical reaction (VantHofts equation). Calculation of equilibrium Composition of a chemical reaction.	8	15
First Internal Examination			
III	**Chemistry of Combustion:** Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.	5	15

	Physics of Combustion: Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.	5	
IV	**Premixed Flame:** One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.	8	15
Second Internal Examination			
V	**Diffusion Flame:** Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion.	7	20
VI	**Combustion and Environment:** Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.	6	20
Cluster Level End Semester Examination			

ELECTIVE- I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6313	REFRIGERATION ENGINEERING	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of principles of refrigeration, basic thermodynamics, at UG Level.

Course Objectives

The course is designed to provide a strong background in the concept of refrigeration. Sound knowledge in vapour compression and vapour absorption system and operations

Syllabus

Vapour Compression refrigeration systems, multi stage refrigeration systems, Cascade systems, Sorption refrigeration, Classification of sorption systems, Absorption and adsorption systems, Dry and wet types; Working principles of sorption refrigeration system, Low temperature refrigeration systems, Air cycle refrigeration, Other methods of refrigeration, Refrigerants, Environmental impact of refrigerants

Expected Outcomes

The students are expected to gain knowledge of advanced refrigeration, sorption refrigeration, and environmentally benign refrigerants. .`

References

1. Stocker W.F. and Jones J.W., *Refrigeration and Air Conditioning*, McGraw-Hill Publishing Company.
2. W. B. Gosney, Principles of Refrigeration, Cambridge University Press, 1982
3. Dossat R.J., *Principle of Refrigeration*, Wiley.
4. K. E. Herold, R. Radermacher and S. A. Klein, Absorption Chillers and Heat Pumps, CRC Press, 1996
5. Arora C.P., *Refrigeration and Air Conditioning*, McGraw-Hill.

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction: Recapitulation of Thermodynamics, Thermodynamics process pertaining to refrigeration and air conditioning. First and Second law applied to refrigerating machines, Carnot principles, COP, EER	4	15
	Physical, thermodynamic, properties of refrigerants (packages, like REFPROP), Environmental impact of Refrigerants Global warming, Ozone depletion, Alternate refrigerants, future refrigerants.	4	
II	Different methods of refrigeration, advanced vapour compression systems, multi pressure systems, Flash gas removal, Two	6	25

	evaporator and one compressor systems.		
	One evaporator and two compressor systems, other combinations of compressors, evaporators and condensers, Low temperature refrigeration, cascade systems.	6	
First Internal Examination			
III	Introduction: Classification of sorption systems, Absorption and adsorption systems, Dry and wet types; Working principles of sorption refrigeration system, heat pump and heat transformer.	6	15
	Wet absorption systems; Refrigerant absorbent combination: LiBr-H2O and NH3-H2O solution thermodynamics, Pressure - concentration - temperature / enthalpy relations and charts.	6	15
Second Internal Examination			
IV	Vapour absorption refrigeration systems, principles of operation, Vapour absorption refrigeration systems, principles of operation, description of components and their constructional features refrigerant, absorber combinations.	8	15
	Criteria for selection, performance analysis, Working principle of three fluid absorption systems; Introduction to dry absorption / adsorption systems.	6	
V	Air Refrigeration Systems: Thermodynamic processes, priority criteria and suitability of air refrigeration system. Types of Air refrigeration system.	4	15
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6415	HYDRAULIC, PNEUMATIC AND FLUID CONTROLS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of hydraulics, pneumatics and various fluid control devices in UG level.

Course Objectives

By completing this module, the student should be able to:

- Understand the main components of the hydraulic and pneumatic systems
- Design and understand the electro-hydraulic and electro-pneumatic circuits.
- Design hydraulic and pneumatic circuits.
- Classify various fluidic devices and their area of application.

Syllabus

Introduction to hydraulic/pneumatic devices-Types of hydraulic motors and their characteristics-Hydraulic valves:-JIC symbols of hydraulic/pneumatic components-Typical hydraulic circuits-Design of hydraulic/pneumatic equipment/circuit- Drawing the circuit using standard symbols-Fluidics: Introduction to fluidic devices

Expected Outcomes:

Students will be able to:

Define various concepts of hydraulics. Classify the accessories use in hydraulic system. Identify various valves and auxiliaries. Rectify the problems; Describe the constructional details of pumps and motors. Classify the hydraulic circuits. Develop Hydraulic Circuits. Identify various components of pneumatic system. Differentiate pneumatic and hydraulic system. Ability to identify or predict the flow regime in a given engineering system based on consideration of the governing groups.

References

1. Pippenger , John J &Koff Richard M: Fluid Power Controls
2. Pippenger , John J &Hicks,Tyler G: Industrial Hydraulics
3. Kirshner, Joseph M: Fluid Amplifiers
4. Kirshner, Joseph M & Silas Katz: Design Theory of Fluidic components
5. Dr. Heinz Zoebl, Techn: Fundamentals of Hydraulic circuitry

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction :** Introduction to hydraulic/pneumatic devices, their applications and characteristics, comparison of electric, hydraulic and pneumatic	12	20

	devices. Pumps and motors: principles of working, range of displacement and pressures. Fixed and variable discharge pumps, gear pumps, internal gear pump, serotor pump, vane pump/piston pump, axial piston pump, swash plate pump, bent-axis pump.		
II	**Hydraulic devices and their accessories:** Types of hydraulic motors and their characteristics. Accessories: Hydraulic accumulators, intensifiers, filters, heater, cooler, tank.	6	15
First Internal Examination			
III	**Types of hydraulic valves and their operation:** Hydraulic valves: Stop valve, non-return valve, relief valve, sequence valve, counter balance valve, pressure reducing valve, flow control valves, direction control valves, their principles of operations and applications. JIC symbols of hydraulic/pneumatic components. Properties of commonly used hydraulic fluids	8	15
IV	**Typical hydraulic circuits**: Examples of practical circuits like those used in machine tools, riveter, pneumatic hammer, hydraulic pressure, power steering.	6	15
Second Internal Examination			
V	**Designing parameters:** Design of hydraulic/pneumatic equipment/circuit to fulfil a given set of requirements like a sequence of operations, load conditions, speed of operation etc. Specifying the components and their rating. Drawing the circuit using standard symbols.	6	15
VI	**Introduction to fluidics:** Introduction to fluidic devices, principle of working of common fluidic devices like wall attachment devices, proportional amplifiers, turbulent amplifiers, fluidic logic devices. Examples of applications of fluidic devices like edge control of steel plate in rolling mills, tension control.	10	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6317	THERMAL ENVIRONMENTAL ENGINEERING	3-1-0- 4	2015

Course Prerequisites

Basic knowledge of Thermodynamics, Refrigeration, Heat transfer at UG/PG Level.

Course Objectives

The course is designed to provide students a strong background in the Air conditioning practices, theory ,basic principles and design of air conditioning systems.

Syllabus

Air conditioning -Properties of air- Applied psychrometry- Estimation of Air Conditioning Load- Summer Air Conditioning Processes- Winter Air Conditioning Processes-Air Distribution-Air duct design- Air Handling Equipments- Air Conditioning Systems.

Expected Outcomes

This course will provide a gist of the theory behind the Air conditioning and will emphasize direct applications of theory to design of an Air conditioning system. The students are expected to apply the general principles of psychrometry and applied psychometrics in Air conditioning with a knowledge of load estimation,equipment selection, duct design etc.

References

1. Threlkeld, J. L., Thermal Environmental Engineering, Second Edition, Prentice Hall, 1970.
2. Norman C. Harris, N. C., Modern Air Conditioning Practice, Third edition, McGraw-Hill, 1985.
3. Levenhagen, J. L., Spethmann, D. H., Heating Ventilating and Air conditioning Controls and Systems, McGraw Hill1993.

Module	Content	Hours	Semester Exam Marks (%)
I	**Air conditioning:** Introduction-physiological basis for air conditioning-classification of air conditioning systems-Air conditioning system components.	3	15
	Properties of air: Applied psychrometry - Psychrometric chart-Thermal comfort, effective temperature, comfort chart – Inside design condition, ventilation standards	5	
II	**Estimation of Air Conditioning Loads:** Summer and Winter air conditioning load-load classification- heating and cooling; heat gain/loss through glass, heat gain/loss through structures, internal load, ventilation load, and infiltration load.	8	15
First Internal Examination			

III	**Summer Air Conditioning Processes:** Room sensible factor, coil sensible factor-ADP-Summer Air Conditioning process.	8	15
IV	**Winter Air Conditioning Processes.**	8	15
Second Internal Examination			
V	**Air Distribution:** Room air distribution, air diffusion equipments, friction losses and dynamic loss in ducts	4	20
	Air duct design: Ducts-types-fittings-methods of sizing.	5	
VI	**Air Handling Equipments:** Fans – types, performance, and selection; air conditioning apparatus, cooling dehumidifying, humidifying heating and cleaning equipments.	4	20
	Air Conditioning Systems: DX system, all water system, all air system, air water system, central and unitary systems, fan coil system; automatic controls of air conditioning systems, thermostats, dampers, and damper motors; automatic valves piping design- water piping, refrigerant piping, steam piping.	5	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6319	SOLAR THERMAL ENGINEERING	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of solar energy, thermal engineering at UG/PG Level.

Course Objectives

The course is designed to provide students a strong background in the concept of solar engineering, solar energy and alternative energy

Syllabus

Introduction, sun and its energy, solar radiation and its measurement, collection of solar energy, solar ait heater, thermal energy storage, passive solar house, energy storage, latent heat storage.

Expected Outcomes

The students are expected to apply the general principles of solar thermal engineering to design solar energy harnessing devices and make professionals in power and energy industry fields

References

1. F Kreith and J F Kreider: Principles of Solar thermal Engg.
2. J A Diffie and W A Beckman: Solar Engineering of Thermal processes
3. A B Meinel and F P Meinel: Applied Solar Engineering
4. S P Sukhatme: Solar Energy
5. Tiwari, G.N. and SayestaSuneja., Solar Thermal engineering Systems, Narosa Publishing House.
6. Duffie and Backuran, Solar Thermal Engineering.
7. H.P. Gupta.,Solar Engineering

Module	Content	Hours	Semester Exam Marks (%)
I	**Sun and it's Energy**: Solar spectrum, solar constant & solar radiations, Sun earth angles, solar hourly radiations-Radiations on Horizontal and inclined surfaces.,	12	20
II	**Solar radiation**- solar radiation data, solar radiation geometry, empirical equations for predicting solar radiation, solar radiation on tilted surfaces, Measurement of Solar Radiation: Pyrheliometer, Pyranometer, Sunshine- Recorder.	8	15
First Internal Examination			
III	**Collection of Solar Energy** : Flat plate collectors, classification, construction, heat transfer coefficients, optimisation of heat losses - Analysis of flat plate collectors, testing of collectors	6	15
IV	**Solar Air Heater** : Description & classification, conventional air heater, air heater above the collector surface air heaters with flow on both sides of absorbers to pan air heater, air heater with finned	6	15

	absorbers, porous absorber		
Second Internal Examination			
V	**Thermal energy storage**- sensible heat storage, latent heat storage , thermochemical storage. Solar Water heater: Collection cum storage water heater, Natural circulation & forced circulation water heater, shallow solar ponds. Solar Concentrators: Classification, characteristic parameters, types of concentrators materials in concentrators.	6	15
VI	**Passive Solar House**: Thermal gain, Thermal cooling, Ventilation. **Energy Storage**: Sensible heat storage, Liquid, Solid, packed bed, **Latent heat storage**. Solar Distillation, Solar Cookers, Solar Refrigeration	10	20
Cluster Level End Semester Examination			

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6321	**BOUNDARY LAYER THEORY AND TURBULENCE**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of fluid mechanics, boundary layer at UG/PG Level.

Course Objectives

- To impart knowledge on the governing equations of boundary layer flow.
- To impart knowledge on the Laminar and turbulence flow Boundary Layer Equations
- To understand the theory of turbulent flow and its modeling, structure types and a detailed insight about turbulence..

Syllabus

Fundamentals Boundary layer theory, Laminar and turbulent boundary layers, boundary layer separation, turbulence and turbulence models, Statistical Theory of Turbulence, Turbulent flows

Expected Outcomes

On successful completion of this course the student will be able to apply the fundamental concepts related to viscous flows in general, and to boundary layer flows ,apply the concepts of boundarylayer theory and turbulence.

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References

1. G. Biswas and E. Eswaran, Turbulent Flows, Fundamentals, Experiments and Modelling, Narosa Publishing House, 2002.
2. H. Schlichting and Klaus Gersten, Boundary Layer Theory, Springer 2000.
3. R.J. Garde, Turbulent Flow, New Age International (p) Limited, Publishers, 2000.

Module	Content	Hours	Semester Exam Marks (%)
I	**Fundamentals Boundary layer theory**-Boundary Layer Concept, Laminar Boundary Layer on a Flat Plate at zero incidences, Turbulent Boundary Layer on a Flat plate at zero incidence,Fully Developed Turbulent Flow in a pipe, Boundary Layer on an airfoil,	10	20
II	**Boundary Layer separation.**	4	10
First Internal Examination			
III	**Turbulent Boundary layers**Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Law of the wall – Friction law – Fully developed Internal flows – Chennel Flow, Couettee – Poiseuille flows, Pipe Flow	8	20
IV	**Turbulence and Turbulence Models:** Nature of turbulence – Averaging Procedures – Characteristics of Turbulent Flows –	8	20

	Types of Turbulent Flows – Scales of Turbulence, Prandtl's Mixing length, Two-Equation Models, Low – Reynolds – Number Models, Large – Eddy Simulation.		
	Second Internal Examination		
V	**Statistical Theory of Turbulence**: Ensemble Average – Isotropic Turbulence and Homogeneous Turbulence – Kinematics of Isotropic Turbulence – Taylor's Hypothesis – Dynamics of Isotropic Turbulence – Grid Turbulence and decay – Turbulence in Stirred Tanks.	8	15
VI	**Turbulent flows** Wall Turbulent shear flows – Structure of wall flow – Turbulence characteristics of Boundary layer – Free Turbulence shear flows – Jets and wakes – Plane and axi - symmetric flows.	8	15
	Cluster Level End Semester Examination		

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;

(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To understand the methodology of doing research;

(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :

(1) Be motivated for research through the attainment of a perspective of research methodology;

(2) Analyze and evaluate research works and to formulate a research problem to pursue research;

(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.

10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling,	5	20

	composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.		
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6409	**SEMINAR-I**	**0-0-2- 2**	**2015**

Course Prerequisites: None

Course Objectives

- Increasing the breadth of knowledge
- Enhancing the ability of self-study
- Improving presentation and communication skills
- Augmenting the skill of Technical Report Writing..

Syllabus

The student is expected to present a seminar in one of the current topics in the field of specialization and related areas. Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. Students are required to prepare a seminar report in the prescribed format given by the Department. The seminar shall be of 30minutes duration and give presentation to the Seminar Assessment Committee (SAC) in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Expected Outcomes :At the end of the course, the student will be able to

- Identify and choose appropriate topic of relevance.
- Assimilate literature on technical articles of specified topic and develop comprehension.
- Prepare technical report.
- Design, develop and deliver presentation on specified technical topic.

Evaluation

Shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee and The student shall submit typed copy of the paper to the Department. Grades will be awarded on the basis of contents of the paper and the presentation

1. Evaluation by the supervisor/s : 30 %
2. Presentation & evaluation by the Committee: 40 %
3. Evaluation of the Report: 20%
4. Regular Attendance : 10 %

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6411	ENGINEERING SOFTWARE LAB	0-0-2- 1	2015

Course Prerequisites: None

Course Objectives

- To impart fundamental knowledge on using various analytical tools like fluent for engineering simulations
- To know various fields of engineering where these tools can be effectively used to improve the output of a product
- To impart knowledge on how these tools are used in industries by solving some real time problems using these tools

Contents

- Solving basic mathematical problems such as curve fitting, numerical differentiation and
- integration and numerical solution of differential equation using
- C/C++/FORTRAN/JAVA/MATLAB
- Modeling and analysis of Fluid dynamics and Heat transfer problems using software such as
- FLUENT / CFX / PHOENIX / ANSYS
- Solving governing equation of fluid flow and heat transfer using numerical methods (By
- using C/C++/FORTRAN/JAVA/MATLAB.

Expected Outcomes. After completion if this course

- Student will be able to appreciate the utility of tools like fluent in solving real time problems and day to day problems
- Students will become versatile in using these tools for any engineering and real time applications
- They will also acquire knowledge on utilizing these tools for a better project un their curriculam

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Dept of Electronics and Instrumentation

M. Tech.

in

Control and Instrumentation(CIE)

(Credits : 66)

Curriculum Structure for M. Tech. in Control & Instrumentation under KTU

FIRST SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EI6101	Applied mathematics in control theory	3	1	-	40	3	60	4
B	10EI6103	Industrial Instrumentation	3	-	-	40	3	60	3
C	10EI6105	Process Dynamics and control	3	-	-	40	3	60	3
D	10EI6107	Modern control Systems	3	-	-	40	3	60	3
E	10EI61XX	Elective-I	3	-	-	40	3	60	3
	10GN6001	Research Methodology	0	2	-	100	-	0	2
	10EI6109	Seminar-1	-	-	2	100	-	0	2
	10EI6111	Industrial Instrumentation Lab	-	-	2	100	-	0	1
	TOTAL		15	2	2	500		300	21

ELECTIVE-I
10EI6113 Multisensor Data fusion
10EI6115 Chemical process systems
10EI6117 Communication protocols for instrumentation
10EC6103 Random processes and Applications
10EE6113 Special machines

SECOND SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EI6102	Biomedical instrumentation	3	-	-	40	3	60	3
B	10EI6104	System Identification and Adaptive control	3	-	-	40	3	60	3
C	10EI6106	SCADA Systems and Applications	3	1	-	40	3	60	4
D	10EI61XX	Elective-II	3	-	-	40	3	60	3
E	10EI61XX	Elective-III	3	-	-	40	3	60	3
	10EI6108	Mini Project	-	-	4	100	-	0	2
	10AE6112	Process Control Lab	-	-	2	100	-	0	1
	TOTAL		15	2	6	400		300	19

ELECTIVES II & III
10EC6404 Adaptive Signal Processing

10EC6102 Digital Image Processing
10EE6104 Control techniques in power electronics
10EC6116 Fibre Optic Communication
10EI6114 Principles of Robotics
10EC6304 Embedded System Design
10EI6116 Bioprocess Instrumentation and Control
10EI6118 Real Time Operating Systems
10EC6204 Digital system design using VHDL
10EI6122Advanced topics in Non Linear control

THIRD SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EI72XX	Elective-IV	3	-	-	40	3	60	3
B	10EI72XX	Elective-V	3	-	-	40	3	60	3
	10EI7101	Seminar-2	-	-	2	100	-	0	2
	10EI7103	Project - Phase 1	-	-	12	50	-	0	6
	TOTAL		**6**	**-**	**14**	**230**		**120**	**14**

ELECTIVES IV & V
10EC7105 Audioprocessing
10EI7105 Optimal Control Theory
10EC7207 Micro Electro Mechanical Systems
10EC7507Soft Computing Techniques
10EI7107 Digital Control Systems Design
10EC7113 Pattern Recognition
10EI7109Adaptive Process control
10EI7111Microcontroller based System Design
10EI7113 Piping & Instrumentation
10EE6126 Energy Management

FOURTH SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
	10EI7104	Project - Phase 2	-	-	23	70	1	30	12
	TOTAL		**-**	**-**	**23**	**70**		**30**	**12**

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EI6101	APPLIED MATHEMATICS IN CONTROL THEORY	3-1-0- 4	2015

Course Prerequisites

Basic knowledge in Matrix Theory at UG level and basic Statistics

Course Objectives

To have an advanced level knowledge on linear algebra, Statistics and its applications..

Syllabus

Vector spaces, Linear transformations, Eigen values and vectors, Simplex and two phase methods, transportation and assignment problems, Random variables, Discrete and continuous distributions, introduction to queuing theory, Curve fitting, correlations and regressions .

Expected Outcomes

The students are expected to apply the general principles of linear algebra, statistics and linear programming in other related areas .`

References

1. Hoffman Kenneth and Kunze Ray, *Linear Algebra,* Prentice Hall of India.

1. Taha H.A., Operations Research: An Introduction, Seventh edition, Pearson Education Edition, Asia, New Delhi (2002).

2. R.E. Walpole, R.H.Myers, S.L. Myers and K.Ye, Probability and Statistics for Engineers & Scientists, Asia, 8th Edition (2007).

3. Donald M.Gross and Carl M. Harris, Fundamentals of Queuing theory, 2nd edition, John Wiley and Sons, New York (1985).

4. Grewal B.S., Numerical Methods in Engineering and Science, 7th edition, Khanna Publishers, 2000.

Module	Content	Hours	Semester Exam Marks (%)
I	**Linear Algebra**: Vector spaces- subspaces- Linear dependence- Basis and dimension	6	15
II	**Linear transformations**- Kernals and Images- Matrix representation of linear transformation- Change of basis- Eigen values and vectors- Cayley Hamilton theorem	7	15
First Internal Examination			
III	**Linear Programming**: Formulation- Graphical Solution – Simplex method – Two Phase Method – Transportation and assignment problems	10	15
IV	**One dimensional Random Variables**: Random variables- Probability function – moments – moment generating function and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal Distributions – Function of a random variable	10	15
Second Internal Examination			
V	**Queuing Models**: Poisson process – Markovian queues – Single and multi server r models – Little's formula – Machine Interference model – Steady state analysis – Self service queue	9	20
VI	**Curve fitting**: Method of least squares – Normal equations – Fitting of straight line – Fitting of second degree curve – Correlations and regressions – Curvilinear regression – Multiple regression & multiple correlation	10	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EI6103	**INDUSTRIAL INSTRUMENTATION**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of Transducers, electronic circuits and digital instrumentation at UG/PG Level.

Course Objectives

To enable students acquire knowledge about the various techniques used for the measurement of industrial parameters, monitoring and their safety considerations.

Syllabus

Review of Industrial Instrumentation- Industrial signal conditioning systems- Calibration-testing- System response- Introduction to EMC- safety and Protection methods- Concept of virtual instrumentation

Expected Outcomes

- To have an adequate knowledge on basic industrial instrumentation.
- To design various signal conditioning systems.
- To enable them to follow industrial procedures while calibration.
- To analyze various responses of a system.
- To understand various industrial safety procedures.
- To get an insight on data acquisition, processing and monitoring system.

References

1. E. O. Doebelin, Measurement Systems - Application and Design, Fifth Edition,Tata McGraw-Hill International Edition, New York, 2005.
2. Dale E. Seborg, Thomas F. Edgar, Duncan A. Melli Champ, Process Dynamics and Control, Second Edition, Wiley-India, 2011.
3. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, New York, 1997.
4. Curtis D. Johnson, Process Control Instrumentation Technology, Eighth Edition, Prentice Hall, 2011.
5. Noltingk B.E., Instrumentation Reference Book, 2nd Edition, Butterworth Heinemann, 1995.

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of Industrial Instrumentation:-** Measurement of Force, Torque, Velocity, Acceleration, Pressure, Temperature, Flow, Level, Viscosity, Humidity & Moisture (Qualitative Treatment Only).	4	15
	Piezo-electric and ultrasonic transducers - application in process and biomedical Instrumentation.	4	
II	**Industrial signal conditioning systems-** Design of signal conditioning circuits for various Resistive, Capacitive, Inductive transducers and piezoelectric transducer.	4	15
	Amplifiers – Filters – A/D converters for industrial measurements systems, Smart and intelligent transmitters - Design of transmitters.	4	

First Internal Examination			
III	**Calibration** and response of industrial instrumentation - standard testing methods and procedures.	4	15
IV	**System response:-** Generalized performance characteristics – static response characterization – dynamic response characterization	4	15
Second Internal Examination			
V	**Introduction to EMC**, interference coupling mechanism, basics of circuit layout and grounding, concept of interfaces, filtering and shielding.	4	20
	Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures – NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.	5	
VI	**Concept of virtual instrumentation** – PC based data acquisition, Block diagram and architecture of a virtual instrument	3	20
	Data flow techniques - Graphical programming in data flow - Comparison with conventional programming	3	
	Development of virtual Instrument using Graphical User Interface (GUI).	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EI6105	**PROCESS DYNAMICS AND CONTROL**	**3-0-0- 3**	**2015**

Course Prerequisites

NIL

Course Objectives

The course is designed to provide students a strong background in the concept of chemical process modelling and control. It discusses the various components and different types of process control arrangements.

Syllabus

Review of Process and Control Systems, Modelling and Dynamic aspects of first order process, Design aspects of Process Control System, Modes of controllers: P,PI,PID, Controller tuning, Control System components, Other control schemes, Selection of controllers, Programmable Logic Controllers

Expected Outcomes

The students are expected to apply the general principles of chemical process control and process modelling.

References

1. George Stephanopoulos, Chemical Process Control, Prentice Hall of India. 2005
2. Caughanour and Koppel, Process systems analysis and control, Tata McGraw Hill. 3rd edition 2008
3. Curtis D. Johnson, Process Control Instrumentation Technology, Eighth Edition, Prentice Hall, 2011
4. Dale E. Seborg, Process Dynamics and Control, John Wiley. 2009

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of Process and Control Systems:** Introduction to control systems, Need for process control, Process control principles, Process control block diagram, Identification of elements, Servomechanism, Self-regulation	4	15
	Modelling and Dynamic aspects of first order process – Process modelling– First order process- Examples of modeling of first order systems – Example of modeling of stirred tank heater- Linearization of non-linear model- Dynamics of liquid process, gas process, flow process, thermal process, mixing process.	5	
II	**Design aspects of Process Control System:** Feedback control, Classification of variables, Design elements of a control system, control aspects of a process. Degrees of freedom and process controllers, Degrees of freedom and design of controllers- case study with a process.	4	15
	Modes of controllers: P,PI,PID: . Modes of operation of P, PI and PID controllers. Effect of variation of controller variables. Controller Tuning – Ziegler Nichols and Cohen Coon Methods.	4	
First Internal Examination			
III	**Control system components :** : I/P and P/I converters, Valve positioner -valve body - globe, butterfly, diaphragm, ball valves	4	15
IV	**Valves and Actuators :** control valve sizing - Cavitation, flashing in control valves – Control valve characteristics - Actuators – Pneumatic,	4	15

	Hydraulic, Electrical/ Electronic.		
Second Internal Examination			
V	**Other control schemes:** Feed forward controllers, Ratio Control, Cascade Control, Override control, Auctioneering control, Adaptive Control	5	20
	`Selection of controllers: Stability considerations. Simple performance criteria, Time integral performance criteria: ISE, IAE, ITAE, Problems in selection and design of feedforward controller.	4	
VI	Processes with large dead time. Dead time compensation. Control of systems with inverse response.	4	20
	Programmable Logic Controllers – ladder diagram, Examples of industrial control systems using PLC.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EI6107	MODERN CONTROL SYSTEMS	3-0-0- 3	2015

Course Prerequisites

Knowledge of Laplace transform, Z-transform, matrix algebra and acquaintance with basic concepts of control theory.

Course Objectives

The course is designed to enable students to apply tools and concepts of modern control theory to solve problems involving linear and non-linear as well as SISO and MIMO systems.

Syllabus

Introduction to control systems, State space analysis, Multivariable Control Systems Analysis, Multivariable Control Systems Design, Non-linear system analysis, Describing function analysis.

Expected Outcomes

At the end of the course students will be able to

1. Formulate state model of physical systems.
2. Analyze the controllability and observability of a given system.
3. Understand the characteristics of a given non-linear system.
4. Predict the response of a non-linear system using describing function.

References

1. Brogan W. L, Modern Control theory, Prentice Hall International, New Jersey, 1991.
2. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010
3. Jean-Jacques E. Slotine, Weiping Li, Applied nonlinear control, Prentice Hall Inc., New Jersey, 1991.
4. T. Kailath, Linear Systems, Prentice-Hall, Englewood Cliff's, NJ, 1980
5. Skelton R. E, Dynamic System Control and Linear System Analysis and Synthesis, John Wiley and Sons Inc., New Delhi, 1993.
6. Vidyasagar .M, Nonlinear system analysis, Second Edition, Prentice Hall Inc., New Jersey, 1993
7. Nonlinear Control, Global Edition, Hassan K. Khalil, Global Edition, 1/E, ISBN-13: 9781292060507, Pearson, (2014).

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to control systems** – Introduction to control systems, properties of signals and systems. Convolution integral, Ordinary differential equation, Transfer function, Pole zero concepts, effect of pole location on performance specification.	5	15
	State space analysis - System models in state space, canonical models, MIMO systems, solution of state equation, stability of systems in state space. State space analysis of discrete-time systems.	5	

II	**Multivariable Control Systems Analysis:** Concept of Controllability, Observability and Reachability, Controllability and Observability tests: Kalman's test matrix, Gilbert's test, Controllability and Observability canonical forms.	5	15
First Internal Examination			
III	**Multivariable Control Systems Design:** Linear state variable feedback: The effect of state feedback on controllability and observability, Condition for arbitrary pole placement, Ackermann's formula for pole placement.	4	15
IV	**State observers:** Full order state observers and minimum order observers. Study of some physical plant like inverted pendulum for analysis and design.	5	15
Second Internal Examination			
V	**Non-linear system analysis:** Non-linear system behaviour, different methods of linearization, Lyapnov stability criterion. Phase plane analysis, singular points, constructing phase portraits, existence of limit cycle.	8	20
VI	**Describing function analysis:** Fundamentals, assumptions, definitions. Describing functions of common non-linearities. Describing function analysis of non-linear systems. Stability of limit cycles, reliability of describing function analysis.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10AE6113	**MULTI SENSOR DATA FUSION**	**3-0-0- 3**	**2015**

Course Prerequisites

Students are expected to have prior experience with state estimation methods.

Course Objectives

The focus of the course is on multiple-sensor estimation methods and to provide practical knowledge to employ and develop multi-sensor data fusion systems.

Syllabus

Multisensor Data Fusion Introduction, inference hierarchy, Benefits of data fusion, Mathematical tools, Algorithms For Data Fusion, Data association, Estimation, Advanced Filtering, Optimal sensor fusion, High Performance Data Structures, Designing optimal sensor systems.

Expected Outcomes

At the end of the course, students will be able to:

1. Describe the data fusion model and applications.
2. Understand the benefits of data fusion.
3. Provide both the theoretical and practical skills necessary to design and implement data fusion algorithms.
4. Understand the concepts of advanced filtering methods.
5. Discover the perception behind decentralized estimation.
6. Depict the design of optimal sensor systems and different data structure representations.

References

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston.
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey,
3. Arthur Gelb, Applied Optimal Estimation, The M.I.T. Press
4. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company, 1987

Module	Content	Hours	Semester Exam Marks (%)
I	Multisensor Data Fusion Introduction: sensors and sensor data, Use of multiple sensors, Fusion applications	4	15
	The inference hierarchy: output data. Data fusion model. Architectural concepts and issues.	4	
II	Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations.	3	15
	Rigid body motion. Dependability and Markov chains, Meta – heuristics.	4	
First Internal Examination			
III	Algorithms For Data Fusion: Taxonomy of algorithms for multisensor	3	15

	data fusion.		
	Data association. Identity declaration. Decision level identify fusion. Knowledge based approaches.	3	
IV	Estimation**:** Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters.	4	15
	Advanced Filtering: Data information filter, extended information filter.	3	
Second Internal Examination			
V	Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement.	3	20
	Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.	4	
VI	High Performance Data Structures: Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures.	4	20
	Designing optimal sensor systems within dependability bounds. Implementing data fusion system.	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EI6115	CHEMICAL PROCESS SYSTEMS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of thermodynamics, chemical reactions at UG/PG Level.

Course Objectives

The course is designed to provide students a strong background in the concept of Chemical processes , equipment and Energy conservation principles in chemical industries

Syllabus

Analysis of chemical processes, General Principles ofProcess Analysis,OverallBalance Equations, Energy Balancing and Heat transfer, Analysis of process Equipment, Process Equipment Classification, Principles and analysis on Energy Conservation and consumption

Expected Outcomes

The students are expected to apply the general principles of chemical process design and reaction engineering.

References

1. W.L. McCabe, J.C. Smith and P. Harriott, “Unit Operations of Chemical Engineering”, sixth Edition, McGraw Hill, 2001.

2. Walter L.Badger and Julivst. Banchero “Introduction to Chemical Engineering”, Tata McGraw Hill publishing company, 1997
3.L.B. Anderson and L.A. Wenzel, “Introduction to Chemical Engineering”, McGraw Hill, 1961.
4.P.Harriot, “Process Control”, McGraw Hill, 1984.

5.D.A. Reay, “Industrial Energy Conservation”, McGraw-Hill, New York, 1979.

Module	Content	Hours	Semester Exam Marks (%)
I	**Analysis of chemical processes:**Typical products and their and uses, Systematic analysis of chemical processes. Flow sheets and symbols for various operations	4	15
	Process Analysis: Variation in process conditions, raw materials and fuels – effect on end products and economy.	4	
II	**Balance Equations**: Overall Balances, Component balances in engineering equipments.	4	15
	Component balances in combustion reactions, Stoichiometric balances in manufacturing processes	4	
First Internal Examination			
III	**Energy Balancing and Heat transfer** :-Forms of energy, Total balance, Heat balance, Heat effects and combustion reactions,Energy balances in manufacturing processes, optimum utilization of energy, Heat transferoperations in chemical reactors.	6	15
IV	**Chemical Equipments-** Fundamental concepts in heat	6	15

	exchangers,Evaporators and distillation column, Design and classification of heat exchangers,Evaporators and distillation column.		
Second Internal Examination			
V	**Process Equipment Classification**: Fundamental principles and classification of heat exchangers, Evaporators, Distillation columns	4	20
	Equipment for Agitation and mixing of fluids dimensional analysis to estimate power consumption for agitation.	4	
VI	**Energy Conservation**:Energy Conservation in process systems and industries, Optimization principles and pinch analysis to calculate energy consumption.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10AE6117	COMMUNICATION PROTOCOLS FOR INSTRUMENTATION	3-0-0- 3	2015

Course Prerequisites
Nil

Course Objectives
1)To study about Networks in process automation
2) To understand various communication protocols
3)To introduce the communication buses namely field bus and profibus.

Syllabus
Networks in process automation, OSI reference model, Communication Protocols, Proprietary and open networks, HART, , Ethernet, Fieldbus, wireless Protocols

Expected Outcomes
To become familiar with Network technologies and Network models.

References:

1. Noltingk B.E., "*Instrumentation Reference Book*", 2nd Edition, Butterworth Heinemann, 1995.
2. B.G. Liptak, Process software and digital networks, 3rd Edition, CRC press, Florida.
3. Romilly Bowden ,'HART Communications Protocol', (Fisher-Rosemount).

Module	Content	Hours	Semester Exam Marks (%)
I	**Module I** (9 hours) Introduction to Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics	4	15
	OSI reference model, Industry Network, Recent networks	4	
II	**Module II** (9 hours) Introduction to Communication Protocols: Communication basics, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection.	7	15
First Internal Examination			
III	**Module III** (5 hours) Proprietary and open networks: Network Architectures, Building blocks, Industry open protocols (RS-232C, RS- 422, RS-485)	7	15
IV	**Module IV** (6 hours) Ethernet, Modbus, Modbus Plus, Data Highway Plus, Advantages and	4	15

	Limitations.		
Second Internal Examination			
V	**Module V** (11 hours) Fieldbus: Fieldbus Trends, Hardware selection, Fieldbus design, Installation, Documentation,	4	20
	Foundation Fieldbus & Profibus-Introduction, Design, Calibration, Commissioning, Advantages and limitations.	4	
VI	**Module VI** (10 hours) HART- Introduction, Design, Installation, calibration, commissioning, Applications	4	20
	Introduction to wireless Protocols- WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6103	**RANDOM PROCESSES AND APPLICATIONS**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in Probability Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives

(1) To impose in-depth knowledge in probability theory.
(2) To throw light into the applications of probability and random processes.

Syllabus

Review of Set Theory, Random experiment, Sample space, Cumulative Distribution Function, Probability Density Function, conditional distribution, Expectation, moments, correlation and covariance, Random Vector, Convergence - Markov and Chebyshev inequalities, convergence in probability, convergence in mean square, Weak law of large numbers, strong law of large numbers, Central Limit Theorem for sequences of independent random variables, Random process, IID process, Poisson counting process, Markov process, Wiener process. Stationarity, power spectral density, Discrete time Markov chains, conditional independence, DTMC, Recurrence analysis, Chapman-Kolmogov theorem, Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge in probability theory;
(2) Know how the theory of probability and random processes could be applied in specific domains

References

1. A. Papoulis and S. UnnikrishnaPillai. *Probability, Random Variables and Stochastic Processes,* TMH
2. B. Hajek, *An Exploration of Random Processes for Engineers*, 2005.
3. D.P. Bertsekas and J. N. Tsitsiklis, *Introduction to Probability*, 2000.
4. Gray, R. M. and Davisson L. D., *An Introduction to Statistical Signal Processing.* Cambridge University Press, 2004.
5. Stark Henry, *Probability and Random Processes With Application to Signal Processing*, 3/e, Pearson Education India.
6. Steven Kay, *Intuitive probability and random processes using MATLAB*, Springer, 2006.
7. Dr. Kishor S. Trivedi. *Probability and Statistics with Reliability, Queuing, and Computer Science Applications,* John Wiley and Sons, New York, 2001.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Set Theory - Set operations, functions, countable and uncountable sets, Random experiment, Sample space, Sigma algebra, Event space, Measure, Probability measure, Borel sigma field	4	15
	Cumulative Distribution Function (CDF), Probability Density Function (PDF), PMF, Joint CDF, Joint PDF, conditional distribution.	4	
II	Expectation - Fundamental Theorem of expectation, moments, characteristic function, correlation and covariance	4	15
	Random Vector - Definition, Joint statistics, Covariance and correlation matrix, Gaussian random vectors.	4	

First Internal Examination			
III	Convergence - Markov and Chebyshev inequalities, Convergence of sequences of random variables- almost sure convergence, convergence in probability, convergence in mean square, Weak law of large numbers, Random sums, Borel Cantelli lemma, strong law of large numbers, Central Limit Theorem for sequences of independent random variables.	8	15
IV	Random process - Definition of Random process, IID process, Poisson counting process, Markov process, birth-death process, Wiener process. Stationarity, Correlation functions of random processes in linear systems, power spectral density.	8	15
Second Internal Examination			
V	Discrete time Markov chains - conditional independence, DTMC, Recurrence analysis, Foster's Theorem, Chapman-Kolmogov theorem, Stopping time.	6	20
VI	classification of states: absorbing, recurrent, transient. Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EE6113	SPECIAL MACHINES	2-1-0:3	2015

Course Prerequisites

Basic knowledge of Electrical Machines at UG Level.

Course Objectives

To impart knowledge about special machines

Syllabus

Stepper motor, Servomotor, Synchronous Reluctance motor, Switched reluctance motor, Permanent magnet BLDC motor & PMAC Motor, Linear Induction motor**.**

Expected Outcomes

The students are expected to apply the general principles of special machines for various industrial applications and house hold applications.

Text books

1. T.J.E. Miller, Brushless Permanent-Magnet and Reluctance Motor Drives, Clarendon Press.
2. R.Krishnan, Switched Reluctance Motor Drives-Modelling, Simulation, Analysis, Design and application, CRC press New York,2001
3. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.T.J.E. Miller, Switched Reluctance Motors And Their Control , Magna physics Publishing, Oxford.
4. T.J.E. Miller, Electronic Control of Switched Reluctance Machines, Newnes Power Engineering Series.
5. Vincent Del Toro, Electric Machines and Power Systems, Prentice Hall
6. M D Desai, Control system components, PHI
7. K Venkataratnam, Special Electrical Machines, Universities press(India) Pvt. Ltd. Hyderabad
8. R Krishnan, Electric Motor Drives, Modeling, Analysis, and control, PHI
9. Nasar S.A., Boldea I., Linear Motion Electric Machine, John Wiley & Sons.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Stepper motor:** Constructional features - Principle of operation-permanent magnet stepper motor - variable reluctance motor - hybrid motor-single and multi stack configurations - Torque equations - modes of excitations - drive circuits-microprocessor control of stepping motors - closed loop control – applications.	8	15
II	**Servomotor:** DC servomotors- construction - principle of operation-transfer function - armature control and field control - AC servomotor-construction - theory of operation - shaded pole ac servomotors – applications.	6	15
First Internal Examination			
III	**Synchronous Reluctance motor**: Constructional features - Types - Principle of operation - Axial and radial flux motors - operating principles - variable reluctance motor - hybrid motor - voltage and torque equations – characteristics – applications.	8	15
IV	**Switched reluctance motor**: Constructional features - principle of	6	15

	operation - torque production - steady state performance prediction- Analytical method - Power converters and their controllers - Methods of rotor position sensing - Closed loop control of SRM – Characteristics – applications.		
	Second Internal Examination		
V	**Permanent magnet motor:** Permanent magnet brushless DC motors - Permanent magnetic materials - Magnetic characteristics - Principle of operation -Types-Magnetic circuit analysis - Torque equations - Power controllers - Motor characteristics and control, Permanent magnet synchronous motors-Principle of operation--Torque equations-characteristics and control.	8	20
VI	**Linear Induction motor** Linear induction motor- Double sided linear induction motor from rotary type Induction motor – Scheme of LIM drive for electric traction – development of single sided LIM – Equivalent circuit- applications.	6	20
	Cluster Level End Semester Examination		

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	RESEARCH METHODOLOGY	0 - 2 - 0 - 2	2015

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.
As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.

16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications*, Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EI6109	SEMINAR - 1	0 - 0 - 2 - 2	2015

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;
(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :
(1) Be motivated in reading which enhances the literature review required for doing project work;
(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EI6111	INDUSTRIAL INSTRUMENTATION LAB	0 - 0 - 2 - 1	2015

Course Prerequisites

Knowledge in Industrial instrumentation UG level

Course Objectives

To equip the students with the basic knowledge of pressure, temperature,flow, level,density and viscosity measurements

To understand the working of different measuring equipments.

List of Experiments

1. Measurement of temperature, level, and flow – study of characteristics of transducers and signal conditioning circuits.
2. Signal Conditioning Circuit for Temperature Measurement & Square root extractor in flow measurement – Implementation.
3. Measurement of torque, displacement, and distance – Implementation of signal conditioning circuits and study of characteristics of transducers.
4. Measuring the speed of a motor shaft with the help of non-contact type pick-ups (magnetic or photoelectric) – Implementation of a complete set-up to display the speed.
5. Use of light sensors - applications.
6. Data acquisition cards – Familiarisation of facilities – Analog i/p, analog o/p, digital i/p, digital o/p.
7. Development of virtual instrument (VI) for level measurement-with display, and visual and sound alarms
8. Development of virtual instrument (VI) for temperature measurement-with display, and visual and sound alarms
9. Developing a data logger
10. Modeling of inverted pendulum and to plot its response
11. Calibration of pressure gauges – dead weight pressure gauge
12. pH meter standardization and measurement of pH values of solutions
13. Measurements of conductivity of test solutions.
14. To test experimental data for Normal Distribution using Chi Square test.

Expected Outcomes

The students are expected to :

Attain a thorough understanding of instrumentation systems through various experiments.

References

1.Liptak B.G ,‵‵‵Process measurement and analysis‵‵‵,Chilton Book company,Radnor,Pennsylvania,2003.
2. A. K. Sawhney And P. Sawhney, “A Course In Mechanical Measurements And Instrumentation”, Dhanpat Rai, New Delhi, 2001
3.R.K Rajput, “Mechanical measurements and instrumentation”, S. K. Kataria & Sons, 2009

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Syllabi and Course plan for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

CIVIL ENGINEERING BRANCH

M. Tech.

in

COMPUTER AIDED STRUCTURAL ENGINEERING

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CE6101	Advanced Numerical Methods	3-0-0	40	60	3	3
B	10CE6103	Theory of Elasticity	3-1-0	40	60	3	4
C	10CE6105	Structural Dynamics	3-0-0	40	60	3	3
D	10CE6107	Advanced Theory and Design of RC Structures	3-1-0	40	60	3	4
E		Elective –I	3-0-0	40	60	3	3
	10GN6001	Research Methodology	0-2-0	100			2
	10CE6109	Seminar I	0-0-2	100			2
	10CE6111	Structural Engineering and Computational Lab	0-0-2	100			1
		TOTAL	**15-4-4**	**500**	**300**	**-**	**22**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 22

Elective

10CE6113 Advance Concrete Technology

10CE6115 Forensic Engineering

10CE6117 Structural Optimisation

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CE6102	Advanced Metal Structures	3-0-0	40	60	3	3
B	10CE6104	Finite Element Method	3-0-0	40	60	3	3
C	10CE6106	Analysis and Design of Earthquake Resistant Structures	3-0-0	40	60	3	3
D		Elective –II	3-0-0	40	60	3	3
E		Elective-III	3-0-0	40	60	3	3
	10CE6108	Mini Project	0-0-4	100			2
	10CE6112	Structural Engineering Design Studio Lab	0-0-2	100			1
		TOTAL	**15-0-6**	**400**	**300**	**-**	**18**

TOTAL CONTACT HOURS : 22
TOTAL CREDITS : 18

Elective

10CE6114 Theory of Plates and Shells
10CE6116 Composite Structures
10CE6118 Fracture Mechanics
10CE6122 Advanced Prestressed Concrete Design
10CE6124 Analysis and Design of Substructures
10CE6126 High Rise Structures

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective	3-0-0	40	60	3	3
B		Elective	3-0-0	40	60	3	3
	10CE7101	Seminar II	0-0-2	100			2
	10CE7103	Project (Phase 1)	0-0-12	50			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective

10CE7105 Design of Bridges
10CE7107 Structural Reliability
10CE7109 Theory of Plasticity
10CE7111 Stability of structures
10CE7113 Random Vibration
10CE7115 Advanced Finite Element Analysis

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credit
					Marks	Duration (hours)	
	10CE7102	Project (Phase 2)	0-0-23	70	30		12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**12**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 12

TOTAL NUMBER OF CREDITS: 66

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6101	Advanced Numerical Methods	3-0-0	3	2015

Course Objectives

To enable students to:

- Get awareness to different numerical solutions.
- Impart ability to apply mathematics to finding solutions to practical problems.

Syllabus

Introduction to numerical methods- errors in numerical methods-Systems of linear algebraic equations- Eigen Value problems- power method- Jacobi method-Practical examples- Lagrangean and Hermitian interpolation- Quadratic and Cubic splines- Multiple linear regression-Numerical integration- Romberg integration- Gaussian quadrature- Newton – Cotes open quadrature- Taylor series expansion of functions-

Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Euler method and its modifications- Runge-kutta method- Higher order equations of the initial value type-Predictor corrector methods- Milne's method and Hamming's method- Stability of solutions-Ordinary differential equations of the boundary value type- Partial differential equations in two dimensions- Finite difference method- Problems with irregular boundaries.

Expected Outcome

- Students get awareness of different numerical solutions.
- Impart ability to apply mathematics to finding solutions to real time problems.

References

1. Chapra S.C. and Canale R.P. Numerical Methods for Engineers, McGraw Hill.
2. Smith G.D. Numerical solutions for Differential Equations, McGraw Hill.
3. Ketter and Prawel, Modern Methods for Engineering Computations, McGraw Hill.
4. Rajasekharan S., Numerical Methods in Science and Engineering, S Chand & company.
5..Rajasekharan S., Numerical Methods for Initial and Boundary value problems, Khanna publishers.
6. Terrence J. Akai, Applied Numerical Methods for Engineers, Wiley publishers.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to numerical methods- errors in numerical methods- Systems of linear algebraic equations- Elimination and factorization methods-ill conditioned systems- symmetric and banded systems- Gauss Seidel iteration for sparse systems.	7	15
II	Eigen Value problems- power method- Jacobi method-Practical examples- Systems of non-linear equations- Newton-Raphson method.	7	15
FIRST INTERNAL EXAM			
III	Langrangean and Hermitian interpolation- Quadratic and Cubic splines (Examples with equal intervals only)- Data smoothing by least squares criterion- Non- polynomial models like exponential model and power equation- Multiple linear regression-Numerical integration-Romberg integration- Gaussian quadrature- Newton – Cotes open quadrature- Taylor series expansion of functions	7	15
IV	Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Euler method and its modifications- Runge- kutta method- Higher order equations of the initial value type- Predictor corrector methods- Milne's method and Hamming's method- Stability of solutions.	7	15
SECOND INTERNAL EXAM			
V	Ordinary differential equations of the boundary value type- Finite difference solution- Weighted residual methods for initial value problems and boundary value problems- Collocation method- Sub domain method- Method of least squares- Galerkin's method.	7	20
VI	Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations- Finite difference method- Problems with irregular boundaries.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6103	Theory of Elasticity	**3-1-0**	**4**	**2015**

Course Objectives

- To understand the behaviour of linear elastic solids under loads
- Provide a firm foundation for more advanced courses, for research and practise in Civil engineering field
- To provide the student with various solution strategies while applying them to practical cases

Syllabus

Analysis of stress in 3D - Analysis of strain in 3D - Stress Strain relations - Two dimensional problems in Rectangular coordinates - Two dimensional problems in polar coordinates - Torsion of prismatic bars.

Expected Outcome

- Understand concepts, principles and governing equations related to the analysis of elastic solids
- To obtain skill and capability in analysing and solving problems in Civil Engineering

References

1. Timoshenko S.P and Goodier. J.N., Theory of Elasticity, McGraw Hill.
2. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw Hill.
3. Sokolnikoff I.S., Mathematical theory of Elasticity, Tata McGraw Hill.
4. Ameen M., Computational Elasticity, Narosa Publishing House.
5. Boresi A.P., Schimidt R.J., Advanced Mechanics of Materials, John Wiley.
6. T.G. Sitharam, Applied Elasticity, Interline publishing.
7. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Analysis of stress in 3D: Definition of stress at a point – Stress tensor – Equilibrium equations Stress on arbitrarily oriented plane – Transformation of stress – Principal stress - Stress invariants – Octahedral stresses – Traction boundary conditions, Hydrostatic and Deviatoric Stress Tensors. Numerical examples	10	15
II	Analysis of strain in 3D: Strain tensor – Strain displacement relations for small deformations – Compatibility conditions – Strain transformations– Principal strains – Strain invariants, Octahedral strains, Hydrostatic and deviatoric strains. Numerical examples	8	15
FIRST INTERNAL EXAM			
III	Stress Strain relations: Generalised Hooke's law – Reduction in number of elastic constants for orthotropic, transversely isotropic and isotropic media, Boundary value problems of elasticity – Displacement, Traction and Mixed types. Navier's Equations, Beltrami-Michell's Equations, Saint Venant's principle. Uniqueness of Solution. Numerical examples	8	15
IV	Two dimensional problems in Rectangular coordinates: Plane stress and plane strain problems - Airy's stress function -Solution by polynomials – Bending of cantilever loaded at free end, Bending of simply supported beam with udl., pure bending of curved beams	10	15
SECOND INTERNAL EXAM			
V	Two dimensional problems in polar coordinates: General equations- Equilibrium equations, Strain displacement relations and Stress strain relations, compatibility relations Biharmonic equations and Airy's stress functions- Problems of axisymmetric stress distributions - Thick cylinders - Stress concentration due to circular hole in plates (Kirsch's problem). Numerical examples	10	20
VI	Torsion of prismatic bars: Saint Venant's Semi inverse and Prandtl's stress function approach – Torsion of Straight bars – Elliptic and Equilateral triangular cross section. Membrane Analogy -Torsion of thin walled open and closed tubes, Numerical examples	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6105	Structural Dynamics	3-0-0	3	2015

Course Objectives

To enable students :

- To understand the behaviour of structures under dynamic loads
- To familiarise with the dynamic analysis of structures subjected to time varying loads

Syllabus

Vibration studies and its importance–Systems with single degree of freedom –Undamped and damped free vibration– Logarithmic decrement. Response of single degree of freedom systems to harmonic, impulse, periodic and general loading. Vibration isolation –Vibration measuring instruments – Methods of vibration control –Multi-degree of freedom systems –Lumped mass and consistent mass – Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes. Co-ordinate coupling - Orthogonality of normal modes - Forced vibration analysis of multi-degree of freedom systems - Mode superposition .Distributed mass (continuous) systems -Forced vibration of single span beams – Lagrange's equation.

Expected Outcome

- Students will be equipped with the analytical tools required to determine the dynamic response of structures
- Will serve as a pre-requisite to study the subject "Analysis and design of earthquake resistant structures".

References

1. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi.
2. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi.
3. Mario Paz, Structural Dynamics – Theory and Computation, CBS Publishers and Distributors, Delhi.
4. Mukhopadhyay M, Structural Dynamics - Vibrations and Systems, Ane Books India, Delhi.
5. Humar J, Dynamics of Structures, CRC Press, Netherlands.
6. Anil K Chopra, Dynamics of Structures- Theory and Application to Earthquake Engineering, Pearson Education, New Delhi.
7. Roy R Craig, Structural Dynamics – An Introduction to Computer Method, John Wiley & Sons, New York.
8. Thomson W T, Theory of Vibration with Application, Pearson Education, New Delhi.
9. Weaver W, Timoshenko S P, Young D H, Vibration Problems in Engineering, John Wiley & Sons, USA.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems- Equation of motion – damping in vibrating system-Undamped and damped free vibration of single degree of freedom system – Logarithmic decrement.	9	15
II	Response of single degree of freedom systems to harmonic, impulse, periodic and general loading (Duhamel integral) – Numerical solution of single degree of freedom systems – Central Difference Method – Average acceleration method, Wilson-θ method- Newmark – β method.	7	15
FIRST INTERNAL EXAM			
III	Vibration isolation –Vibration measuring instruments – Methods of vibration control – Tuned mass damper – Multi-degree of freedom systems – Equation of motion – Lumped mass and consistent mass – Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes by solution of characteristic equation.	7	15
IV	Co-ordinate coupling - Orthogonality of normal modes – Stodola and Rayleigh's methods for the evaluation of natural frequencies and mode shapes – Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis - Response of discrete systems to support motion.	7	15
SECOND INTERNAL EXAM			
V	Distributed mass (continuous) systems – differential equation of motion – Axial vibration of rods – Flexural vibration of single span beams -simply supported beam, cantilever beam and fixed beam - Evaluation of frequencies and mode shapes	7	20
VI	Beam flexure including shear deformation and rotary inertia – Forced vibration of single span beams – Lagrange's equation.	5	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6107	Advanced Theory and Design of RC Structures	**3-1-0**	**4**	**2015**

Course Objectives

This course is designed to

- Provide the ability to analysis and design basic reinforced concrete components;
- Study of advanced topics including theory and design of reinforced concrete structures

Syllabus

Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete -Failure criteria for concrete. -Estimation of deflection and control of cracking, RCC beam – column joints- Flat Slabs- Design of special RC members-Strut and Tie Models- Development- Design methodology- .Design of concrete corbels, deep beams, ribbed slabs, pile caps. Yield line analysis of slabs, Moment redistribution in continuous beams

Expected Outcome

- To design the main elements in reinforced concrete structures
- To study the behaviour of reinforced concrete structures
- To analyse and design flat slabs
- To design special reinforced concrete members and components

References

1. Park, R. and Pauley, T., Reinforced Concrete Structures, John Wiley
2. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice-Hall
3. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata McGraw Hill
4. Subramanian, N., Design of Reinforced Concrete Structures, Oxford University Press.
5. Gambhir, M. L., Design of Reinforced Concrete Structures, PHI Learning Private Limited.
6. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
7. ACI 318M-14, American Concrete Institute, Building Code Requirements for Structural Concrete

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Review on Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete under uniaxial and multiaxial states of stress - confined concrete- Effect of cyclic loading on concrete and reinforcing steel. Stress block parameters-Failure criteria for concrete.	10	15
II	Estimation of deflection- immediate and long term deflection- control of cracking, estimation of crack width in RC members, codal procedures on crack width computations.	8	15
FIRST INTERNAL EXAM			
III	RCC beam – column joints- classification – shear strength- design of exterior and interior joints- wide beam joints.	8	15
IV	Flat Slabs – Structural requirements-Determination of design bending moments-Direct design method – equivalent frame method-comparison of flat slab with two way slab-Openings in flat slabs.	10	15
SECOND INTERNAL EXAM			
V	Strut and Tie Models- Development- Design methodology- selecting dimensions for struts- ACI Provisions- Applications. Design of concrete corbels, deep beams, ribbed slabs, pile caps.	10	20
VI	Yield line analysis of slabs, yield line mechanisms-equilibrium and virtual work method, Hillerborg's strip method. Limitations of yield line theory-Moment redistribution in continuous beams.	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10GN6001	Research Methodology	0-2-0	2	2015

Course Objectives

This course is designed to

- To attain a perspective of the methodology of doing research;
- To develop skills related to professional communication and technical report writing.
- As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcome

The students are expected to :

- Be motivated for research through the attainment of a perspective of research methodology;
- Analyze and evaluate research works and to formulate a research problem to pursue research;
- Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, Research Methodology : Methods & Techniques, New Age International Publishers
2. R. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, Management Research Methodology, Integration of Principles, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, Research Methodology – Concepts & Cases, Vikas Publishing House.
5. J.W. Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, New York.
6. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

8. Douglas C Montgomery, Design and analysis of experiments, Wiley International
9. Ranjit Kumar, Research Methodology: A step by step guide for beginners, Pearson Education.
10. Donald Cooper, Business Research Methods, Tata McGraw Hill, New Delhi.
11. Leedy P D, Practical Research : Planning and Design, 4th Edition, N W MacMillan Publishing Co
12. Day R A, How to Write and Publish a Scientific Paper, Cambridge University Press.
13. Coley S M and Scheinberg C A, Proposal Writing, Newbury Sage Publications.
14. Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall of India, New Delhi.
15. Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi.
16. Vesilind, Engineering, Ethics and the Environment, Cambridge University Press.
17. Wadehra, B.L. Law relating to patents, trademarks, copyright designs and geographical indications, Universal Law Publishing

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Overview of Research Methodology: Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	Research Problem and Design : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
FIRST INTERNAL EXAM			
III	Thesis Writing, Reporting and Presentation : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	Research proposals, Publications, Ethics and IPR : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
SECOND INTERNAL EXAM			
V	Research Methods - Modelling and Simulation : Modelling and simulation, concepts of modelling, mathematical modelling, composite modelling, modelling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modelling.	5	20
VI	Research Methods - Measurement, Sampling and Data Acquisition : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6109	Seminar **I**	**0-0-2**	**2**	**2015**

Course Objectives

The student has to present a seminar in one of the current topics in the stream of specialisation. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit a seminar report at the end of the semester**.**

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6111	Structural Engineering and Computational Lab	**0-0-2**	**1**	**2015**

Course Objectives

- Practical training for conducting experiments related to structural engineering.
- Ability to solve stress analysis problems.
- Ability to write algorithms for problem solving

Syllabus

Details of experiments

1. Review of testing methods of cement, coarse aggregate and fine aggregate as per Indian Standards.
2. Design of concrete mixes as per Indian Standard
3. Study of behaviour of RCC beams
4. Study of behaviour of RCC columns.
5. Accelerated curing experiments for concrete.
6. Study of behaviour of steel beams.
7. Free vibration analysis of steel cantilever beams.
8. Non- destructive testing of concrete
    a) Rebound hammer
    b) Core cutting
    c) Ultrasonic pulse velocity
    d) Pullout test
    e) Detection of embedded reinforcements
9. Analysis of plates using software package.
10. Analysis of shells using software package.
11. Analysis of frames using software package.
12. Writing programs in any high level language for solving computational problems

Expected Outcome

- Acquire capacity to organise experiments for project work.
- Capability to use finite element packages for stress analysis.
- Building capacity to write programs for problem solving

Expt. No.	Title	Hours Alloted
1	Review of testing methods of cement, coarse aggregate and fine aggregate as per Indian Standards.	2
2	Design of concrete mixes as per Indian Standard	2
3	Study of behaviour of RCC beams	2
4	Study of behaviour of RCC columns.	2
5	Accelerated curing experiments for concrete.	2
6	Study of behaviour of steel beams.	2
7	Free vibration analysis of steel cantilever beams	2
8	Non- destructive testing of concrete a) Rebound hammer b) Core cutting c) Ultrasonic pulse velocity d) Pullout test e) Detection of embedded reinforcements	2
9	Analysis of plates using software package.	2
10	Analysis of shells using software package.	2
11	Analysis of frames using software package	2
12	Writing programs in any high level language for solving computational problems	8

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6113	Advanced Concrete Technology	3-0-0	3	2015

Course Objectives

- The course is designed to provide an advanced level knowledge on properties of concrete and its performance based on the behavior of ingredients and environmental conditions.

Syllabus

Ready mix concrete, under water concreting, shotcrete, Temperature problems, High strength concrete, High performance concrete, Fiber reinforced concrete, Ferro cement, Light weight concrete, High density concrete, Durability, Test on Hardened concrete, NDT tests on concrete.

Expected Outcome

The students are expected to select concrete mix based on the requirement of the structure and performance based on the environmental conditions.

References

1. Kumar Mehta.P., Paulo J.M. Monteiro., Concrete- Microstructure, Properties and Materials, Tata McGraw Hill.
2. Neville, A.M and J.J. Brooks., Concrete Technology, Prentice Hall.
3. Neville, A.M.., Properties of Concrete, Prentice Hall.
4. Zongjin Li, Advanced Concrete Technology, Wiley.
5. Gambhir, M.L., Concrete Technology - Theory and Practice, McGraw Hill Education (India) Private Limited.
6. Shetty, M.S., Concrete Technology, Chand & Co.
7. Santhakumar, A. R., Concrete Technology, Oxford University Press.
8. IS: 10262–2009, Recommended Guidelines for concrete Mix Design, Bureau of Indian Standard.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Ready mix concrete - manufacture, transporting, placing, precautions and methods of purchase. Code recommendations	5	15
II	Temperature problems in concreting- Hot weather problems and hot weather concreting, large concrete masses, cold weather concreting, problems.	5	15
FIRST INTERNAL EXAM			
III	Fiber reinforced concrete - Fibers types and properties, Behavior of FRC in compression, tension including pre-cracking stage and post-cracking stages.	7	15
IV	Ferro cement - materials, techniques of manufacture, properties and application, advantages.	7	15
SECOND INTERNAL EXAM			
V	Light weight concrete- materials properties and types. Typical light weight concrete mix- High density concrete -materials, properties and applications. High performance concrete-methods of obtaining high performance concrete, factors controlling high performance materials, properties, applications.	8	20
VI	Durability and impermeability- Cracking, carbonation, alkali-silica reaction, chemical attack-sulphate attack and chloride attack. Test on Hardened concrete-Effect of end condition of specimen, capping, H/D ratio, rate of loading, moisture condition. Compression, tension and flexure tests. NDT tests on concrete- concepts-Rebound hammer, pulse velocity methods.	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6115	Forensic Engineering	**3-0-0**	**3**	**2015**

Course Objectives

- To discuss the causes of damages observed in concrete and steel structures
- Know- how of repair and retrofitting

Syllabus

Failure of Structures: Causes of distress in structural members-Environmental Problems and natural Hazards. Causes of deterioration in concrete and steel structures. Preventive measures, Diagnosis and assessment of deterioration- Methods of repair of cracks- Repairing of corrosion damage of reinforced concrete. Modern techniques of Retrofitting. Strengthening by pre-stressing. Repair of steel structures

Expected Outcome

Student develops the capability to identify reasons of distress in structures and suggest repair/ remedial measures

References

1. Sidney M Johnson, Deterioration, Maintenance and Repairs of Structures, McGraw Hill Book Company, New York
2. Dovkaminetzky, Design and Construction Failures, Galgotia Publication, New Delhi
3. Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – causes of distress in structural members – design and material deficiencies – over loading. Environmental Problems and Natural Hazards.	5	15
II	Causes of deterioration in concrete and steel structures. Preventive measures, maintenance and inspection.	5	15
FIRST INTERNAL EXAM			
III	Diagnosis and assessment of deterioration, visual inspection, non destructive tests, ultrasonic pulse velocity method, rebound hammer method, pull out tests, Windsor probe test, crack detection techniques, etc.	7	15
IV	Case studies on diagnosis of deterioration – single and multi-storey buildings – Fibre optic method for prediction of structural weakness. Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326.	7	15
SECOND INTERNAL EXAM			
V	Methods of repair of cracks, repairing spalling and disintegration, repairing concrete floors and pavements. Repairing of corrosion damage of reinforced concrete. Repair of steel structures.	8	20
VI	Modern Techniques of Retrofitting. Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
10CE6117	Structural Optimisation	**3-0-0**	**3**	**2015**

Course Objectives

- The ability to identify the importance of optimization in the civil engineering field
- Should be able to use optimization techniques for real life time applications
- Ability to apply optimization concepts for solving multi task applications

Syllabus

Problem formulation with examples-Single Variable Unconstrained Optimization Techniques-Multi Variable Unconstrained Optimization Techniques-Constrained Optimization Techniques-Indirect methods-Direct methods-Specialized Optimization techniques

Expected Outcome

- Understand various optimization methods
- Understand capabilities of optimization programmes
- Understand & analyse various techniques and apply them for real time situations

References

1. Rao S. S., Engineering Optimisation – Theory and Practice, New Age International.
2. Deb, K., Optimisation for Engineering Design – Algorithms and examples, Prentice Hall.
3. Kirsch U., Optimum Structural Design, McGraw Hill.
4. Arora J S. Introduction to Optimum Design, McGraw Hill
5. Rajeev S and Krishnamoorthy C. S., Discrete Optimisation of Structures using Genetic Algorithms, Journal of Structural Engineering, Vol. 118, No. 5, 1992, 1223-1250.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Problem formulation with examples.	7	15
II	Single Variable Unconstrained Optimization Techniques –Optimality Criteria - Interpolation methods Quadratic Interpolation, Cubic Interpolation -Gradient Based methods- Bisection, Newton Raphson, Secant Methods.	7	15
FIRST INTERNAL EXAM			
III	Multi Variable Unconstrained Optimization Techniques- Unidirectional Search, Pattern Search– Optimality Criteria. Simplex method - Gradient based methods-Cauchy's method, Newton's method, Quasi Newton Methods, Fletcher reeves method, Marquardt's method.	7	15
IV	Constrained Optimization Techniques –Classical methods - Linear programming problem.	7	15
SECOND INTERNAL EXAM			
V	Indirect methods- Transformation Techniques, Exterior and Interior penalty function. Direct methods—Zoudentijk's method, Rosen's GRG method.	7	20
VI	Specialized Optimization techniques –Dynamic programming, Geometric programming, Genetic Algorithms.	7	20
END SEMESTER EXAM			

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Syllabi and Course plan for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

CIVIL ENGINEERING BRANCH

M. Tech.

in

STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT

FIRST SEMESTER

Exam slot	Course Number	Name	Hours/Week			Internal Marks	End Semeste Examinatio		Credi
			L	T	P		Hrs	Marks	
A	10CE 6201	Advanced Numerical and Statistical Methods	3	0	0	40	3	60	3
B	10CE6203	Construction Management	3	0	0	40	3	60	3
C	10CE6103	Theory of Elasticity	3	1	0	40	3	60	4
D	10CE6107	Advanced Theory and Design of RC Structures	3	1	0	40	3	60	4
E		Elective- I	3	0	0	40	3	60	3
	10GN6001	Research Methodology	1	1	0	100	0	0	2
	10CE6209	Seminar-I	0	0	2	100	0	0	2
	10CE6211	Construction Management Lab	0	0	2	100	0	0	1
	TOTAL		**16**	**3**	**4**	**500**		**300**	**22**

ELECTIVE

10CE6213 Quality Control & Project Safety Management

10CE6215 Modern Construction Materials, Methods and Equipment's

10CE6113 Advanced Concrete Technology

10CE6115 Forensic Engineering

SECOND SEMESTER

Exam slot	Course Number	Name	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10CE6202	Construction Personnel Management	3	0	0	40	3	60	3
B	10CE6104	Finite Element Method	3	0	0	40	3	60	3
C	10CE6106	Analysis and Design of Earthquake Resistant structures	3	0	0	40	3	60	3
D		Elective-II	3	0	0	40	3	60	3
E		Elective-III	3	0	0	40	3	60	3
	10CE6208	Mini Project	0	0	4	100	0	0	2
	10CE6212	Structural Engineering Lab	0	0	2	100	0	0	1
	TOTAL		**16**	**0**	**6**	**400**		**300**	**18**

ELECTIVES

10CE6214 Advanced Construction Techniques

10CE6216 Building Service

10CE6218 Construction Economics and Finance Management

10CE6222 Experimental Technique and Instrumentation

10CE6116 Composite Structures

10CE6122 Advanced Pre stressed concrete structures

10CE6124 Analysis and Design of Substructures

10CE6126 High Rise structures

THIRD SEMESTER

Exam slot	Course Number	Name	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A		Elective- IV	3	0	0	40	3	60	3
B		Elective- V	3	0	0	40	3	60	3
	10CE7201	Seminar -II	0	0	2	100			2
	10CE7203	Project Phase 1	0	0	8	50			6
	TOTAL		**6**	**0**	**10**	**230**		**120**	**14**

ELECTIVES

10CE7205 Pavement Construction Practice

10CE7207 Quantitative Techniques in Management

10CE7209 Disaster Management

10CE7211 System Integration in Construction

10CE7105 Design of Bridges

10CE7107 Structural Reliability

10CE7111 Stability of Structures

10CE7115 Advanced Finite Element Analysis

FOURTH SEMESTER

Course Number	Name	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
10CE7204	Project - Phase 2	0	0	23	70	0	30	12
TOTAL		**0**	**0**	**23**	**70**		**30**	**12**

TOTAL NUMBER OF CREDITS: 66

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6201	ADVANCED NUMERICAL AND STATISTICAL METHODS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of Mathematics at UG Level.

Course Objectives

- Get awareness to different numerical and Statistical solutions.
- Impart ability to apply mathematics to finding solutions to real time problems.

Syllabus

Introduction to numerical methods- errors - linear algebraic equations- interpolation- Quadratic and Cubic splines-Ordinary differential equations- 1st order equations- Higher order equations of the initial value type- Predictor corrector methods- Ordinary differential equations of the boundary value type- Partial differential equations in two dimensions- Finite difference method- Problems with irregular boundaries. Basic Statistics, Correlation, method of least squares, Regression, fitting of straight line and parabola, Binominal, Poisson and normal distributions Testing of Hypothesis

Expected Outcomes

The students are expected to apply the theory of elasticity and the analytical techniques for solving practical problems of elasticity.

References

1. Chapra S.C. and Canale R.P. Numerical Methods for Engineers,McGraw Hill
2. Smith G.D. Numerical solutions for Differential Equations,McGraw Hill
3. Ketter and Prawel, Modern Methods for Engineering Computations,McGraw Hill
4. Rajasekharan S., Numerical Methods in Science and Engineering, S Chand & company
5.Rajasekharan S., Numerical Methods for Initial and Boundary value problems, Khanna
6. Terrence J.Akai, Applied Numerical Methods for Engineers, Wiley publishers
7. C.B Gupta , Vijay Gupath An Introduction to statistical Method ,Vikas publications
8. Gupta S.C and Kappr V.K , Fundamental of Mathematical Statics , S. Chand publications

	Course plan		
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Introduction to numerical methods- errors in numerical methods-Systems of linear algebraic equations- Gaussian Elimination method -ill conditioned systems-	6	15
	Eigen Value problems-Power method	2	
II	Langrangean and Hermitian interpolation- Quadratic and Cubic splines (Examples with equal intervals only)	4	15
	Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Higher order equations of the initial value type- Predictor corrector methods. Ordinary differential equations of the boundary value type- Finite difference solution	4	
First Internal Examination			
III	Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference Schmidt method- Crank-Nicholson implicit method- Ellipse equations- Finite difference method- Problems with irregular boundaries.	8	15
IV	Basic Statistics: Sources of Data, Organization of Data, The Histogram, Correlation, Coefficient of correlation, method of least squres, Rank correlation, Regression, fitting of straight line and parabola	6	15
Second Internal Examination			
V	Binominal, Poisson and normal distributions – definitions – simple problems only (Derivation not Included)	6	20
VI	Testing of Hypothesis sampling distributions – test based on normal, T and Chi- Square.	6	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course name	L-T-P-credits	Year of introduction
10CE6203	CONSTRUCTION MANAGMENT	3-0-0-3	2015

Course objectives

The course is designed to provide students a strong background in Understanding the concept of scientific management, the process of bidding and awarding construction contracts and the theory and practice in construction Economy.

Syllabus

Scientific Management, Legal Requirements, Construction contract, Engineering economy, Budgeting, Arbitration

Expected outcome

The students are expected to apply the general principles of construction management in the field of Construction economy. `

Reference

1. Bonny J. B. "Hand book of Construction Management Organization", Van NostrandReinhold New York
2. Robert G Murdick, Joel E. Ros, James and Clegget "Information systems for Modern Management"- second edition, Prentice Hall of India, New Delhi.
3. Collier, William BG. Ledbetter, "Engineering Cost Analysis"- Courtland A., Harper andRow Publishers, New York.
4. Kumar NeerajJha,*Construction Project Management Theory & Practice* , Pearson
5. Gajaria G.T., "Laws Relating to Building and Engineering Contracts in India", M.M.Tripathi Private Ltd., Bombay,
6. Jimmie Hinze, "Construction Contracts", 2nd Edition, McGraw Hill,
7. Joseph T. Bockrath, " Contracts and the Legal Environment for Engineers and Architects", McGraw Hill,
8. Richard Hudson Clough, Glenn A. Sears, "Construction Contracting", J.Wiley,

Course plan

Module	Contents	Hours	Sem. Exam marks

I	**Scientific Management:** Contributions of pioneers in scientific Management - Basic principles of management with special reference to construction industry- construction organization setup.	8	15
II	**Legal Requirements**-Insurance and Bonding-Laws Governing Sale, Purchase and use of Urban and Rural land-	6	15
FIRST INTERNAL EXAM			
III	**Construction contract** – bidding process – types of contracts – contract documents – important clauses in construction contracts –mistakes in bids – breach of the contract – contract changes – differing site conditions – delays, suspensions and terminations – liquidated damages, force majeure and time extensions	8	15
IV	Tax Laws-Income Tax, Sales Tax, Excise and customs duties and their influence on construction costs- Labour Administration- Insurance and Safety Regulations-Workmen's Compensation Act.	6	15
SECOND INTERNAL EXAM			
`V	**Budgeting** Capital budgeting, Working capital management, Construction accounting. Appraisal through financial statements-ratio's analysis, Long term Financing..–sources of funding – comparing alternative proposals	6	20
VI	**Arbitration**-Comparison of Actions and Laws-Agreements, subject matter-Violations Appointment of Arbitrators-Conditions of Arbitrations-Powers and duties of Arbitrator-Rules of Evidence-Enforcement of Award-costs	8	20
	Total	42	
CLUSTER LEVEL END SEMESTER EXAMINATION			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6103	THEORY OF ELASTICITY	3-1-0- 4	2015

Course Prerequisites

Basic knowledge of applied mechanics at UG Level.

Course Objectives

- To understand the behaviour of linear elastic solids under loads
- Provide a firm foundation for more advanced courses, for research and practise in Civil engineering field
- To provide the student with various solution strategies while applying them to practical cases

Syllabus

Analysis of stress in 3D - Analysis of strain in 3D - Stress Strain relations - Two dimensional problems in Rectangular coordinates - Two dimensional problems in polar coordinates - Torsion of prismatic bars.

Expected Outcomes

- Understand concepts, principles and governing equations related to the analysis of elastic solids

To obtain skill and capability in analysing and solving problems in Civil Engineering

References

1. Timoshenko S.P and Goodier. J.N., Theory of Elasticity, McGraw Hill.
2. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw Hill.
3. Sokolnikoff I.S., Mathematical theory of Elasticity, Tata McGraw Hill.
4. Ameen M., Computational Elasticity, Narosa Publishing House.
5. Boresi A.P., Schimidt R.J., Advanced Mechanics of Materials, John Wiley.
6. T.G. Sitharam, Applied Elasticity, Interline publishing.
7. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill.

	Course plan		
Module	Content	Hours	Semester Exam Marks (%)
I	Analysis of stress in 3D: Definition of stress at a point – Stress tensor – Equilibrium equations Stress on arbitrarily oriented plane – Transformation of stress – Principal stress - Stress invariants – Octahedral stresses – Traction boundary conditions, Hydrostatic and Deviatoric Stress Tensors. Numerical examples	10	15

II	Analysis of strain in 3D: Strain tensor – Strain displacement relations for small deformations – Compatibility conditions – Strain transformations– Principal strains – Strain invariants, Octahedral strains, Hydrostatic and deviatoric strains. Numerical examples	8	15
First Internal Examination			
III	Stress Strain relations: Generalised Hooke's law – Reduction in number of elastic constants for orthotropic, transversely isotropic and isotropic media, Boundary value problems of elasticity – Displacement, Traction and Mixed types. Navier's Equations, Beltrami-Michell's Equations, Saint Venant's principle. Uniqueness of Solution. Numerical examples	8	15
IV	Two dimensional problems in Rectangular coordinates: Plane stress and plane strain problems - Airy's stress function -Solution by polynomials – Bending of cantilever loaded at free end, Bending of simply supported beam with udl., pure bending of curved beams	10	15
Second Internal Examination			
V	Two dimensional problems in polar coordinates: General equations- Equilibrium equations, Strain displacement relations and Stress strain relations, compatibility relations Biharmonic equations and Airy's stress functions- Problems of axisymmetric stress distributions - Thick cylinders - Stress concentration due to circular hole in plates (Kirsch's problem). Numerical examples	10	20
VI	Torsion of prismatic bars: Saint Venant's Semi inverse and Prandtl's stress function approach – Torsion of Straight bars – Elliptic and Equilateral triangular cross section. Membrane Analogy -Torsion of thin walled open and closed tubes, Numerical examples	10	20
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6107	ADVANCED THEORY AND DESIGN OF RC STRUCTURES	3-1-0- 4	2015

Course Prerequisites

Basic knowledge of applied mechanics at UG Level.

Course Objectives

This course is designed to

- Provide the ability to analysis and design basic reinforced concrete components;
- Study of advanced topics including theory and design of reinforced concrete structures

Syllabus

Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete -Failure criteria for concrete. -Estimation of deflection and control of cracking, RCC beam – column joints- Flat Slabs- Design of special RC members-Strut and Tie Models- Development- Design methodology- .Design of concrete corbels, deep beams, ribbed slabs, pile caps. Yield line analysis of slabs, Moment redistribution in continuous beams.

Expected Outcomes

- To design the main elements in reinforced concrete structures
- To study the behaviour of reinforced concrete structures
- To analyse and design flat slabs

To design special reinforced concrete members and components

References

1. Park, R. and Pauley, T., Reinforced Concrete Structures, John Wiley
2. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice-Hall
3. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata McGraw Hill
4. Subramanian, N., Design of Reinforced Concrete Structures, Oxford University Press.
5. Gambhir, M. L., Design of Reinforced Concrete Structures, PHI Learning Private Limited.
6. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
7. ACI 318M-14, American Concrete Institute, Building Code Requirements for Structural Concrete

	Course plan		
Module	Content	Hours	Semester Exam Marks (%)

I	Review on Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete under uniaxial and multiaxial states of stress - confined concrete-Effect of cyclic loading on concrete and reinforcing steel. Stress block parameters-Failure criteria for concrete.	10	15
II	Estimation of deflection- immediate and long term deflection- control of cracking, estimation of crack width in RC members, codal procedures on crack width computations.	8	15
First Internal Examination			
III	RCC beam – column joints- classification – shear strength-design of exterior and interior joints- wide beam joints.	8	15
IV	Flat Slabs – Structural requirements-Determination of design bending moments-Direct design method – equivalent frame method-comparison of flat slab with two way slab-Openings in flat slabs	10	15
Second Internal Examination			
V	Strut and Tie Models- Development- Design methodology-selecting dimensions for struts- ACI Provisions-Applications. Design of concrete corbels, deep beams, ribbed slabs, pile caps.	10	20
VI	Yield line analysis of slabs, yield line mechanisms-equilibrium and virtual work method, Hillerborg's strip method. Limitations of yield line theory-Moment redistribution in continuous beams.	10	20
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0-2-0**	**2015**

Course Objectives

This course is designed to

1. To attain a perspective of the methodology of doing research;
2. To develop skills related to professional communication and technical report writing.
3. As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

- The students are expected to :
- Be motivated for research through the attainment of a perspective of research methodology;
- Analyze and evaluate research works and to formulate a research problem to pursue research;
- Develop skills related to professional communication, technical report writing and

publishing papers.

References

1. C.R Kothari, Research Methodology : Methods & Techniques, New Age International Publishers
2. R. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, Management Research Methodology, Integration of Principles, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, Research Methodology – Concepts & Cases, Vikas Publishing House.
5. J.W. Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, New York.
6. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication

	Course plan		
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Overview of Research Methodology: Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	Research Problem and Design : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	Thesis Writing, Reporting and Presentation : Interpretation and report writing, techniques of interpretation, precautions	4	15

	in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences		
IV	Research proposals, Publications, Ethics and IPR : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	Research Methods - Modelling and Simulation : Modelling and simulation, concepts of modelling, mathematical modelling, composite modelling, modelling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modelling..	5	20
VI	Research Methods - Measurement, Sampling and Data Acquisition : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20
	Total	28	
Department Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6209	SEMINAR-I	0-0-2- 2	2015

Course Prerequisites: None

Course Objectives

- Increasing the breadth of knowledge
- Enhancing the ability of self-study
- Improving presentation and communication skills
- Augmenting the skill of Technical Report Writing..

Syllabus:

The student has to present a seminar in one of the current topics in the stream of specialization. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester**.** Seminar I and seminar II shall be offered in first and third semesters. Institutions can advise students belonging to about 50% of number of students in the SECM Stream to opt for Structural Engineering field in Semester 1 for the seminar topic and Construction management field in Semester 3 for the seminar topic and vice versa.

Expected Outcomes :At the end of the course, the student will be able to

- Identify and chose appropriate topic of relevance.
- Assimilate literature on technical articles of specified topic and develop comprehension.
- Prepare technical report.
- Design, develop and deliver presentation on specified technical topic.

Evaluation: The seminar shall be of 30minutes duration and shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee and the student shall submit typed copy of the paper to the Department in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Grades will be awarded on the basis of contents of the paper and the presentation

1. Evaluation of the Report : 30%
2. Presentation : 40 %
3. Ability to answer the questions on the topics : 30 %

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6211	CONSTRUCTION MANAGEMENT LAB	0-0-2- 1	2015

Course Objectives

- Practical training for resource allocation and leveling using MSP
- Capability to use software's for Quantity take off, Preparation and delivery of the bid or proposal.
- Identify and estimate resources for the items of the project and prepare detailed project schedule.

List of Experiments

1. Exercises on
   a. Quantity take off
   b. Preparation of bid document
   c. Delivery of the bid
   for an Engineering construction project
2. Scheduling of a small construction project using MS project / primavera etc including
   a. Manpower Deployment schedule
   b. Equipment deployment Schedule
   c. Financial analysis of the project
   d. Cash Flow analysis
   e. Reports and tracking.
3. Exercise on Valuation : Valuation of land and building using various methods
4. Break up of activities for construction of Residential Building using MS projects
5. Time Estimate for activities and Expected Time calculation using MS projects
6. Exercises on Resource allocation and levelling
7. Drawing a Fishbone diagram of a problem: .The manager of a construction company faces serious problems in coordinating the work. In order to sort out the problem using Cause and Effect Analysis he is asked to find out
   a. The root cause of a problem.
   b. Uncover bottlenecks in the processes.
   c. Identify where and why a process isn't working.
   d. identifies the factors, and adds these to his diagram:
   e. Analysis the diagram and find out major problem.

List of Equipment's / Software's / Tools Requirements
MS OFFICE, MS PROJECT/ PRIMAVERA, AutoCAD, PERT MASTER etc

Expected Outcomes. After completion if this course

1. Acquire capacity to organize drawing, estimation, specification and resource allocation for project
2. Ability to use the software package for Analysis, design and detailing of structures.

Assessment :
Practical Records /outputs 40%, Regular Class Viva-Voce 20%, Final Test (Objective) 40%

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6213	QUALITY CONTROL AND PROJECT SAFETY MANAGEMENT	3-0-0- 3	2015

Course Prerequisites

None

Course Objectives

The course is designed to provide students a strong background in the concept of quality , total quality management, and safety management

Syllabus

Quality, quality control , quality policy, planning , quality leaders The PSDA Cycle, Six sigma Quality, Total quality Management- TQM Organization -Consumer satisfaction, Ergonomics, Taguchi's concept of quality, Quality Assurance.-Codes and standards. Quality Inspection, Quality audit, Statistical Quality control, types of control charts, control charts for variables and attributes, Introduction to Safety Management, safety planning and design, Injury and Accidents, Causes, Investigations and Prevention of Accidents, Hazards-Nature, Causes And Control Measures, Safety programmes, Safety measures , Safety assessment

Expected Outcomes

After completing the course

- Able to apply the principles of quality and TQM in construction industry
- Able to identify and apply the safety in Construction organization. `

References

1. James, J.O Brien, "Construction Inspection Handbook - Quality Assurance and Quality Control ", Van Nostrand, New York,
2. Kwaku A., Tenah and Jose M.Guevera, "Fundamental of Construction Management and Organization ",Prentice Hall of India,
3. Juran Frank, J.M. and Gryna, F.M. " Quality planning and Analysis ", Tata McGraw Hill,
4. Jimmy W.Hinze, "Construction Safety ", Prentice Hall Inc.,

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Quality:** Evolution of quality, definition, elements of quality	3	15
	Quality Control: Definition, Approach to quality control, Objectives of quality control, quality characteristics.	3	
II	**Quality Management**: Quality policy, Quality Planning-	3	15

	tools, Major items in Construction job requiring in quality control.		
	Characteristics of Quality leaders, role of Leaders in quality control, Continuation Process improvement. The PSDA Cycle, Six sigma Quality	4	
First Internal Examination			
III	**Total quality Management:** Definition, TQM Concepts, Basic approach, The Deming's philosophy ,principles of TQM, Benefits of TQM, Involvement of management in TQM	4	15
	TQM Organization -Consumer satisfaction-Ergonomics-Time of Completion-Taguchi's concept of quality	3	
IV	**Quality Assurance** –Objectives, specification. Codes and standards.	2	15
	Inspection –purpose, stage, procedure, methods, technical service for inspection Quality audit-audit cycle.	3	
	Statistical Quality control – definition, advantage, functions, process control, product control, sub-grouping	4	
Second Internal Examination			
V	**Safety Management** - objectives , safety planning and design Injury and Accidents-Definitions of Unsafe Act – Unsafe Condition-Causes, Investigations And Prevention of Accidents.	3	20
	Hazards, Type Of Industrial Hazards-Nature, Causes And Control Measures, Hazard Identifications And Control Techniques -Cost of Construction Injuries	3	
VI	**Safety Programmes** – principles of Safety- Need- Safety measures adopted in work sites.	3	20
	Measurement of Safety Performance, Safety Audit, Problem Areas in Construction Safety- Elements of an Effective and Safety Programme	2	
	Job site Safety assessment- Safety Meetings- Safety Policy, Safety Record Keeping, Safety Culture- safety organization	2	
	Total	42	
CLUSTER LEVEL END SEMESTER EXAMINATION			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6215	MODERN CONSTRUCTION MATERIALS, METHODS AND EQUIPMENTS	3-0-0- 3	2015

Course Objectives

The course is designed for students to familiarize with materials, methods and equipment's in construction field.

Syllabus

Introduction to Modern construction materials, Finishes, Treatments and Construction Chemicals, Metals and Special alloys of steel, Heat treatment in Steels and Tendons, Polymers in Civil Engineering, Weathering, Flooring and Façade materials, Prefabricated Buildings, Pre Engineered Buildings, Tunnel boring methods, Soil improvement techniques, Construction Equipment for different construction operations, Types of Pumps used in construction andMaterial Handling Equipment's.

Expected Outcomes

The students are expected to select and use the suitable and most efficient materials, methods and equipment's in a construction project.

Reference Books:

1. Peurifoy, R.L. "*ConstructionPlanning Equipment and Methods*", McGraw Hill. Singapore
2. Sharma S.C. "*Construction Equipment and Management* ", Khanna Publishers New Delhi,
3. Shan Somayaji, "*Civil Engineering Materials* ", 2nd Edititon , Prentice Hall Inc.
4. Mamlouk, M.S. and Zaniewski, J.P., " *Materials for Civil and Construction Engineers* ", Prentice Hall Inc.
5. Deodhar, S.V. "*Construction Equipment and Job Planning* ", Khanna Publishers, New Delhi.
6. Dr. Mahesh Varma, "*Construction Equipment and its Planning and Application* ", Metro-politan Book Company, New Delhi
7. James, J.O Brien, "Construction Inspection Handbook - Quality Assurance and Quality Control ", Van Nostrand, New York.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Modern Construction Materials:** Overview of Building	4	15

	materials–Study of Advance Building materials - Aluminum – Glass and Fabric – Advantages and Applications of Advance Building materials.		
	Types of Finishing materials, Construction chemicals- Sealants – Grouts – Mortars – Admixtures and Adhesives.	4	
II	**Metals:** Types of metals – Properties – Applications – Types of Steels – Grades of Steel – Properties - Applications	4	15
	Special alloys of Steel : Water Jet Cut Stainless Steel – Mild Steel – Tension Rods – Cast Iron – Heat Treatment in Steel and Tendons	4	
First Internal Examination			
III	Concrete construction- batching, mixing, transport, placement, finishing, formwork, scaffolding. Steel construction- fabrication and erection	6	15
IV	**Construction Building Methods :** Prefabricated Buildings – Properties, Advantages, Limitations and Applications	6	15
Second Internal Examination			
V	**Construction Equipment's**: Fundamentals of Earthwork operations – Equipment's for Excavation, Dredging, Trenching, Drilling, Blasting – Equipment's for compaction and erection .Tunneling equipment's	8	20
VI	Concrete Pumps - Boom pump, Stationary Pump, Specialized usage pumps – Dewatering and Grouting ,Foundation and Pile Driving Equipment	5	
	Material Handling Equipment : Trucks and Hauling Equipment, Finishing Equipment –Conveyors – Fork lift and Portable Material handlers	3	
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6113	ADVANCED CONCRETE TECHNOLOGY	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of ingredients of concrete their properties and their influence for strength and performance of concrete at UG level

Course Objectives

- The course is designed to provide advanced level knowledge on properties of concrete and its performance based on the behavior of ingredients and environmental conditions.

Syllabus

Ready mix concrete, under water concreting, shotcrete, Temperature problems, High strength concrete, High performance concrete, Fiber reinforced concrete, Ferro cement, Light weight concrete, High density concrete, Durability, Test on Hardened concrete, NDT tests on concrete.

Expected Outcomes

The students are expected to select concrete mix based on the requirement of the structure and performance based on the environmental conditions.

References

1. Kumar Mehta.P., Paulo J.M. Monteiro., Concrete- Microstructure, Properties and Materials, Tata McGraw Hill.
2. Neville, A.M and J.J. Brooks., Concrete Technology, Prentice Hall.
3. Neville, A.M.., Properties of Concrete, Prentice Hall.
4. Zongjin Li, Advanced Concrete Technology, Wiley.
5. Gambhir, M.L., Concrete Technology - Theory and Practice, McGraw Hill Education (India) Private Limited.
6. Shetty, M.S., Concrete Technology, Chand & Co.
7. Santhakumar, A. R., Concrete Technology, Oxford University Press.
   IS: 10262□2009, Recommended Guidelines for concrete Mix Design, Bureau of Indian Standard

COURSE PLAN

Module	Content	Hours	Semester Exam Marks (%)
I	**Ready mix concrete -** manufacture, transporting, placing, precautions and methods of purchase. Code recommendations	5	15
II	**Temperature problems** in concreting- Hot weather problems and hot weather concreting, large concrete masses, cold weather concreting, problems	5	15
First Internal Examination			
III	**Fiber reinforced concrete** - Fibers types and properties, Behavior of FRC in compression, tension including pre-cracking stage and post-cracking stages.	7	15
IV	**Ferro cement** - materials, techniques of manufacture, properties and application, advantages.	7	15
Second Internal Examination			
V	**Light weight concrete**- materials properties and types. Typical light weight concrete mix- High density concrete - materials, properties and applications. High performance concrete-methods of obtaining high performance concrete, factors controlling high performance materials, properties, applications	8	20
VI	Durability and impermeability- Cracking, carbonation, alkali-silica reaction, chemical attack-sulphate attack and chloride attack. Test on Hardened concrete-Effect of end condition of specimen, capping, H/D ratio, rate of loading, moisture condition. Compression, tension and flexure tests. NDT tests on concrete- concepts-Rebound hammer, pulse velocity methods.	10	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CE6115	FORENSIC ENGINEERING	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of civil engineering at UG/PG Level.

Course Objectives

- To discuss the causes of damages observed in concrete and steel structures
- Know- how of repair and retrofitting

Syllabus

Failure of Structures: Causes of distress in structural members-Environmental Problems and natural Hazards. Causes of deterioration in concrete and steel structures. Preventive measures, Diagnosis and assessment of deterioration- Methods of repair of cracks- Repairing of corrosion damage of reinforced concrete. Modern techniques of Retrofitting. Strengthening by pre-stressing. Repair of steel structures

Expected Outcomes

Student develops the capability to identify reasons of distress in structures and suggest repair/ remedial measures

References

1. Sidney M Johnson, Deterioration, Maintenance and Repairs of Structures, McGraw Hill Book Company, New York
2. Dovkaminetzky, Design and Construction Failures, Galgotia Publication, New Delhi
3. Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability	5	15

	– causes of distress in structural members – design and material deficiencies – over loading. Environmental Problems and Natural Hazards		
II	Causes of deterioration in concrete and steel structures. Preventive measures, maintenance and inspection.	5	15
First Internal Examination			
III	Diagnosis and assessment of deterioration, visual inspection, non destructive tests, ultrasonic pulse velocity method, rebound hammer method, pull out tests, Windsor probe test, crack detection techniques, etc.	7	15
IV	Case studies on diagnosis of deterioration – single and multi-storey buildings – Fibre optic method for prediction of structural weakness. Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326.	7	15
Second Internal Examination			
V	Methods of repair of cracks, repairing spalling and disintegration, repairing concrete floors and pavements. Repairing of corrosion damage of reinforced concrete. Repair of steel structures.	8	20
VI	Modern Techniques of Retrofitting. Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.	10	20
	Total	42	
CLUSTER LEVEL END SEMESTER EXAMINATION			

KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*10*
Branch	**:**	*Computer Science & Engineering*
Stream	**:**	*Computer Science & Information Security*
Year	**:**	*2015*
No. of Credits	**:**	*68*

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CS6201	Mathematical Foundations of Computer Science	3-0-0	40	60	3	3
B	10CS6202	Algorithms and Complexity Theory	3-1-0	40	60	3	4
C	10CS6203	Topics in Computer Networks	3-1-0	40	60	3	4
D	10CS6204	Foundations of Cryptography and Network Security	3-1-0	40	60	3	4
E		Elective I	3-0-0	40	60	3	3
F	10GN6001	Research Methodology	0-2-0	100			2
G	10CS6208	Seminar I	0-0-2	100			2
H	10CS6210	Network and Information Security Lab	0-0-2	100			1
		TOTAL	**15-2-4**	**500**	**300**	**-**	**23**

TOTAL CONTACT HOURS : 21
TOTAL CREDITS : 23

Elective I

10CS6212 Parallel Computing
10CS6213 Pattern Recognition
10CS6214 Compiler Design
10CS6215 Computational Intelligence
10CS6216 Computability Theory

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CS6205	Advanced Topics in Cryptography	3-1-0	40	60	3	4
B	10CS6206	Topics in Operating Systems	3-0-0	40	60	3	3
C	10CS6207	Topics in Database Management Systems	2-1-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
F	10CS6209	Mini Project	0-0-4	100			2
G	10CS6211	Operating Systems and Database Management Systems Lab	0-0-2	100			1
		TOTAL	**14-1-6**	**400**	**300**	**-**	**19**

TOTAL CONTACT HOURS : 21
TOTAL CREDITS : 19

Elective II/III

10CS6217	Information Theory & Coding
10CS6218	Optimization Techniques
10CS6219	Principles of Secure Coding
10CS6220	Natural Language Processing
10CS6221	Image Processing
10CS6222	Data Mining
10CS6223	Data Compression
10CS6224	Information Retrieval
10CS6225	Topics in Graph Theory
10CS6226	Formal Methods in Secure Computing

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective IV	3-0-0	40	60	3	3
B		Elective V	3-0-0	40	60	3	3
	10CS7201	Seminar II	0-0-2	100			2
	10CS7202	Project (Phase 1)	0-0-12	50			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective IV/V

10CS7204	Digital Watermarking and Information Hiding
10CS7205	Crypto complexity
10CS7206	Cyber Laws and Intellectual Property Rights
10CS7207	Secure Network Protocols
10CS7208	Cloud Architecture and Security
10CS7209	Information Security Management
10CS7210	Mobile & Wireless Security
10CS7211	Ethical Hacking
10CS7212	Electronic Commerce
10CS7213	UML & Design Patterns

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credit
					Marks	Duration (hours)	
	10CS7203	Project (Phase 2)	0-0-23	70	30		12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**12**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 12

TOTAL NUMBER OF CREDITS: 68

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6201	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**	**3-0-0-3**	**2015**

Course Prerequisites

Basic knowledge of number theory and discrete computational structures at UG Level.

Course Objectives

The course is designed to provide students strong mathematical foundations required for advanced studies in computer science.

Syllabus

Introduction to basics of number theory including Congruence's,Discrete computational structures including Groups,Rings,Fields,Discrete Logarithm,Elliptic Curve Arithmetic,Fundamental Principles of Counting, Sets ,Relations,Boolean Algebra,Fundamentals of Graph Theory.

Expected Outcomes

The students are expected to develop deeper problem analysing and solving capabilities with strong mathematical foundations

References

1. Niven,H.S Zuckerman and Montgomery,An Introduction to the Theory of Numbers, 3/e, John Wiley and Sons,New York,1992.
2. R.P Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 3/e.
3. B. Kolman and R.C Bubsy,Discrete Mathematical Structures for Computer Science.PHI,New Delhi
4. J.Clark and D.A Holton,A First Look at Graph Theory,Allied Publishers (World Scientific) New Delhi 1991.
5. C.L.Liu,Elements of Discrete Mathematics,McGraw Hill,2/e.Singapore,1985

	Course plan		
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Basic number theory**: Divisibility, GCD,prime numbers,fundamental theorem of arithmetic,Congruences-Definition and properties,solution of congruences.	5	15
II	Residueclass,Euler's phi function,Fermat's theorem,primality testing,Chinese remainder theorem,Wilson's theorem.	5	15
	First Internal Examination		
III	**Principles of Counting:**Fundamental principles of counting,pigeonhole principle,countable and uncountable sets,principle of inclusion and exclusion, derangements, equivalence relations and partitions,partial order,lattices and Boolean algebra.	8	15
IV	**Group Theory:** Groups, definitions and properties,subgroups,homomorphism theorems, cosets and normal subgroups,Lagrange's theorem.	8	15
	Second Internal Examination		

V	**Rings and Fields :** Rings, finite fields,polynomial arithmetic,quadratic residues, reciprocity,Legendre symbol,Jacobi symbol, discrete logarithms, elliptic curve arithmetic	8	20
VI	**Graph theory:** Graphs,Euler tours,Hamiltonian graphs,Euler's formula,graph colouring,trees,weighted trees,shortest path algorithms,spanning trees,the max-flow min-cut theorem.	8	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6202	COMPUTER ALGORITHMS AND COMPLEXITY	3-1-0-4	2015

Course Prerequisites: Basic knowledge of Computer Algorithms and complexity at UG Level.

Course Objectives

The course is designed to provide students a strong background in the concept of analysis and design of computer algorithms. Upon completion of this course, students will be able to do the following:

1. Analyse the asymptotic performance of algorithms.
2. Demonstrate a familiarity with major graph algorithms and advanced data structures.
3. Classification of computing problems based on deterministic and randomized category
4. Synthesize efficient algorithms in common engineering design situations.

Syllabus

Analysis of Algorithms, Asymptotic notations, Recurrence analysis, Amortized Analysis, Advanced Data structures, Design and Analysis of Graph algorithms, all pair shortest path algorithms, Network flow, Matroid, Complexity Classes, reduction, Approximation Algorithms, Randomized algorithms.

Expected Course outcomes

At the end of the course the student will be able to

1. Analyze running times of algorithms using asymptotic analysis. Describe different strategies for amortized analysis, including the accounting method and the potential method. Solve recurrence relations.
2. Explain and use the major advanced data structures like B. Tree, Binomial heap, Fibonacci heap, and Disjoint set.
3. Explain the major graph algorithms and their analyses. Employ graphs to model shortest path and flow problems, when appropriate.
4. Classify problems into different complexity classes corresponding to both deterministic and randomized algorithms.
5. Analyze approximation algorithms including algorithms that are polynomial time approximation scheme and fully polynomial time approximation scheme.
6. Explain the basic properties of randomized algorithms and methods for analyzing them

References

1. Thomas H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, The MIT Press.
2. Dexter C Kozen, The Design and Analysis of Algorithms, Springer.
3. Rajeev Motwani and PrabakarRagavan, Randomized Algorithms, Cambridge University Press.
4. Jon Kleinberg, Eva Tardos Algorithm Design, Pearson.
5. Gilles Brassard, Paul Bratley, Fundamentals of Algorithms, PHI.
6. Alfred V. Aho,John E. Hopcroft,Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley.
7. Christos H Papadimitriou, Kenneth Steiglitz Combinatorial Optimization Algorithms and Complexity, Dover Books.

8. Michael Sipser, Introduction to Theory of Computation, Wadsworth Publishing Co Inc.
9. Garey Michael R, Johnson davis S, Computers and Intractability: A Guide the theory of NP-Incompleteness,W.H. Freeman & Co.1979.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Analysis of Algorithms:** Model of Computation- RAM Model [Ref. 1,6] Asymptotic Notations; Recurrence Analysis: Substitution Method, Recursion tree Method, Master Method- and its Proof; [Ref. 1]. **Amortized Analysis:** Aggregate analysis, Accounting method, Potential method; [Ref. 1].	9	15
II	**Advanced Data structures:** Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, Disjoint Sets, Union by Rank and Path Compression; [Ref. 1].	9	15
First Internal Examination			
III	**Design and Analysis of Graph algorithms:** Graph Algorithms and complexity: All-Pairs Shortest Paths: The Floyd-Warshall algorithm, Johnson's algorithm; Maximum Flow: The Ford-Fulkerson method, The Edmonds-Karp algorithm; Bipartite Matching;[Ref. 1,4] Matroid Theory-task-scheduling problem [Ref. 1].	10	15
IV	**Complexity Classes:** Complexity Classes, NP Hard & NP Complete Problems, Reductions and NP Completeness, Cook's Theorem[Ref. 2,4,7,8,9]; NP completeness reductions for clique, vertex cover, subset sum, Hamiltonian cycle and TSP.	9	15
Second Internal Examination			
V	**Approximation Algorithms:** Polynomial Time and Fully Polynomial Time Approximation Schemes [Ref. 8]; Approximation Algorithms, vertex cover, TSP, set covering and subset sum [Ref. 1].	9	20
VI	**Randomized algorithms:** Randomized Algorithms: Las Vegas and	10	20

	Monte Carlo Algorithms [Ref. 3, 5], Randomized Divide and conquer Approach [Ref. 4], Randomized version of Quick Sort Algorithm [Ref. 4, 1], Miller Rabin Randomized Primality Test; Integer factorization: Pollard's rho heuristic [Ref. 1]; De-Randomization; Randomized Complexity Classes [Ref. 6]; Probabilistic Algorithms [Ref. 8].		
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6203	TOPICS IN COMPUTER NETWORKS	3-1-0- 4	2015

Course Prerequisites

None

Course Objectives

Upon completing the course, the student will:
- be familiar with the basics of data communication
- be familiar with various types of computer networks
- have experience in designing communication protocols
- be exposed to the TCP/IP protocol suite.

Syllabus

Network architecture – layers,Physical Layer,Framing, Medium Access, Routing, Transport layer TCP, UDP,Application Layer, Security, Socket programming.

Expected Outcomes

The students will be able to
1. master the terminology and concepts of the OSI reference model and the TCP-IP Reference model.
2. master the concepts of protocols, network interfaces, and design/performance issues in local area networks and wide area networks
3. be familiar with network programming

References

1. Andrew S. Tanenbaum, Computer Networks, Fourth Edition, 2003.
2. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Third Edition, Morgan Kauffmann Publishers Inc., 2003.
3. Behrouz A. Forouzan: Data Communications and Networking, 4th Edition, Tata McGraw-Hill, 2006.
4. Computer Networking: A Top-Down Approach Featuring the Internet by J. Kurose, K. W. Ross, 3rd edition, Addison-Wesley 2004.
5. W. Richard Stevens, UNIX Network Programming Volume I, Pearson Education
6. D.E. Comer, Internetworking with TCP/IP Volume III, Pearson Education

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to computer networks**:Network architecture – layers – Physical links – Channel access on links – Hybrid multiple access techniques - Issues in the data link layer - Framing – Error correction and detection – Link-level Flow Control	8	15
II	**Medium access**:CSMA – Ethernet – Token ring – FDDI - Wireless LAN – Bridges and Switches	8	15
First Internal Examination			
III	**Network Layer**:Circuit switching vs. packet switching / Packet switched networks – IP – ARP – RARP – DHCP – ICMP – Queuing discipline – Routing algorithms – RIP – OSPF – Subnetting – CIDR – Inter-domain routing – BGP – Ipv6 – Multicasting –	12	20

	Congestion avoidance in network layer		
IV	**Transport Layer:**UDP – TCP – Adaptive Flow Control – Adaptive Retransmission - Congestion control – Congestion avoidance – QoS	12	20
Second Internal Examination			
V	**Application Layer** : Email (SMTP, MIME, IMAP, POP3) – HTTP – DNS- SNMP – Telnet – FTP – Security – PGP - SSH	8	15
VI	**Introduction to Socket Programming:** Introduction to Sockets – Socket address Structures – Byte ordering functions – address conversionfunctions – Elementary TCP Sockets – socket, connect, bind, listen, accept, read, write, close functions – Iterative Server – Concurrent Server.	8	15
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6204	FOUNDATIONS OF CRYPTOGRAPHY & NETWORK SECURITY	3-1-0-4	2015

Course Prerequisites
Nil

Course Objectives
The course is designed to provide the students a strong background in the concept of cryptography and network security. Various cryptographic techniques for security and authentication are covered. Also various network security protocols and methods are also enclosed.

Syllabus
Introduction to Cryptography, Symmetric key cryptosystem, Authentication techniques, Public-key cryptosystem, Key exchange, Digital signatures, Network security, Electronic Mail Security, IP Security, Web Security, Firewalls

Expected Outcomes
The students will get a thorough understanding on the fundamentals of cryptographic systems and they will be able to implement various symmetric and asymmetric key cryptography techniques. They will also be able to critically analyze and implement different cryptographic authentication mechanisms and differentiate and use appropriate network security mechanisms.

References
1. AthulKahate, Cryptography and Network Security, TMH
2. William Stallings, Cryptography and Network Security Principles and Practice, 5th edition
3. Bernard Menezes, “Network Security and Cryptography”, Cengage Learning, New Delhi, 2010.
4. Bruce Schneier, “Applied Cryptography”, John Wiley & Sons, New York.
5. Kaufman, R. Perlman, and M. Speciner, Network Security: Private Communication in a Public World, Prentice Hal.
6. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone: “Handbook of applied cryptography”, CRC Press
7. Wenbo Mao, “Modern Cryptography – Theory and Practice”, Pearson Education, New Delhi.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction**:One-way and trapdoor one-way functions, cryptanalysis, classical cryptography.Block ciphers: Modes of operation, DES and its variants, RC5, IDEA, Blowfish, AES, linear and differential cryptanalysis. Stream ciphers: Stream ciphers based on linear feedback shift registers, SEAL, unconditional security.	11	20
II	**Hash Algorithms**:Message digest: MD2, MD5.Properties of hash functions, Secure Hash Algorithms, Keyed hash functions, Attacks on hash functions.	8	15
First Internal Examination			
III	**Public-key encryption**:RSA, Rabin and EIGamal schemes, Goldwasser-Micali, Blum-Goldwasser cryptosystems, Elliptic Curve cryptosystems. Side channel attacks.	10	20
IV	**Key exchange:**Diffie-Hellman and MQV algorithms. Digital signatures: RSA, DSA and NR signature schemes, blind and undeniable signatures	9	15
Second Internal Examination			
V	**Network security**:Electronic Mail Security: Pretty good privacy-S/MIME. Security - transport layer security-secure electronic transaction.	9	15

	IP Security: Architecture- authentication Header- Encapsulating Security payload- Combining Security associations- Key management.		
VI	**Web Security**: Web Security considerations- secure Socket Layer and Transport layer Security- Secure electronic transaction.Firewalls-Packet filters- Application Level Gateway- Encrypted tunnels.	9	15
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6212	**PARALLEL COMPUTING**	**3-0-0-3**	**2015**

Course Prerequisites: None.

Course Objectives

The course is designed to provide the students with the fundamental knowledge in the design principles for general-purpose parallel computers. Students will understand the principles and practices in parallel computer architecture and computing.

Syllabus

Motivation and Scope of Parallel Computing, Physical Organization, Parallel Algorithm Design, Communication Operations, Analytical Modelling of Parallel Programs, Performance considerations, Programming Using the Message-Passing Paradigm.

Expected Course outcomes

The students are expected to learn how algorithms that were originally developed for single-processor systems can be converted to run efficiently on parallel computers and also how to develop efficient parallel programs.

References

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, Second Edition, Addison Wesley.
2. Michael J Quinn, Parallel Computing Theory and Practice, Second Edition, Tata McGraw Hill, 2002.
3. David E. Culler, Jaswinder Pal Singh, Anoop Gupta, Parallel Computer Architecture: A Hardware/ Software Approach, Morgan Kaufmann Publishers
4. Peter S. Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann Publishers, 2011

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to Parallel Computing -** Motivation, Scope, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	6	15
II	**Principles of Parallel Algorithm Design -** Basics, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models	8	15
First Internal Examination			

III	**Basic Communication Operations** —One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication	8	15
IV	**Analytical Modeling of Parallel Programs** -Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems, Asymptotic Analysis of Parallel Programs.	7	15
Second Internal Examination			
V	**Programming Using the Message-Passing Paradigm -** Principles, Send and Receive Operations, the Message Passing Interface, Topologies and Embedding	7	20
VI	Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators	6	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6213	**PATTERN RECOGNITION**	**3-0-0-3**	**2015**

Course Prerequisites: None.

Course Objectives

This course comprises some of the well-known methods used in various stages of a pattern recognition

Syllabus

Basics of Pattern recognition , Methods for parameter estimation , Sequential pattern classification , Dimension reduction methods , Non-metric methods for pattern classification , Regression

Expected Course outcomes

The course is primarily meant to introduce various pattern recognition techniques. The students would be encouraged use various pattern recognition techniques on different area.

References

1.R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001

2.S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

3.C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Basics of Pattern recognition**– Bayesian Decision Theory-Minimum error rate classification,Classifiers, discriminant functions, decision surfaces -The normal density and discriminant-functions for the Normal density-Continuous and discrete valued features-Bayesian Belief Networks	7	15

II	**Methods for parameter estimation**– Maximum-Likelihood (ML) estimation-Maximum a posteropri (MAP) estimation-Bayesian estimation-Gaussian mixture model (Both unimodal-and multimodal distribution) -Expectation-maximization method	7	15
First Internal Examination			
III	**Sequential pattern classification-** Discrete hidden Markov model-Continuous density hidden Markovmodels-Non-parametric techniques for density estimation-Parzen-window method ,K-Nearest Neighbour method	8	15
IV	**Dimension reduction methods**– Principal component analysis-Fisher discriminant analysis ,Linear discriminant function based classifiers-Perceptron-Minimum Mean Squared Error (MME) method	8	15
Second Internal Examination			
V	**Non-metric methods for pattern classification** - introduction-Decision trees-Classification and Regression Tree (CART)-Applications	6	20
VI	**Regression:** Linear models for regression-Polynomial regression-Bayesian regression-Unsupervised learning and clustering-Criterion functions for clustering-Algorithms for clustering:-K-means, -Hierarchical clustering – Cluster validation.	6	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6214	COMPILER DESIGN	3-0-0-3	2015

Course Prerequisites: Computer programming course at PG/UG level.

Course Objectives

To familiarize the concepts in different phases of compiler such as lexical Analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization, code generation.

Syllabus :

Introduction and overview, Syntax analysis, Semantic Analysis, Control flow analysis, Code Optimization and Code Generation

Expected Course outcomes

The students are expected to understand the general principles of different phases of compiler.

References:

1. Aho A Ravi Sethi and J D Ullman, Compilers Principles Techniques and Tools,Addison Wesley
2. Kenneth C Louden, “Compiler Construction Principles and Practice”, Cenage Learning Indian Edition
3. D M Dhamdhare, System programming and operating system,TMH
4. Tremblay and Sorenson,The theory and practice of Compiler writing,TMH
5. Allen T Hollub , Compiler design in C ,PHI

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction and Review:** Language processors; The structure of a Compiler; Phases of a compiler-Analysis and synthesis phases-Lexical analysis The evolution of programming languages; Introduction to Advanced Topics–Informal Compiler Algorithm Notation; Applications of Compiler technology	6	15

II	**Syntax analysis:** Top down parsing-Recursive Descent parsing –LL(1) parsing-Bottom up parsing-Shift reduce parsing-Operator precedence parsing-LR parsing-Simple LR, Canonical LR and LALR parsers-Design of syntax analyser using YACC.Comparison of YACC and LEX.	8	15
First Internal Examination			
III	**Semantic analysis:** Syntax directed definitions. -Type system and Type checking-Design of a simple type checker Intermediate Code Generation 3 Address code-Triples and quadruples	8	15
IV	**Control Flow Analysis:** Data Flow Analysis – Dependency analysis – Alias analysis	4	15
Second Internal Examination			
V	**Code Optimization:** Review of Early Optimizations – Redundancy Elimination – Loop Optimizations, Register Allocation – Local and Global Instruction Scheduling – Advanced Topics in Code Scheduling– Low Level Optimizations.	8	20
VI	**Code Generation:** Basic issues in code generation-Data descriptors-Expression trees-Generating target code from expression trees-Symbol table handling-Symbol table requirements and organization. Error handling-Types of errors-Compile time errors and recovery-Runtime errors-Runtime Error Handling.	8	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6215	COMPUTATIONAL INTELLIGENCE	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of Algorithms at PG/UG level.

Course Objectives

This course is an introduction to the basic concepts of Artificial Intelligence, with illustrations of current state of the art research and applications. The course will cover a broad spectrum of AI concepts and methods.They will be introduced to AI programming languages such as LISP and PROLOG.

Syllabus

Artificial Intelligence, Structures and Strategies for state space search, Knowledge representation , Introduction to Agent based problem solving ,Machine Learning , Genetic Algorithm , Languages and Programming Techniques for AI

Expected Outcomes

1. The student will be introduced to Artificial Intelligence programming.
2. The student will learn to apply knowledge representation techniques and problem solving strategies to common AI applications.
3. analyse and solve problems involving various forms of search algorithms, including the design of heuristic functions to improve the efficiency of such solutions
4. develop systems that utilize artificial intelligence

References

1. George.F.Luger, Artificial Intelligence- Structures and Strategies for Complex Problem Solving, 4/e, 2002, Pearson Education.
2. E. Rich, K.Khight, Artificial Intelligence, 2/e, Tata McGraw Hill
3. Fundamentals of Neural Networks", LaureneFauseett, Prentice Hall India, New Delhi,1994.
4. Winston. P. H, LISP, Addison Wesley
5. Ivan Bratko, Prolog Programming for Artificial Intelligence, 3/e, Addison Wesley, 2000

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Artificial Intelligence:**History and Applications, Production Systems, Basic concepts-single layer perceptron-Multi layer perceptron- Adaline-Madaline- Learning rules-Supervised learning-Back propagation networks-Training algorithm	5	15
II	**Structures and Strategies for state space search:** Data driven and goal driven search, Depth First and Breadth First Search, DFS with Iterative Deepening, Heuristic Search- Best First Search, A* Algorithm, AO* Algorithm, Constraint Satisfaction, Using heuristics in games- Minimax Search, Alpha Beta Procedure.	7	15
First Internal Examination			

III	**Knowledge representation**: Propositional calculus, Predicate Calculus, Theorem proving by Resolution, Answer Extraction, AI Representational Schemes- Semantic Nets, Conceptual Dependency, Scripts, Frames.	7	15
IV	Introduction to Agent based problem solving ,Machine Learning-Symbol based and Connectionist, Social and Emergent models of learning	7	20
Second Internal Examination			
V	**Genetic Algorithm**: Genetic Programming, Overview of Expert System Technology- Rule based Expert Systems, Introduction to Natural Language Processing.	8	20
VI	**Languages and Programming Techniques for AI:**Introduction to PROLOG and LISP, Search strategies and Logic Programming in LISP, Production System examples in PROLOG.	8	15
	Total	42	
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6216	**COMPUTABILITY THEORY**	**3-0-0-3**	**2015**

Course Prerequisites: None.

Course Objectives

To familiarize the concepts in computability theory such as CFG,Regular expression and Turing Machine

Syllabus

Introduction, Regular expressions (RE),Turing machines, Variants of TMs, Decidability, Time and Space complexity classes

Expected Course outcomes

The students are expected to apply the general principles of computability theory in decidable and undecidable problems.

References

1. J E Hopcroft And J D Ullman : Introduction to Automata Theory and Computation, Addison Wesley

2. John C Martin : Introduction to Languages and the Theory of Computation(3 rd Edition) , TMH

3. H R Lewis and C H Papadimitriou : Elemnts of Theory of Computation

4. Sipser : Introduction to theory of Computation, CENAGE LEARNING Indian Edition

5. Linz P : An Introduction to Formal Languages and Automata, Narosa

6. PAPADIMITRIOU, C. H. Computational Complexity, Addison Wesley, 1994

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction**– alphabets, Strings and Languages; Automata and Grammars - Finite automata (FA) -DFA-NFA –Finite Automata with epsilon-transitions-Equivalence of DFAs and NFAs. Proving languages tobe non-regular - Pumping Lemma – Applications	6	15

II	**Regular expressions (RE)** – Definition,RE to FA, FA to RE, algebraic laws for RE, applications of REs. -Regular grammars and FA .Closure Properties of RE and R sets - Undecidability – Reductions – RE Completeness – Non-RE languages - Rice Theorems.	6	15
First Internal Examination			
III	**Turing Machines -** Formal definition and behaviour - TM as a computer of integer functions –Programming techniques for TMs -Storage in state, multiple tracks, subroutines, etc.- Turing Machines – Turing Acceptable, Decidable and Enumerable languages. Computing a partial function with Turing machine	7	15
IV	**Variants of TMs** – Multitape TMs, Nondeterministic TMs. -TMs with semi-infinite tapes, multistack machines.-universal Turing Machines-Equivalence of the various variants with the basic model-Models of computation and Church-Turing Thesis.	7	15
Second Internal Examination			
V	**Decidability**- Decidable languages, decidable problems concerning regular languages, decidable concerning context free languages, halting problem–diagonalization method. Undecidable problems from language theory, mapping reducibility- formal definition	8	20
VI	**Time and Space complexity classes** :- Relations between deterministic and Non-Deterministic time and Space complexity classes – Hierarchy Theorems, - Savitch's Theorem – ImmermanSzelepscenyi Theorem -NP Completeness – Cook's Theorem – Reductions – PSPACE completeness, NLCompleteness.	8	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6210	**NETWORK & INFORMATION SECURITY LAB**	**0-0-2-1**	**2015**

Course Prerequisites

Basic knowledge of computer networking at PG/UG level.

Course Objectives

The course is designed to provide students practical knowledge of computer networking, network programming and familiarize them with the cryptographic algorithms present in Java.

Syllabus

Linux Network configuration, socket programming, Java cryptographic library.

Expected Outcomes

After the completion of this course student will be able to,

1. Set up a computer network
2. Protect machines with firewall.
3. Develop network applications using socket programming
4. Use various cryptographic classes in Java.

References

1. Wale Soyinka, Linux Administration: A Beginner's Guide, 6th Edition, McGraw-Hill Education
2. W. Richard Stevens, UNIX Network Programming Volume I, Pearson Education
3. D.E. Comer, Internetworking with TCP/IP Volume III, Pearson Education
4. Jason Weiss, Java Cryptography Extensions: Practical Guide for Programmers (The Practical Guides), Morgan Kaufmann Publishers.

Course plan

Experiments	Semester Exam Marks (%)
1. Socket Programming 2. Familiarization of network tools in Linux and windows 3. Static configuration of routing tables in Linux 4. DNS configuration 5. Firewall configuration 6. Familiarization of cryptographic algorithms in Java	50

Assessment :

1. Practical Records /outputs 40%
2. Regular Class Viva-Voce 20%
3. Final Test (Objective) 40%

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Computer Science & Engineering

(CSE)

M. Tech.

in

Computer Science and Engineering(Networks and Security)

(CNS)

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CS6301	Mathematical Foundations(Networks)	3-0-0	40	60	3	3
B	10CS6303	Advanced Algorithms and Analyzes	3-1-0	40	60	3	4
C	10CS6305	Topics in Networking	3-1-0	40	60	3	4
D	10CS6307	Network Design and Performance Evaluation	3-1-0	40	6 60	3	4
E		Elective I	3-0-0	40	60	3	3
F	10GN6001	Research Methodology	0-2-0	100			2
G	10CS6309	Seminar I	0-0-2	100			2
H	10CS6311	Advanced Networking Laboratory	0-0-2	100			2
		TOTAL	**15-5-4**	**500**	**300**	**-**	**23**

Total Contact hours: 24

Total Credit: 23

Electives 1

10CS6313	Advanced Computer Architectures
10CS6315	Applied Probability and Statistics
10CS6317	Ethical Hacking
10CS6319	Wireless Networks
10CS6321	Storage Management and Security
10CS6323	High Performance Networks
10CS6325	Energy Aware Computing
10CS6327	Data Mining and Knowledge Discovery
10CS6329	Virtualization Techniques
10CS6331	Networking in Embedded Systems

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6301	MATHEMATICAL FOUNDATIONS(NETWORKS)	3-0-0-1	2015

Course Prerequisites

Basic courses in Discrete Mathematics, Data structures, Simulation at UG level

Course Objectives

Syllabus

Review of queuing models, important queuing models, Burke's theorem and Jackson's theorem.

Proof Techniques

Review of formal logic concepts, Propositional logic, Predicate Logic, Higher order logic and the incompleteness theorem

Review of Computational logic, Unification, resolution and theorem proving with resolution, logic programming.

Review of graph theoretic concepts, graph isomorphism, Euler's paths, Depth-first and Breadth-First trees on graph, Connected components, articulation points, Networks, flows and cuts.

Expected Outcomes

Texts:

1. Grimaldi P.R, "Discrete & Combinatorial Mathematics", Addison Wesley
2. James L. Hein, Discrete Structures, Logic,and Computability, Jones and Bartlett Publishers, 3rd Edition
3. Kolman, Busby & Ross "Discrete Mathematical Structures", PHI.
4. J.P. Tremblay & R. Manohar, "Discrete Mathematical Structure with Application to Computer Science", TMH, New Delhi (2000).
5. Dimitri P. Bertsekas and Robert G. Gallager, 'Data Networks' , 2nd Edition, PHI
6. J. Clark and D.A. Holton, " A First Look at Graph Theory" , World Scientific.
7. A.O. Allen, "Probability, Statistics and Queueing Theory with Computer Applications", Elsevier, 2nd edition, 2005.

References:

1. J. Truss, “Discrete Mathematics”, Addison Wesley.
2. C.L.Liu, “Elements of Discrete Mathematics”, McGraw Hill Book Company.
3. M.Lipson & Lipshutz, “Discrete Mathematics”, Schaum’s Outline series.
4. Iyengar, Chandrasekaran and Venkatesh, “Discrete Mathematics”, Vikas Publication
5. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Springer-Verlag London 3rd Ed.
6. Copi Irving M., *Symbolic logic*, Prentice-Hal, Fifth Edition
7. K.S. Trivedi, “Probability and Statistics with Reliability, Queueing and Computer Science Applications”, John Wiley and Sons, 2nd edition, 2002.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Queuing Models:-** General concepts, Arrival pattern, service pattern, Queue Disciplines, FIFO Queuing systems, M/M/1, M/M/c, M/M/∞, M/G/1, M/M/m/m and other Markov models, non markov models,Network queues, Burke’s theorem, Jackson’s theorem.	11	25
II	**Proof Techniques:-** Proofs, Techniques for theorem proving, Direct Proof, Proof by Contra position, Proof by exhausting cases and proof by contradiction,	4	10
	First Internal Examination		
III	**Formal Logic**:- Propositional Logic, well formed formula and semantics, logical equivalence, truth functions and normal forms, Validity of arguments, Proof rules and proof, derived rules, Quantifiers, Predicates, Predicate Logic, validity, Prenex Normal form, Higher order logic - Order of Predicates, Quantifiers, WFF and logic, Higher order reasoning. Soundness, Completeness and Gödel’s Incompleteness Theorem(without proof)	8	20
II	**Computational Logic:-** Clauses and clausal form, Skolem’s rule and algorithm , Resolution for propositions, Substitution, Composition and unification, Most General Unifier, Robinson unification algorithm, Martelli-Montanari algorithm, General resolution rule and resolving Clauses, Theorem proving with Resolution, Logic programming , Horn clause, SLD	9	20

resolution.

Second Internal Examination			
III	**Graph Theory**:- Graphs, Isomorphic graphs, Euler path & hamiltonian circuits, Sub graphs, regular graphs, Euler's formula (proof) five color theorem and four color problem (without proof), Chromatic number and chromatic Polynomial of a graph, Directed graphs, Indegree and out degree, Trees, Depth-first and breadth first search, trees associated with DFS & BFS, Connected components, articulation points, Networks, flows and cuts.	10	25
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6303	ADVANCED ALGORITHMS AND ANALYZES	3-1-0-4	2015

Course Prerequisites

Basic courses in Algorithms and Analysis, Number theory at UG level

Course Objectives

Syllabus

Model of Computation, Recurrence Analysis, Amortized Analysis, Case studies with advanced Data structures

Complexity Classes, Randomized Algorithms, Randomized complexity classes

Linear Programming, Number Theoretic Algorithms, Approximation Algorithms, Parallel & Distributed Algorithms.

Expected Outcomes

References:

1. Thomas H Cormen, C E Leiserson, R L Rivest, C Stein Introduction to Algorithms

2. Dexter C Kozen The Design and Analysis of Algorithm

3. Rajeev Motwani and Prabakar Ragavan Randomized Algorithms

4. Jon Kleinberg, Eva Tardos Algorithm Design

5. Prabakar Gupta, Vineet Agarwal, Manish Varshney Design and Analysis of Algorithms

6. Vijay V Vazirani Approximation Algorithms

7. Richard Johnsonbaugh, Marcus Schaefer Algorithms

8. Christos H Papadimitriou, Kenneth Steiglitz Combinatorial Optimization Algorithms and Complexity.

9. Chandra Mohan Design & Analysis of Algorithm

10. Sara Baase, Allen Van Gelder Computer Algorithm

11. Michael Sipser Introduction to Theory of Computation

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Model of Computation**- RAM Model- Notations; **Recurrence Analysis**: Substitution Method, Recursion tree Method, Master Method- Masters Theorem and its Proof;	5	10
II	**Amortized Analysis**: Aggregate analysis, The Accounting method, The Potential method-;Case Study with Datastructures: B-Trees, Binomial Heaps;	7	10
III	**Complexity Classes**, NP Hard & NP Complete Problems, Reductions and NP Completeness, Cook's Theorem.	7	15
First Internal Examination			
IV	**Randomized Algorithms**: Las Vegas and Monte Carlo Algorithms, Randomized Divide and conquer Approach, Randomized version of Quick Sort Algorithm, Miller Rabin Randomized Primality Test, De-Randomization; Randomized Complexity Classes; Probabilistic Algorithms.	10	15
V	**Linear Programming**: Standard and Slack forms, Formulating problems as linear programs, The simplex algorithm, Duality, The initial basic feasible solution;	7	15
VI	**Number Theoretic Algorithms**: Elementary number theoretic notions, Greatest Common Divisor, Modular Arithmetic, Solving modular linear equations, the Chinese remainder theorem, powers of an element, the RSA Public key crypto system, Primality testing.	7	15
Second Internal Examination			
VII	**Approximation Algorithms**, Polynomial Time and Fully Polynomial Time Approximation Schemes; Randomized Approximation Schemes;	7	10
VIII	**Parallel & Distributed Algorithms**: Introduction, the parallel random access machine, Sorting networks, Parallel	6	10

Architectures, Distributed algorithms;	
Total	56

Cluster Level End Semester Examination

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6305	TOPICS IN NETWORKING	3-0-0-3	2015

Course Prerequisites

Basic courses in Data Communication and computer networks at UG level.

Course Objectives

Syllabus

Protocol Design, Specification and Verification, validation

Routing and Addressing, IPv6 addressing, Routing

Congestion, Traffic Management & QoS in IP Networking,

Network Management Tools and Applications, Multimedia Communications in Networks.

Expected Outcomes

References:

1. Pallapa Venkataram and SunilKumar S. Manvi: Communication Protocol Engineering, PHI, 2004

2. Mohammed G. Gouda: Elements of protocol Design, Wiley Student Edition, 2004.

3. High-speed networks and internets: performance and quality of service. Author, William Stallings. Publisher, Pearson Education, 2002

4. Network Routing: Algorithms, Protocols and Architectures Deepankar Medhi and Karthikeyan Ramasamy(Morgan Kaufmann Series in Networking)

5. Larry L Peterson and Bruce S Davie "Computer Networks: A system approach", 3rd edition,morgan Kauffman publishers.

6. William Stallings "High Speed Networks: TCP/IP and ATM Design Principles" Prentice Hall Upper saddle river new Jersey 07458

7. J.F. Kurose and K.W. Ross, Computer Networking: A Top-Down Approach Featuring

Internet,3/e, Perason Education, 2005.

8. Mani Subramaniam, ‘Network Management: Principles and Practices’, Pearson Education, 2000

9. Multimedia Communications: protocols and applications, Franklin F Kuo, J. Joaquin Garcia, Wolf gang Effelsberg, Prentice Hall Publications

10. Multimedia Communications: Applications, Networks, Protocols and Standards, Fred Halsall, Pearson Publications.

11. Multimedia Communication Systems: Techniques, standards and Networks’ author: K.R. Rao. Zoran.S. Bojkovic, Dragorad A.Milovanovic, PHI,2009.

12. “A practical guide to advanced networking”, Third Edition, Jeffrey. S. Beasley and Piyasat Nilkaew, Pearson publication.

13. “Computer Networks: Principles, Technologies and protocols for network design” author: Natalia Olifer and Victor Olifer, Wiley India Edition.

Course plan

Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Protocol Specification and Verification:** Communication protocol - Communication protocol development methods, protocol engineering process - Protocol Specification - Components, Communication Service, Protocol Entity, Interface, Multimedia protocol, Internet protocol Specification: Examples - SDL: Examples - Protocol Verification - Verification Using FSMs, Protocol validation, Protocol Design Errors, Protocol validation approaches, SDL based protocol verification, SDL based protocol validation.	11	20
II	**Routing and Addressing:** Address types of TCP/IP stack - IP Address format & assignment order - Mapping IP to local addresses – DNS – DHCP - IP Routing method - Routing using masks - Routing Information Protocol - Network Address Translation - Router architectures, Packet Processing - IPv6 addressing - IPv6 network settings - configuring a router for IPv6 - IPv6 Routing - Troubleshooting IPv6	11	20

connection.

	First Internal Examination		
III	**Congestion, Traffic Management & QoS in IP Networking:** Congestion Control And Resource Allocation - Issues in Resource allocation (Network Model, Taxonomy, Evaluation Criteria), Queuing Disciplines, TCP Congestion Control, Congestion Avoidance Mechanism(DECbit, RED, Source based congestion avoidance), End System traffic management - Link level flow and error control - Transport level traffic control - Network Traffic Management - Internetwork traffic management, Traffic and Congestion Control in ATM Networks - QoS in IP Networks(Integrated and Differentiated services), Protocols for QoS Support, QoS Routing.	11	20
IV	**Network Management Tools and Applications:** Network Management and its infrastructure-Internet standard management framework - SNMPv2 and SNMPv3 - Remote Monitoring - RMON SMI and MIB - Network management tools, Systems and engineering - NMS Design, Network management systems - Network Management applications - Fault & performance management - event correlation technique - Security, accounting, report, service level and policy based managements - Management in IPv6	11	20
	Second Internal Examination		
V	**Multimedia Communications in Networks:** Multimedia Communications - multimedia information representation, multimedia networks, Multimedia applications in networks - application level framing, audio/video conferencing, Video servers, Application requiring reliable multicast, Multimedia applications in WWW, Interactive multiplayer games, application and networking terminology, Standards for multimedia communications, Video transport across generic networks, multimedia transport across ATM networks, The Internet: IPv6, IPv4/IPv6 Interoperability.	12	20
	Total	56	
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6307	**NETWORK DESIGN AND PERFORMANCE EVALUATION**	**3-1-0-4**	**2015**

Course Prerequisites

Basic courses in Simulation & Modeling, Computer Networks at UG level

Course Objectives

Syllabus

Introduction to Network Design, Network requirements, Network flows, Network architecture, Network design

Analytical Network modeling and performance evaluation.

Expected Outcomes

Text books:

1. Network Analysis, Architecture, and Design By James D. McCabe, Morgan Kaufmann, Third Edition, 2007.ISBN-13: 978-0123704801

2. Top-down Network Design: [a Systems Analysis Approach to Enterprise Network Design] By Priscilla Oppenheimer, Cisco Press , 3rd Edition, ISBN-13: 978-1-58720- 283-4 ISBN-10: 1-58720-283-2

3. Computer Networks and Systems:Queueing Theory and Performance Evaluation, Thomas G. Robertazzi

References:

1. Simulation Modeling and Analysis, 2nd Ed., by Law and Kelton, McGraw-Hill, 1991.

2. Fundamentals of Queueing Theory , D. Gross and CM Harris, John Wiley and Sons, 1974.

3. Queueing Systems - Vol. I & II, by L. Kleinrock, John Wiley and Sons, 1975.

4. Probability and Statistics with Reliability, Queuing and Computer Science Applications, by Kishor Trivedi.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Introduction to Network Design:** Overview of Analysis, Architecture and Design Process - System Methodology, Service methodology, Service Description - Service characteristics - Performance Characteristics - Network supportability - Requirement analysis - User Requirements - Application Requirements - Device Requirements - Network Requirements - Other Requirements - Requirement specification and map	10	20
II	**Network requirements:** Requirement Analysis Process – Gathering and Listing Requirements- Developing service metrics – Characterizing behavior – Developing RMA requirements – Developing delay Requirements - Developing capacity Requirements - Developing supplemental performance Requirements –Requirements mapping – Developing the requirements specification.	9	15
First Internal Examination			
III	**Network flows:** introduction - identifying and developing flows - data sources and sinks - flow models - flow prioritization and specification.	5	5
IV	**Network architecture:** models-addressing and routing architecture-performance architecture-	16	30

	security and privacy architecture **Network design:** Design Concepts – Design Process - Network Layout – Design Traceability – Design Metrics – Logical Network Design – Topology Design – Bridging, Switching and Routing Protocols - Physical Network Design – Selecting Technologies and Devices for Campus and Enterprise Networks – Optimizing Network Design		
Second Internal Examination			
V	**Analytical Network modeling and performance evaluation:** Probability review, Queuing Systems review, Network of queues: The Product Form Solution - Algebraic Topological Interpretation of P.F. Solution - Recursive Solution of Non-Product Form Networks; Numerical Solution of Models; Closed Networks; Convolution Algorithm - Mean Value Analysis - Discrete Time Queuing Systems - Simulation of Communication Networks.	16	30
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6313	ADVANCED COMPUTER ARCHITECTURES	3-0-0-3	2015

Course Prerequisites

Basic course in computer architecture at UG level

Course Objectives

Syllabus

Advanced ILP Exploitation Techniques, High performance computing

Multiprocessor Architecture, Multithreaded processors and Multicore processors,

Simulators in Computer Architecture , Design of High performance architectures

Memory technology optimization, Design of Memory hierarchies

Expected Outcomes

References

1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, 3rd Edition, Morgan Kaufmann Publishers, 2002.

2. The WWW Computer Architecture page http://arch-www.cs.wisc.edu/tools/ (23/07/2012)

3. David E. Culler, Jaswinder Pal Singh, “Parallel Computing Architecture : A hardware/ software approach” , Morgan Kaufmann / Elsevier, 1997

4. K. Hwang and F. A. Briggs, Computer Architecture and Parallel Processing, McGrawHill, 1984.

5. ACM SIGARCH Computer Architecture News.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Advanced ILP Exploitation Techniques:** Hardware and software techniques for ILP extraction - speculative execution - studies on ILP. Overview and history of computing – Architectural Classification schemes - High performance computing - overview and performance quantification criteria.	**9**	**20**
II	**Multiprocessor Architecture**: Symmetric and distributed shared memory architectures – Cache coherence issues - Performance Issues – Synchronization issues – Models of Memory Consistency - Interconnection networks – Buses, crossbar and multi-stage switches.	**9**	**20**
First Internal Examination			
III	Multithreaded processors and Multicore processors, methodologies and analysis. Speculative multithreading. Multicore processor design and compilation issues, scheduling. CMPs and Polymorphic processors Concept, Studies and Analysis, Intel Multi-core architecture – SUN CMP architecture	**9**	**20**
Second Internal Examination			
IV	Simulators in Computer Architecture Introduction – methods, ADLs,traces, dynamic compilation. Multicore simulators. Functional and performance Simulators Design of high performance architecture, parallel vs. pipeline architectures. Pipeline processing. Theory of pipeline scheduling and implementation. Hazards in Pipeline processors. Hazard detection and resolution techniques.	**9**	**20**
V	Memory Technology and Optimizations – Transactional Memory - Optimizations of Cache Performance - Protection:	**9**	**20**

Virtual Memory and Virtual Machines - Design of Memory Hierarchies - Case Studies.

Total	**45**

Cluster Level End Semester Examination

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6315	APPLIED PROBABILITY AND STATISTICS	3-0-0-3	2015

Course Prerequisites

Basic course in elementary statistics and probability at UG level

Course Objectives

Syllabus

One Dimensional Random Variables,

Two Dimensional Random,

Estimation Theory,

Testing of Hypothesis,

Multivariate Analysis

Expected Outcomes

References

1 Jay L. Devore, "Probability and Statistics For Engineering and the Sciences",Thomson and Duxbury, 2002.

2 .Richard Johnson. "Miller & Freund's Probability and Statistics for Engineer",Prentice Hall , Seventh Edition, 2007.

3. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical

Analysis", Pearson Education, Asia, Fifth Edition, 2002.

4. Gupta S.C. and Kapoor V.K."Fundamentals of Mathematical Statistics", Sultan anSons, 2001.

5. Dallas E Johnson , "Applied Multivariate Methods for Data Analysis", Thomson an Duxbury

press,1998.

6. T. Veerarajan- Probability, Statistics and Random Processes(II Edn) (Tata McGraw Hill)

7. Irwin Miller, Marylees Miller- Mathematical Statistics(7th Edn)(Pearson Edn)

8. Douglas.C.Montgomery, George.C.Runger-Applied Statistics & Probability for Engineers -5th Edn(wiley Student Edn)

9. Hogg, Tanis,Tao- Probability & statistical Inference(7th Edn) –Pearson Edn)

10. Vijay. K. Rohagi, A.K. Md.Ehsanes Saleh- An introduction to probability and statistics

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**One Dimensional Random Variables :** Random variables -Probability function — Moments — Moment generating functions and their properties — Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions — Functions of a Random Variable.	9	20
II	**Two Dimensional Random Variables :** Joint distributions — Marginal and Conditional distributions — Functions of two dimensional random variables — Regression Curve — Correlation	9	20
	First Internal Examination		
III	**Estimation Theory:** Unbiased Estimators — Method of Moments — Maximum Likelihood Estimation - Curve fitting by Principle of least squares — Regression Lines.	9	20
IV	**Testing of Hypothesis :** Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions — Tests for Independence of attributes and	9	20

	Goodness of fit.		
Second Internal Examination			
V	**Multivariate Analysis:** Random Vectors and Matrices – Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components Population principal components - Principal components from standardized variables.	**9**	**20**
	Total	**45**	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6317	**ETHICAL HACKING**	3-0-0-3	2015

Course Prerequisites

Basic courses in Computer networks, Wireless networks, Web based services at UG level.

Course Objectives

Syllabus

Introduction to Hacking

Network Hacking

Wireless Hacking

Software Hacking

Expected Outcomes

References

1. Staurt McClure, Joel Scambray and George Kurtz, "Hacking Exposed Network Security Secrets &Solutions", Tata McGraw-Hill Publishers,2010 (6th Edition)

2. Bensmith and Brian Komer,"Microsoft Windows Security Resource Kit", Prentice Hall of India,2010

3. Staurt McClure, Joel Scambray and George Kurtz, "Hacking Exposed Network Security Secrets &Solutions", Tata McGraw-Hill Publishers(2nd Edition).

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to Hacking:** Casing the Establishment –What are Foot Printing - Internet Foot printing – Scanning – Enumeration - Basic banner grabbing - Enumerating common network services. Case study - Network security monitoring Security permission; Securing file and folder permission - Using the encrypted file system; Securing registry permissions; Securing services - Managing service permission – Default services in windows 2000 and windows XP; UNIX - The Quest for Root – Remote Access vs. Local Access - After hacking root.	**10**	**20**
II	**Network Hacking:** Dial-up, PBX,Voice mail and VPN hacking - preparing to dial-up – War-Dialing - Brute-Force scripting – Network Devices – Discovery - Autonomous System Lookup - Public Newsgroups – Service Detection - Network Vulnerability - Detecting Layer 2 Media.	**10**	**20**
	First Internal Examination		
III	**Wireless Hacking:** Wireless hacking - wireless foot printing - Wireless Scanning and Enumeration - Gaining Access - Tools that exploiting WEP Weakness - Denial of services attacks – Firewalls – Firewalls landscape - Firewall Identification - Scanning through firewalls - Packet filtering -Application Proxy Vulnerabilities - Denial of Service Attacks - Motivation of DoS attacks - Types of DoS attacks - Generic DoS attacks - UNIX and Windows DoS.	**12**	**30**
	Second Internal Examination		
IV	**Software Hacking:** Remote Control Insecurities - Discovering Remote Control Software - Connection Weakness – VNC - MicrosoftTerminal Server and Critrix ICA - Advanced Techniques: Session Hijacking, Back Doors, Trojans – Cryptography - Subverting the systems Environment – Social	**13**	**30**

Engineering - Web hacking - Web server hacking, web application hacking -Hacking the internet User - Malicious Mobile codes’ fraud - mail hacking, IRC hacking - Global Counter measures to Internet User hacking.

Total	**45**

Cluster Level End Semester Examination

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6319	**WIRELESS NETWORKS**	**3-0-0-3**	**2015**

Course Prerequisites:

Basic courses in Data Communication, Computer Networks, Wireless networks at UG level

Course Objectives

Syllabus:

Overview of Wireless Networks, Mobile and Adhoc Networks, Wireless Sensor Networks and Special Wireless Sensor Networks.

Different routing protocols used in mobile Adhoc networks, wireless sensor architecture and classification of protocols.

Expected Course outcomes

Text Books:

1. Ian F. Akyildiz and Mehmet Can Vuran, Wirless Sensor Networks, Wiley

2. Siva Ram Murthy C. and Manoj B. S., “Ad Hoc Wireless Networks: Architectures and Protocols”, 2nd Edn. Pearson Education 2005

References:

1. Imielinski T. and Korth H.F., “Mobile Computing”, Kluwer Academic Publishers, 1996.

2. William Stallings, “Wireless Communications and Networks”, Prentice Hall, 2004.

3. Clint Smith. P.E., and Daniel Collins, “3G Wireless Networks”, 2nd Edition, Tata McGraw Hill, 2007.

4. Carlos de Morais Cordeiro and Dharma Prakash Agrawal, “Ad Hoc & Sensor Networks: Theory and Applications”, World Scientific, 2007.

5. Toh C. K., “Ad Hoc Mobile Wireless Networks Protocols and Systems”, Prentice Hall, PTR,

2001.

6. Yi-Bing and Imrich Chlamtac, “Wireless and Mobile Networks Architectures”, John Wiley & Sons, 2001.

7. Introduction to Wireless and Mobile System, Dharma Prakash Agrawal, Qing-An Zewg, edition 3, Celengage Learning, 2010

8. From GSM to LTE: An Introduction to Monile Network and Mobile Broadband, Martin Sauter, John Wiley and sons, 2010

9. Fundamental of Wireless Sensor Network Theory and Practical, Waltenegus Dargie and Christian Poollabaner, John Wiley and sons, 2010

10. Wireless Sensor Network: Technology, Protocols and Application by Kazem Sohrahy, Daniel Minoli Tailab Znati, John Wiley and sons, 2007

11. IP for 4G, Dave Wisely, John Wiley and sons, 2009

Course plan

Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Overview of Wireless Networks: Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sublayer-MAC Management Sublayer-Wireless ATM - HIPERLAN - HIPERLAN 2, WiMax, Wireless Local Loop (WLL). Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, CDMA2000 overview- Radio and Network components, Network structure. 4G features and challenges, Technology path, IMS Architecture, Convergent Devices, 4G technologies, Advanced Broadband Wireless Access and Services.	**11**	**25**
II	Mobile and Adhoc Networks: Introduction to Mobile Networks, Heterogeneity in Mobile Devices, Types of Mobile Communications, Types of Mobile Host Movements, Challenges Facing Mobile Networks,	**10**	**25**

	Introduction to Ad-hoc Wireless Networks, Overview, MAC Protocols. Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, DSDV, WRP, AODV, DSR, TORA.		
	First Internal Examination		
III	Wireless Sensor Networks: Introduction to Wireless Sensor Networks, Overview, Characteristics, Network Applications, Design Objectives, Technological Background, Wireless Sensor Networks Architecture, Classification, Protocol stack, MAC Protocols. Routing Protocols – Flat – Architectural Protocols – Hierarchical Protocols – Geographic Routing Protocols – QoS Based Protocols. Time Synchronization – Localization and Positioning – Topology Management.	**12**	**25**
	Second Internal Examination		
IV	Special Wireless Sensor Networks : Wireless Sensor and Actor Networks – Network Architecture – Sensor Actor Coordination – Actor Actor Coordination. Wireless Multimedia Sensor Networks – Network Architecture. Wireless Underwater Sensor Networks – Network components – Communication Architecture – Basics of Acoustic Propagation. Wireless Underground Sensor Networks – Applications – Network Architecture – Communication.	**12**	**25**
	Total	**45**	
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6321	STORAGE MANAGEMENT AND SECURITY	3-0-0-3	2015

Course Prerequisites:

Basic course in Information Storage Management at UG level

Course Objectives:

Syllabus:

Introduction to Information Storage Management, Various storage networks, Distributed Storage systems

Storage System Environments, components

Large and distributed storage systems

Storage Security and management

Expected Course outcomes:

References:

1. EMC Education Services" Information Storage and Management: Storing, Managing and Protecting Digital Information", John Wiley & Sons, 2010.

2. lohn Chirillo, ScottB]aul " Storage Security: Protecting SANs, NAS and DAS", Wiley, 2003.

3. David Alexander, Amanda French, Dave Sutton"Information Security Management Principles" BCS, The Chartered Institute 2008.

4. Gerald J.Kowalski, Mark T.Maybury" Information Storage and Retrieval Systems: Theory And Implementation ", Springer, 2000.

5. Foster Stockwell , "A history *or* information storage and retrieval" McFarland, 2001.

6. R. Kelly Rainer, Casey G. Cegielski ,"Introduction to Information Systems: Enabling and Transforming Business, John Wiley & Sons, 2010.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Introduction to Information Storage and Management: Introduction, History: computing, networking, storage, Need for storage networking - SAN, NAS, SAN/NAS Convergence, Distributed Storage Systems. Mainframe/proprietary vs. open storage – Storage Industry Organizations and Major Vendors Market – Storage networking strategy (SAN/NAS) Technology.	**10**	**25**
II	Storage System Environment: Storage Components; Data organization: File vs. Block, Object, Data store; Searchable models: Storage Devices (including fixed content storage devices) – File Systems - Volume Managers - RAID systems – Caches – Prefetching; Error Management: Disk error Management – RAID Error Management - Distributed Systems Error Management.	**12**	**25**
First Internal Examination			
III	Large Storage Systems: Google FS/Big Table, Cloud/Web - based systems (Amazon S3) - FS÷DB convergence; Programming models: Hadoop - Archive 1 5Ssiems' - Content addressable storage; Backup: server less, LAN free, LAN Replication issues – Storage Security; Storage Management:- Device Management – NAS Management - Virtualization - Virtualization solutions; SAN Management: Storage Provisioning, Storage Migration.	**15**	**30**
Second Internal Examination			
IV	Storage Security and Management: Securing the storage infrastructure - Storage Security framework - Risk Triad – Storage Security Domains - Security	**8**	**20**

Implementation in Storage Networking - Managing the Storage Infrastructure - Monitoring the Storage Infrastructure - Storage Management Activities - Developing an Ideal Solution - Concepts in Practice.

Total	**45**

Cluster Level End Semester Examination

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6323	HIGH PERFORMANCE NETWORKS	3-0-0-3	2015

Course Prerequisites:

Basic courses in Data Communication, Computer Networks at UG level

Course Objectives:

Syllabus:

Introduction, QoS in high performance networks, Design issues

Gigabit Ethernet Architecture, standards, applications

ATM Architecture and protocols, ADSL and DSL Technologies

Introduction to MPLS, QoS, basic working, Storage networking

SAN topologies, Fiber Channel products, SAN software

Expected Course outcomes:

References:

1. Storage Networks Explained – Uif Troppens, Raiver Erkens and Wolfgang Muller, John Wiley & Sons, 2003.

2. Alex Goldman, "Storage Area Networks Fundamentals", Cisco Press 2002

3. Storage Area Network Essentials: a Complete Guide to understanding and implementing SANs- Richard Barker and Paul Massiglia, John Wiley India

4. William Stallings: ISDN And BISDN

5. William Stallings: High Speed Networks

6. M Shwartz: Telecommunication Network Protocol Modeling And Analysis: Addison Wesley

7. Gallangar: Data Networks: Prentice Hall

8. Fred Halsall: Data Communication Computer Networks, And Open Systems: Addison Wesley

9. Kershanbaum : Telecommunication Network Design Algorithms: MGH

10. Jochetl Schiller: Mobile Communication: Addison Wesley.

11. Tanenbaum: Computer Networks: PHI

12. Johnson: Fast Ethernet

13. Tom Clark, "Designing Storage Area Networks", Addison-Wesley Professional, 1st edition, 1999

14. Storage Networks: The Complete Reference – Robert Sparding, Tata Mcgraw Hills, 2003.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Network Performance analysis :** Objectives and requirements for Quality of Service (QoS) in high performance networks; Architecture of high performance networks (HPN) – design issues - protocols for HPN - VHF backbone networks - virtual interface architectures - virtual interface for networking - High-speed switching and routing - internet and PSTN IP switching techniques - SRP protocols – SRP authentication and key exchange - comparison of TCP/IP, FTP, TELNET, queuing systems - network modeling as a graph.	**9**	**20**
II	**Gigabit Ethernet:** Architecture, standards, interface, applications, network design **Frame relay:** Frame relay protocols and services, frame relay congestion Control **ATM:** Architecture, protocol, switching, traffic and congestion control, flow control ATM service categories, ATM in LAN environment, classical IP over ATM **ADSL and DSL Technologies :** Background and technological capabilities, Standards and associations,	**9**	**20**

	Architecture. Fiber Optics Communication: GPON (Gigabit capable Passive Optical Network), SONET/SDH and comparison with other available standards.		
	First Internal Examination		
III	Introduction to MPLS and QOS - Network Components of MPLS -working RSVP protocol - MPLS network Components - MPLS basic working – Applications – IETF approach - RSVP protocol - Integrated & differential Services Framework. Storage and networking concepts – SCSI bus architecture – Networking in front of the server – Networking behind the server – Network-attached Storage – Fibre channel internals – Layers – Data encoding – Framing protocol – class of service – flow control – Name and addressing conventions.	**13**	**30**
	Second Internal Examination		
IV	SAN topologies – Point-to Point – Arbitrated Loop – Loop Addressing-Loop Initialization- Port Login-Loop port state machine – Design considerations for Arbitrated Loop –Fabrics – Fabric login – Simple Name Server – State Change Notification – Private Loop Support – Fabric Zoning – Building Extended SANs. Fibre Channel Products – Gigabit Interface Converters (GBICs) – host Bus Adapters – Fibre channel RAID – Fibre channel JBODs – Arbitrated Loop Hubs – hub Architecture – Unmanaged Hubs – Managed Hubs – Switching Hubs – Fabric Switches – Fibre Channelto-SCSI Bridges – SAN software Products – Problem isolation in SANs – Isolation Techniques – Fibre channel Analyzers.	**14**	**30**
	Total	**45**	
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6325	**ENERGY AWARE COMPUTING**	**3-0-0-3**	**2015**

Course Prerequisites:

Courses in Computer organization, Embedded systems at UG level

Course Objectives:

Syllabus:

Introduction, Energy efficient multi core systems, Low power memory systems
Energy efficient storages, energy saving techniques for disk storages,
Energy efficient algorithms,
Energy minimisation in real time systems, energy aware applications

Expected Course outcomes:

Textbooks:

1. Ishfaq Ah mad, Sanjay Ranka, Handbook of Energy Aware and Green Computing, Chapman and Hall/CRC, 2012
2. Chong-Min Kyung, Sungioo yoo, Energy Aware System Design Algorithm and Architecture, Springer, 2011

Reference:

1. Bob steiger waid, Chris:Luero, Energy Aware Computing, Intel Press 2012

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks(%)**
I	**Introduction:** Energy efficient network on chip architecture for multi core system - Energy efficient MIPS CPU core with fine grained run time power gating - Low power design of emerging memory technology.	**8**	**20**
II	**Energy Efficient Storages:** Disk energy management – Power efficient strategy for storage system - Dynamic thermal management for high performance storage system - Energy saving technique for disk storage system.	**7**	**15**

First Internal Examination			
III	**Energy Efficient Algorithms:** Scheduling of parallel tasks - Task level dynamic voltage scaling - Speed scaling -Processor optimization - Memetic algorithms - Online job scheduling algorithms.	**11**	**25**
IV	**Real Time Systems:** Multi-processor systems - Real time tasks - Energy minimization - Energy aware scheduling - Dynamic reconfiguration - Adaptive power management - Energy harvesting embedded system.	**11**	**25**
Second Internal Examination			
V	Energy Aware Applications: On chip network - Video Codec Design - Surveillance camera - Low power mobile storage.	**8**	**20**
	Total	**45**	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6327	DATA MINING AND KNOWLEDGE DISCOVERY	3-0-0-3	2015

Course Prerequisites:

Basic course in Data mining at the UG level

Course Objectives:

Syllabus:

Introduction to data mining, data mining and knowledge discovery,
Association Rule for data mining, Genetic algorithms for rule discovery,
Issues in classification and prediction,
Cluster analysis and applications, trends in data mining

Expected Course outcomes:

References:

1. Jiawei Han and Micheline Kamber "Data Mining Concepts and Techniques" Second Edition, Elsevier, Reprinted 2008.
2. Alex A. Freitas, "Data Mining and Knowledge Discovery with Evolutionary Algorithms", Natural Computing Series, Springer International Edition, Springer
3. K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.
4. G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
5. Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Data Mining:** Data Mining and Knowledge Discovery – Desirable Properties of Discovered Knowledge – Knowledge representation – Classification – Dependence Modeling Introduction to Data Mining - Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Attribute selection - Data Discretization and Concept Hierarchy Generation – Attribute construction. Evolutionary Algorithms for Data Preparation – Attribute selection – Attribute weighting – Combining selection and weighting	**9**	**20**
II	**Rule discovery:** Association Rule Mining: -Efficient and scalable frequent item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining. Genetic Algorithms for Rule Discovery – Individual representation – Task-specific operators – Task-specific population initialization and seeding – Task-specific rule selection - Fitness evaluation	**11**	**25**
First Internal Examination			
III	**Classification and Prediction:** Issues Regarding Classification and Prediction –Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section	**13**	**30**
Second Internal Examination			
IV	**Cluster Analysis and Applications and Trends in Data Mining:** Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis	**12**	**25**

Scaling up Evolutionary Algorithms for Large Datasets – Using data subsets in fitness evaluation – Basics of parallel processing – Parallel EA for data mining - Data Mining Applications – Trends in Data Mining.

Total	**45**

Cluster Level End Semester Examination

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6329	VIRTUALIZATION TECHNIQUES	3-0-0-3	2015

Course Prerequisites:

Basic courses in Operating system, Distributed computing at UG level.

Course Objectives:

Syllabus:

Basics of virtualization, Virtualization types, Taxonomy of virtual machines
Server consolidation,
Network virtualisation,
Virtualizing storage, Virtualizing softwares

Expected Course outcomes:

References:

1. William von Hagen, Professional Xen Virtualization, Wrox Publications, January, 2008.

2. Chris Wolf , Erick M. Halter, Virtualization: From the Desktop to the Enterprise, Apress 2005.

3. Kumar Reddy, Victor Moreno, Network virtualization, Cisco Press, July, 2006.

4. James E. Smith, Ravi Nair, Virtual Machines: Versatile Platforms for Systems and Processes, Elsevier/Morgan Kaufmann, 2005.

5. David Marshall, Wade A. Reynolds, Advanced Server Virtualization: Vmware and Microsoft Platform in the Virtual Data Center, Auerbach Publications, 2006.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Basics of Virtualization:** Virtualization Types – Desktop Virtualization – Network Virtualization – Server and Machine Virtualization – Storage Virtualization – System-level or Operating Virtualization – Application Virtualization-Virtualization Advantages – Virtual Machine Basics – Taxonomy of Virtual machines - Process Virtual Machines – System Virtual Machines – Hypervisor - Key Concepts.	10	20

II	**Server Consolidation:** Hardware Virtualization – Virtual Hardware Overview - Sever Virtualization – Physical and Logical Partitioning - Types of Server Virtualization – Business cases for Sever Virtualization – Uses of Virtual server Consolidation – Planning for Development – Selecting server Virtualization Platform.	**10**	**20**
	First Internal Examination		
III	**Network virtualization:** Design of Scalable Enterprise Networks - Virtualizing the Campus WAN Design – WAN Architecture - WAN Virtualization – Virtual Enterprise Transport Virtualization–VLANs and Scalability theory - Network Device Virtualization Layer 2 - VLANs Layer 3 - VRF Instances Layer 2 - VFIs - Virtual Firewall Contexts - Network Device Virtualization - Data- Path Virtualization Layer 2: 802.1q - Trunking Generic Routing Encapsulation – Ipsec L2TPv3 Label Switched Paths – Control- Plane Virtualization–Routing Protocols- VRF - Aware Routing Multi-Topology Routing.	**13**	**30**
	Second Internal Examination		
IV	**Virtualizing Storage:** memory management in virtualization, partitioning, reclamation, ballooning; SCSI- Speaking SCSI- Using SCSI buses – Fiber Channel – Fiber Channel Cables – Fiber Channel Hardware Devices – iSCSI Architecture – Securing iSCSI – SAN backup and recovery techniques – RAID – SNIA Shared Storage Model – Classical Storage Model – SNIA Shared Storage Model – Host based Architecture – Storage based architecture – Network based Architecture – Fault tolerance to SAN – Performing Backups – Virtual tape libraries. Overview of Hypervisors : Xen Virtual machine monitors- Xen API – VMware – Vmware products – Vmware Features – Microsoft Virtual Server – Features of Microsoft Virtual Server.	**12**	**30**
	Total	**45**	
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6331	NETWORKING IN EMBEDDED SYSTEMS	3-0-0-3	2015

Course Prerequisites:

Basic courses in Data Communication, Microprocessor and microcontroller at UG level

Course Objectives:

Syllabus:

Embedded network, Embedded communication protocols,
USB bus and CAN bus,
Embedded ethernet, Element of a network and building a network,
Wireless embedded networking, security of networks

Expected Course outcomes:

References:

1. Frank Vahid, Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley publications

2. Jan Axelson, Parallel Port Complete, Penram publications

3. Dogan Ibrahim, Advanced PIC microcontroller projects in C, Elsevier 2008

4. Jan Axelson, Embedded Ethernet and Internet Complete, Penram publications

5. Bhaskar Krishnamachari, Networking wireless sensors, Cambridge press 2015

6. PIC Microcontroller and Embedded System by Muhammad Ali Mazidi, Rolind D Mekinlay, Danny Causey

7. Introduction to Wireless and Mobile System,Dharma Prakash Agrawal, Qing-An Zewg, 3rd edition, Celengage Learning, 2010

8. Wireless Sensor Network: Technology, Protocol and Application, Kazem Sohraby,Daniel Minoili Taileb Znati, John Wiley and sons, 2007

9. Serial Port Complete: Com Port, USB Virtual Com Ports and Port for Embedded System, Jan Axelson, Lakeview Research, U.S.; 2nd Revised edition edition (14 November 2007)

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Embedded Communication Protocols:** Embedded network: Introduction - Serial parallel communication – Serial communication protocols – RS232 standard - RS485 standard - Synchronous serial protocols - Serial peripheral interface(SPI) - Inter integrated circuits - PC parallel port programming - ISA/PCI bus protocol – Firmware.	**10**	**20**
II	**USB and CAN BUS:** USB bus – Introduction – Speed identification on the bus - USB state - USB Bus Communication: Packets - Data flow types – Enumeration – Description - PIC Micro controller USB Interface - C Program - CAN Bus- Introduction - Frames - Bit stuffing - Types of errors - Nominal Bit Timing - PIC micro controller CAN Interface - A simple application with CAN.	**13**	**30**
First Internal Examination			
III	**Embedded Ethernet:** Element of a network - Inside Ethernet - Building a network: Hardware option - Cables - Connections and network speed – Design choices: Selecting components - Ethernet Controllers - Exchanging message using UDP and TCP - Serving web page with dynamic data - Serving web pages that respond to user input - Email for embedded systems - Using FTP - keeping device and network secure.	**11**	**25**
IV	**Wireless Embedded Networking:** Wireless Sensor Networks – Introduction – Application - Network Topology – Localization - Time Synchronization - Energy efficient MAC Protocols – SMAC - Energy Efficient and Robust routing – Data Centric Routing.	**11**	**25**
Second Internal Examination			
	Total	45	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6309	SEMINAR-I	0-0-2-2	2015

Course Prerequisites:

Knowledge of technical document preparation systems, Language skills

Course Objectives

Methodology

The student is expected to present a seminar in one of the current topics in the field of specialization and related areas. The student shall prepare a Paper and present a Seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit typed copy of the paper to the Department. Grades will be awarded on the basis of contents of the paper and the presentation. A common format in (.pdf format) shall be given for reports of Seminar and Project. All reports of Seminar and Project submitted by students shall be in this given format.

Expected Outcomes

Internal work assessment

1. Marks for the report : 30%

2. Presentation & evaluation by the Committee: 40%

3. Ability to answer questions on the topic : 30%

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6311	**ADVANCED NETWORKING LABORATORY**	**0-0-2-2**	**2015**

Course Prerequisites:

Course in Computer networking, Internet programming, Network programming laboratory at UG level

Course Objectives

Syllabus

Experiments Of Network Programming and Security using C/Java,

Network Simulation and performance Evaluation Using Simulator (like NS2)

Expected Outcomes

References

1. W. Richard Stevens, "UNIX Network Programming", PHI , Eastern Economy Edition

2. J.F. Kurose and K.W. Ross, Computer Networking: A Top-Down Approach Featuring Internet,3/e, Perason Education, 2005.

3. Using Java2 Platform – Weber (AWL)

4. Douglas E.Comer, Hands on Networking with Internet Technologies, Pearson Education.

5. Network And System Security, edited by John R. Vacca

Experiments

Experiments Of Network Programming and Security using C/Java

1) Implementation of ARP and improvisation of protocol by resolving various security problems involved in it.

2) Implementation of Remote Command Execution with the various scenarios such as Remote File copy, Remote Distribution etc.

3) Programs to integrate Link State and Distance Vector Routing Protocols.

4) Implement a protocol which ensures reliable QoS to transfer a file across a network and measure its performance in comparison with TCP.

5) Implementation of network protocol used on the Internet or local area networks to provide a bidirectional interactive communications facility.

6) Implement a protocol for Authenticated Routing in LAN networks.

Network Simulation and performance Evaluation Using Simulator (like NS2)

7) Simulation and Performance Comparison of various Routing Protocols.

8) Simulation of Wireless Networks (Eg. Wifi, Adhoc etc).

9) Simulation and Performance Comparison of different congestion control and avoidance mechanisms which have been proposed for TCP/IP protocols.

Assessment :

1. Practical Records /outputs 40%

2. Regular Class Viva-Voce 20%

3. Final Test (Objective) 40%

Mapping Of Experiments to purpose to show the scope/usage of each experiment

Ex No	N/w Programming	Protocol Design	Network Simulation	Performance Evaluation	Security	Internetworking Experiments	Tracking	Management
1	Y	Y			Y		Y	
2	Y							Y
3	Y	Y				Y		
4	Y	Y						Y
5	Y	Y				Y		
6	Y	Y			Y		Y	
7			Y	Y				
8			Y					
9			Y	Y				

KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	:	*10*
Branch	:	*Computer Science & Engineering*
Stream	:	*Computer Science & Engineering*
Year	:	*2015*
No. of Credits	:	*67*

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CS6101	Advanced Mathematical Structures	3-0-0	40	60	3	3
B	10CS6103	Computer Algorithms and Complexity	3-1-0	40	60	3	4
C	10CS6105	Computer Networks and Network Management	3-1-0	40	60	3	4
D	10CS6107	Computer Architecture	3-1-0	40	60	3	4
E		Elective I	3-0-0	40	60	3	3
F	10GN6001	Research Methodology	0-2-0	100			2
G	10CS6109	Seminar I	0-0-2	50			2
H	10CS6111	Advanced Networking Lab	0-0-2	50			1
		TOTAL	**15-5-4**	**400**	**300**	**-**	**23**

TOTAL CONTACT HOURS : 21
TOTAL CREDITS : 23

Elective I

10CS6113	Information Security
10CS6115	Mobile and Pervasive Computing
10CS6117	Linear Algebra and Applications
10CS6119	Soft Computing
10CS6121	Concurrency Models

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	10CS6102	Modern Database Systems	3-0-0	40	60	3	3
B	10CS6104	Advanced Operating Systems	3-0-0	40	60	3	3
C	10CS6106	Advanced Compiler Design	2-1-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
F	10CS6108	Mini Project	0-0-4	100			2
G	10CS6112	Software Systems Lab	0-0-2	50			1
		TOTAL	**14-1-6**	**350**	**300**	**-**	**18**

TOTAL CONTACT HOURS : 21
TOTAL CREDITS : 18

Elective II/III

10CS6114 Ad-Hoc & Wireless Sensor Networks
10CS6116 Artificial Intelligence
10CS6118 Computational Linguistics
10CS6122 Web Technologies
10CS6124 Image Processing
10CS6126 Principles of Distributed Computing
10CS6128 Data Compression
10CS6132 Information Retrieval
10CS6134 Real Time Systems
10CS6136 High Performance Computing

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective IV	3-0-0	40	60	3	3
B		Elective V	3-0-0	40	60	3	3
	10CS7101	Seminar II	0-0-2	50			2
	10CS7103	Project (Phase 1)	0-0-12	100			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective IV/V

10CS7105 Grid Computing

10CS7107 XML and Web Services

10CS7109 Data Mining and Data Warehousing

10CS7111 Software Project Management

10CS7113 Machine Learning

10CS7121 Cloud Computing

10CS7123 Bioinformatics

10CS7125 Database Tuning

10CS7127 Object Oriented Software Engineering

10CS7129 Information Storage Management

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination Marks	End Semester Examination Duration (hours)	Credit
	10CS7104	Project (Phase 2)	0-0-23	100			12
		TOTAL	**0-0-23**	**100**		**-**	**12**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 12

TOTAL NUMBER OF CREDITS: 67

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6101	**ADVANCED MATHEMATICAL STRUCTURES**	**3-0-0-3**	**2015**

Course Prerequisites

Basic knowledge in statistics.

Course Objectives

To enable students to:

1. Familiarize with the concepts of stochastic processes and identify the real life examples.
2. Demonstrate the problems with the help of mathematical tools.
3. Classify problems and identify the queuing models.
4. Synthesize efficient tool to solve problems mathematically.

Syllabus

Random processes, Stochastic processes, Markov chains, BD equations, Continuous and discrete time Markov chains, Matrix operations, LU decomposition.

Expected Outcomes

The students will be to

1. Explain and use the concepts of stochastic processes in real life.
2. Explain the major concepts in Markov chain and use it in problems.
3. Classify problems into different models and solve them by applying these concepts.
4. Explain the basic properties of matrix operators and use it in problems.
5. Explain the basic models in queuing systems and the methods to analyze them.
6. Explain and use the concepts behind matrix operations for computations.

References

1. Ronald W. Wolff, Stochastic Modeling and Theory of Queues, Prentice- Hall International Inc 1989.
2. Anurag Kumar, D. Manjunath and Joy Kuri, Communication Networking: An Analytical Approach, Morgan Kaufman Publ. 2004.
3. Gary N Higginbottom, Performance Evaluation of Communication Networks, Artech House, 1998.
4. E. Kreizig: Advanced Engineering Mathematics. Wiley.
5. S. M. Ross, Introduction to Probability Models, Harcourt Asia Pvt. Ltd. and Academic Press.
6. John B Thomas, An Introduction to Applied Probability and Random Processes, John Wiley & Sons.

	Course plan		
Module	**Content**	**Hours**	**Semester Exam Marks (%)**

I	**Essential statistics**: Random variables, mean, variance, expectation. [Ref 5]. **Discrete distributions-** definition, binomial, Poisson exponential and geometric distributions [Ref 6].	5	15
II	**Random processes:** definition, stochastic processes, Renewal processes, Poisson processes and applications [Ref 1].	5	15
First Internal Examination			
III	**Markov chains:** Markov Chains: Definition, Examples, Transition Probability Matrices of a Markov Chain, Classification of states and chains, Basic limit theorem, Limiting distribution of Markov chains. [Ref 1,2]	8	15
IV	**BD processes:** Continuous Time Markov Chains: General pure Birth processes and Poisson processes, Birth and death processes, Finite state continuous time Markov chains[Ref 2]	8	15
Second Internal Examination			
V	**Queuing theory:** definition, Single Class and Multi class Queuing Networks: Simple Markovian queues- M/G/1 queue,M/G/C queues, other models, central limit theorem, Elementary renewal theorem, Brownian motion, Martingales[Ref 2,3,4]	8	20
VI	**Matrix theory:** : Matrix operations, Eigen values and Eigen vectors, LU decomposition, Singular Value decomposition, Review of Vector Algebra[Ref 5]	8	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6103	**COMPUTER ALGORITHMS AND COMPLEXITY**	**3-1-0-4**	**2015**

Course Prerequisites: Basic knowledge of Computer Algorithms and complexity at UG Level.

Course Objectives

The course is designed to provide students a strong background in the concept of analysis and design of computer algorithms. Upon completion of this course, students will be able to do the following:

1. Analyze the asymptotic performance of algorithms.
2. Demonstrate a familiarity with major graph algorithms and advanced data structures.
3. Classification of computing problems based on deterministic and randomized category
4. Synthesize efficient algorithms in common engineering design situations.

Syllabus

Analysis of Algorithms, Asymptotic notations, Recurrence analysis, Amortized Analysis, Advanced Data structures, Design and Analysis of Graph algorithms, all pair shortest path algorithms, Network flow, Matroid, Complexity Classes, reduction, Approximation Algorithms, Randomized algorithms.

Expected Course outcomes

At the end of the course the student will be able to

1. Analyze running times of algorithms using asymptotic analysis. Describe different strategies for amortized analysis, including the accounting method and the potential method. Solve recurrence relations.
2. Explain and use the major advanced data structures like B. Tree, Binomial heap, Fibonacci heap, and Disjoint set.
3. Explain the major graph algorithms and their analyses. Employ graphs to model shortest path and flow problems, when appropriate.
4. Classify problems into different complexity classes corresponding to both deterministic and randomized algorithms.
5. Analyze approximation algorithms including algorithms that are polynomial time approximation scheme and fully polynomial time approximation scheme.
6. Explain the basic properties of randomized algorithms and methods for analyzing them

References

1. Thomas H Cormen, C E Leiserson, R L Rivest, C Stein Introduction to Algorithms, The MIT Press.
2. Dexter C Kozen, The Design and Analysis of Algorithms, Springer.
3. Rajeev Motwani and PrabakarRagavan, Randomized Algorithms, Cambridge University Press.
4. Jon Kleinberg, Eva Tardos Algorithm Design, Pearson.
5. Gilles Brassard, Paul Bratley, Fundamentals of Algorithms, PHI.
6. Alfred V. Aho,John E. Hopcroft,Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley.
7. Christos H Papadimitriou, Kenneth Steiglitz Combinatorial Optimization Algorithms and Complexity, Dover Books.

8. Michael Sipser, Introduction to Theory of Computation, Wadsworth Publishing Co Inc.
9. Garey Michael R, Johnson davis S, Computers and Intractability: A Guide the theory of NP-Incompleteness,W.H. Freeman & Co.1979.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Analysis of Algorithms:** Model of Computation- RAM Model [Ref. 1,6] Asymptotic Notations; Recurrence Analysis: Substitution Method, Recursion tree Method, Master Method- and its Proof; [Ref. 1]. **Amortized Analysis:** Aggregate analysis, Accounting method, Potential method; [Ref. 1].	9	15
II	**Advanced Data structures:** Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, Disjoint Sets, Union by Rank and Path Compression; [Ref. 1].	9	15
First Internal Examination			
III	**Design and Analysis of Graph algorithms:** Graph Algorithms and complexity: All-Pairs Shortest Paths: The Floyd-Warshall algorithm, Johnson's algorithm; Maximum Flow: The Ford-Fulkerson method, The Edmonds-Karp algorithm; Bipartite Matching;[Ref. 1,4] Matroid Theory-task-scheduling problem [Ref. 1].	10	15
IV	**Complexity Classes:** Complexity Classes, NP Hard & NP Complete Problems, Reductions and NP Completeness, Cook's Theorem[Ref. 2,4,7,8,9]; NP completeness reductions for clique, vertex cover, subset sum, Hamiltonian cycle and TSP.	9	15
Second Internal Examination			
V	**Approximation Algorithms:** Polynomial Time and Fully Polynomial Time Approximation Schemes [Ref. 8]; Approximation Algorithms, vertex cover, TSP, set covering and subset sum [Ref. 1].	9	20
VI	**Randomized algorithms:** Randomized Algorithms: Las Vegas and	10	20

	Monte Carlo Algorithms [Ref. 3, 5], Randomized Divide and conquer Approach [Ref. 4], Randomized version of Quick Sort Algorithm [Ref. 4, 1], Miller Rabin Randomized Primality Test; Integer factorization: Pollard's rho heuristic [Ref. 1]; De-Randomization; Randomized Complexity Classes [Ref. 6]; Probabilistic Algorithms [Ref. 8].		
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6105	COMPUTER NETWORKS AND NETWORK MANAGEMENT	3-1-0- 4	2015

Course Prerequisites

Basic knowledge of Data Communication at UG Level.

Course Objectives

The course is intended to provide students a strong understanding intheprinciples, protocols, issues and advances in computer Networking. It also gives an overview of the network Monitoring and control protocols.

Syllabus

Introduction to computer networks, Data link layer protocols and issues, concepts in Network layer,Transport layer protocols and issues,Application Layer Technology and Introduction to security, Advanced networking concepts and Network management.

Expected Outcomes

The students will be able to

1. Understand the working principle of data link layer such as switching, framing, error control, MAC etc.
2.
   a. Understand routing protocols in internet.
   b. Design, calculate, and apply subnet masks and addresses to fulfill networking requirements.
3. Acquireknowledge of transport layer issues such as connection less and connection oriented protocols, congestion and different Queuing management options.
4. Get a basic knowledge of the advanced networking concepts such as QoS, VPN, and MPLS etc.
5.
   a. Analyze the features and operations of various application layer protocols such as HTTP, FTP, DNS, and Email Protocols.
   b. Understand the basics of network security.
6. Understand network management using SNMP and RMON.

References

1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach,Third Edition, Morgan Kauffmann Publishers Inc., 2003.
2. Andrew S. Tanenbaum, Computer Networks, Fourth Edition, 2003.
3. Behrouz A. Forouzan: Data Communications and Networking, 4th Edition, Tata McGraw-Hill, 2006.
4. Computer Networking: A Top-Down Approach Featuring the Internet by J. Kurose, K. W. Ross, 3rd edition, Addison-Wesley 2004.
5. High-speed networks and internets: performance and quality of service,William Stallings, Pearson Education India, 2002.
6. Alberto Leon Garcia &IndraWidjaja,Communication Networks – Fundamental Concepts & key architectures, 2nd Edition, Tata McGraw-Hill, India.
7. Nadir F Mir, Computer & Communication Networks, Pearson Education, India.
8. Mani Subramanian, Network Management: Principles and Practice, Pearson Education India, 2010.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	**Introduction to computer networks**: layers – Physical links – Issues in the data link layer – Framing, Switching – Error correction and detection – Link-level Flow Control, Medium access, Ethernetand its fast Variants , Wireless LAN	10	15
II	**The Internet Protocol**: Switching vs.Routing,IPv6,Internet Routing Protocols-RIP and OSPF, Multicast Routing, BGP, DHCP, NAT, CIDR, Introduction to Mobile IP,ARP	10	15
First Internal Examination			
III	**Transport introduction**: Port numbers, service models, UDP. Introduction to reliability,TCP, Congestion Controlin TCP,buffer management, FIFO, FQ, RED. Congestion control taxonomy, fairness and effectiveness	9	15
IV	**Applications, Network Security:**Application layer overview, Domain Name System (DNS), Remote Login Protocols, E-mail(SMTP,POP,IMAP), FTP,HTTP and HTTPS Overview of network security, Overview of security methods, Firewalls	8	20
Second Internal Examination			
V	**QoS, VPNs, Tunnelling, Overlay Networks** : Overview of QoS, Integrated Services QoS, Differentiated services QoS, Virtual Private Networks, MPLS, Overlay networks.	10	15
VI	**Network Monitoring:** Monitoring and Control – SNMP, V2, V3, RMON, RMON2.	9	20
	Total	56	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6113	INFORMATION SECURITY	3-0-0-3	2015

Course Prerequisites

Basic knowledge of Cryptography and Number Theory at UG Level.

Course Objectives

The course is designed to understand the fundamentals of Cryptography and to acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity. And, to understand the various key distribution and management schemes.

Syllabus

Introduction to security, Computer Security Concepts Attacks,Number Theory concepts,Digital Signature Standard and Trusted systems.

Expected Outcomes

Upon Completion of the course, the students will be able to,

1. Understand computer security concepts and encryption algorithms.
2. Apply the knowledge of public key encryption.
3. Analyze the need for digests and Hash Algorithms.
4. Understand digital signature and various authentication applications.
5. Apply the knowledge of system and network security.
6. Examine the need for intellectual property, privacy and ethical issues.

References

1. Stallings, Cryptography & Network Security Principles & Practice, Prentice Hall, 3rdEdition 2002.
2. Bruce, Schneier, Applied Cryptography, 2nd Edition, Toha Wiley & Sons, 1996.
3. Man Young Rhee, Internet Security, Wiley, 2003.
4. Pfleeger&Pfleeger, Security in Computing, Pearson Education, 3rd Edition, 2003.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction**:Computer Security Concepts Attacks -The OSI Security Architecture -Steganography - Classical Encryption Techniques-DES Differential and Linear Cryptanalysis – Modes of operation – Encryption Algorithms -Triple DES.	8	20
II	**Public Key Encryption**:Number Theory concepts, Primality, Modular Arithmetic, Fermat & Euler Theorem, Euclid Algorithm. RSA Algorithm – Elliptic Curve Cryptography – Diffie Hellman Key Exchange.	8	20
First Internal Examination			
III	**Authentication and Security Practice**:Digests – Requirements –MAC-Hash function –Security of Hash and MAC – Birthday Attack – MD5–SHA – RIPEMD.	6	20
IV	**Digital Signature**,Digital Signature Standard - Authentication applications – Kerberos – Kerberos Encryption Techniques – PGP.	6	15
Second Internal Examination			
V	**System and Network Security**:Intruders and Intrusion – Viruses and Worms– Firewalls – Design Principles – Packet Filtering – Application gateways,Trusted systems – Counter Measures, IP Security - Electronic Mail Security - transport layer security-secure electronic transaction.	8	15
VI	**Legal and Ethical Issues**: Cyber Crime and Computer Crime, Intellectual property, Privacy, Ethical issues.	6	10

	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6115	**MOBILE AND PERVASIVE COMPUTING**	**3-0-0-3**	**2015**

Course Prerequisites: None.

Course Objectives

The course is designed to provide students a background in mobile and pervasive computing. Upon completion of this course, students will be able,

1. To understand fundamentals of mobile and pervasive computing and different MAC methods in mobile networks.
2. To understand the mobile computing environment and different handoff mechanisms in mobile networks.
3. To understand the concepts of pervasive computing and the open protocols in context aware computing.

Syllabus

Introduction to wireless, mobile and cellular mobile systems, Medium access control , Emerging technologies in Wireless networks, Mobile computing environment and Handoff in wireless mobile networks, Pervasive Computing, Open protocols, Context aware mobile services.

Expected Course outcomes

1. At the end of the course the student will be able to
2. Explain the concepts of mobile and wireless communications.
3. Describe emerging technologies and Mobile IP protocols in wireless networks.
4. Discuss the components for mobile environment creation.
5. Explain hand offs and location management mechanisms in wireless mobile networks.
6. Describe the pervasive computing.
7. Explain context aware networks and open protocol useful in pervasive computing.

References

1.Ivan Stojmenovic , Handbook of Wireless Networks and Mobile Computing, John Wiley & sons Inc, Canada, 2002.

2. Asoke K Taukder,Roopa R Yavagal,Mobile Computing, Tata McGraw Hill Pub Co., New Delhi, 2005.

3. SengLoke, Context-Aware Computing Pervasive Systems, Auerbach Pub., New York,

2007.

4. UweHansmannetl ,Pervasive Computing,Springer,New York,2001.

5. JochenSciiiller, Mobile Communications, Pearson Education Asia Publications (Low Price Edition), 2000

6. William C.Y Lee, Mobile Cellular Telecommunications , McGraw Hill International Editions, 1995

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to wireless, mobile and cellular mobile systems-** cellular mobile telephone systems, analog and digital cellular systems-- frequency reuse, co-channel interference. **Medium access control** - MAC, SDMA, FDMA, TDMA, CDMA, Hand offs and dropped calls-initiation of handoff, power difference, mobile assisted cell-site and Intersystem Handoff	7	15
II	**Wireless networks-** emerging technologies- Bluetooth, WiFi, WiMAX, 3G, WATM. Mobile IP protocols -WAP push architecture-Wml scripts and applications.	6	15
First Internal Examination			
III	**Mobile computing environment**—functions-architecture-design considerations,content architecture - CC/PP exchange protocol,context manager. Data management in WAE-Coda file system- caching schemes- Mobility QOS, Security in mobile computing.	8	15
IV	**Handoff in wireless mobile networks-**reference model-handoff schemes. Location managementin cellular networks - Mobility models-location and tracking management schemes- time,Movement, profile and distance based update strategies, ALI technologies.	7	15
Second Internal Examination			
V	**Pervasive Computing-** Principles, Characteristics- interaction transparency, context aware, automated experience capture. Architecture for pervasive computing- Pervasive devicesembedded controls.- smart sensors and actuators -Context communication and access services	7	20
VI	**Open protocols-** Service discovery technologies- SDP, Jini, SLP, UpnP protocols–data synchronization- SyncML framework - Context aware mobile services -Context aware sensor networks, addressing and communications. Context aware security	7	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6117	**LINEAR ALGEBRA AND APPLICATIONS**	**3-0-0-3**	**2015**

Course Prerequisites: None.

Course Objectives

- To provide students with a good understanding of the concepts and methods of linear algebra
- To help the students to develop the ability to solve problems using linear algebra.
- To connect linear algebra to other fields both within and without mathematics.

Syllabus

Introduction, Vector Spaces, Subspace, Solutions of Linear Systems, Important Subspaces associated with a matrix, Rank theorem, Orthogonality, Matrices, Determinants, Eigenvalues and Eigenvectors, Diagonalizable Matrices, General Matrices, Jordan Normal Form , Selected Topics in Applications.

Expected Course outcomes

At the end of the course the student will be able to

1. Apply the concepts and methods of vector space and subspace in solving various problems.
2. Solve systems of linear equations and homogeneous systems of linear equations by Gaussian elimination and Gauss-Jordan elimination.
3. Find the kernel, range, rank, and nullity of a linear transformation.
4. Use the Gram-Schmidt process to produce an orthonormal basis.
5. Determine if a matrix is diagonalizable, and if it is, how to diagonalize it.
6. Know a number of applications of linear algebra and solve.

References

1. Peter D. Lax, Linear Algebra and its Application, Second Edition, Wiley.

2. Greub, W. : Linear Algebra, Springer-Verlag, Graduate Texts in Mathematics 97, (4-th 3. edition) 1981.

3. Halmos, P. R. : Finite-Dimensional Vector Spaces, Springer-Verlag, 1993.

4. Hoffman, K. and Kunze, R, Linear Algebra, Prentice-Hall, 1972.

5. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition, Brooks Cole, 2005.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Algebraic Structures – Vector Spaces – Subspaces – Linear Equations – Gauss Elimination –Generating Systems – Linear Independence – Bases – Dimension of Vector Spaces- Homomorphism of Groups - Linear Maps – Space of Linear Maps – Linear Maps and Bases.	7	15
II	The Rank Theorem – Direct Sums and Projections – Dual Spaces – Quotient Spaces –Operations of Groups.	7	15
First Internal Examination			
III	**Orthogonality-** Inner product - Inner product Spaces - Cauchy – Schwarz inequality - Norm – Orthogonality - Gram – Schmidt orthonormalization - Orthonormal basis - Expansion in terms of orthonormal basis – Fourier series - Orthogonal complement - Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagorus Theorem.	8	15
IV	Matrices – Rank of Matrices – Elementary Matrices – Permutations – Multi Linear Maps –Determinant Functions – Computation Rules for Determinants – Determinants of Linear Maps – Orientations – Determinants and Volumes – Polynomials in One Variable and Several Variables – Eigen Values – Characteristic Polynomials – Minimal Polynomials.	8	15
Second Internal Examination			
V	Diagonalisable and Trigonalisable Operators - Decompositions Theorems – Jordan Normal Form.	6	20
VI	Application of linear algebra:- Optimization and Linear Programming - Network models -Game Theory -Image Compression.	6	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6119	**SOFT COMPUTING**	**3-0-0-3**	**2015**

Course Prerequisites: Artificial Intelligence or Machine Learning course at UG level.

Course Objectives

An introduction to advanced topics in artificial neural network and fussy systems are given. It also provides the concepts of Evolutionary and Stochastic techniques, Rough Sets and Hybrid Systems.

Syllabus :

Soft Computing: Introduction, Artificial Intelligence, productions system and control strategies - Knowledge Representation, Reasoning - Artificial Neural Networks - Fuzzy sets and Fuzzy Logics - Rough Sets - Genetic Algorithm, Stochastic models - Hybrid Systems.

Expected Course outcomes

At the end of the course the student will be able to

1. Familiarize soft computing concepts and techniques, and foster their abilities in designing and implementing soft computing based solutions for real-world and engineering problems.
2. Explain the students about Artificial Neural Networks and various categories of ANN
3. Familiarize the salient approaches in soft computing based on fuzzy sets and its operations, fuzzy logic and its applications.
4. Comprehend and discuss the concept of Rough Sets and Decision Tables.
5. Introduce genetic algorithm fundamentals and its operators, stochastic models and applications.
6. Evaluate soft computing methodologies and interface them through hybrid system logic in solving problems.

Text Books:

1. S. Rajasekaran and G.A.VijaylakshmiPai. Neural Networks, Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.
2. Rough Sets, Z. Pawlak, Kluwer Academic Publisher, 1991.
3. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.
4. Neuro-Fuzzy and Soft Computing, Jang, Sun, &Mizutani, PHI.

References:

1. K.H.Lee.. First Course on Fuzzy Theory and Applications, Springer-Verlag.
2. J. Yen and R. Langari.. Fuzzy Logic, Intelligence, Control and Information, Pearson Education.
3. Neural Fuzzy Systems, Chin-Teng Lin & C. S. George Lee, Prentice Hall PTR.
4. Genetic Algorithms in Search and Optimization, and Machine Learning, D. E. Goldberg, Addison-Wesley, 1989.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Soft Computing:** Introduction, requirement, soft computing vs. hard computing, different tools and techniques, usefulness and applications. **Artificial Intelligence:** Introduction, Different types and characteristics of production systems, Search Techniques and various types of control strategies.	6	15
II	**Knowledge Representation Issues**, Prepositional and predicate logic, monotonic and non monotonic reasoning, forward Reasoning, backward reasoning, Weak & Strong Slot & filler structures, NLP. **Artificial Neural Network:** Introduction, basic models, Learning methods, Architecture of back propagation network, Applications. Issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories.	8	15
First Internal Examination			
III	**Fuzzy sets and Fuzzy logic:** Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database - fuzzification and defuzzification methods - applications.	8	15

IV	**Rough Set:** Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.	4	15
Second Internal Examination			
V	**Evolutionary and Stochastic techniques:** Genetic algorithm- Fundamentals, encoding, fitness function, reproduction, Genetic modeling and operators, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional method. Simulated annealing and Stochastic models, Boltzmann Machine, Applications.	8	20
VI	**Hybrid Systems:** Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.	8	20
	Total	42	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6121	CONCURRENCY MODELS	3-0-0- 3	2015

Course Prerequisites

Basic knowledge of Operating System and JAVA Programming at UG level.

Course Objectives

To enable the students to understand when concurrent programming techniques are appropriate to use and how to create correct programs using several different concurrent programming mechanisms in different programming languages. And also, to enable them to know how to use concurrent programming paradigms or patterns.

Syllabus

FSP and graph models,Modelling,Safety and liveness properties,Concurrency architectures and design,Linear temporal logic.

Expected Outcomes

After completing this course, students will be able to

1. Apply the knowledge of FSP and graph models.
2. Understand the concepts of mutual exclusion, conditional synchronization, semaphores and nested monitors.
3. Understand safety properties of a system.
4. Examine the liveness properties of a system.
5. Understand concurrency architectures and design.
6. Apply the knowledge of linear temporal logic.

References

1. Jeff Magee & Jeff Kramer, "Concurrency: State Models and Java Programs", Second Edition, John Wiley, 2006.
2. M. Huth& M. Ryan, "Logic in Computer Science – Modeling and Reasoning about Systems", Second Edition, Cambridge University Press, 2004.
3. B. Goetz, T. Peierls, J. Bloch, J. Bowbeer, D. Holmes, and D. Lea, "Java Concurrency in Practice", Addison-Wesley Professional, 2006.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**FSP and graph models :**Concurrency and issues in concurrency – models of concurrency – graphical models – FSP & LTSA – modelling processes with FSP – concurrency models with FSP – shared action – structure diagrams – issues with shared objects.	7	15
II	**Modelling:** Mutual exclusion – conditional synchronization – modelling semaphores – nested monitors – monitor invariants.	6	15
First Internal Examination			
III	**Safety properties**: Deadlocks – deadlock analysis in models – dining philosophers problem – safety properties –single-lane bridge problem.	6	15
IV	**Liveness properties**:–liveness of the single-lane bridge – readers writers problem – message passing – asynchronous message passing models –	7	20

	synchronous message passing models – rendezvous.		
Second Internal Examination			
V	**Concurrency architectures and design**: Modelling dynamic systems – modeling timed systems – concurrent architectures – Filter pipeline – Supervisor-worker model – announcer-listener model – model-based design – from requirements to models – from models to implementations – implementing concurrency in Java – program verification	8	20
VI	**Linear temporal logic (LTL):**Syntax of LTL – semantics of LTL – practical LTL patterns – equivalences between LTL statements – specification using LTL – LTL and FSP – Fluent proposition – Temporal propositions – Fluent Linear Temporal Logic (FLTL) – FLTL assertions in FSP – Database ring problem.	8	15
	Total	42	
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6109	**SEMINAR-I**	**0-0-2 -2**	**2015**

Course Prerequisites: None

Course Objectives

1. To develop soft skill
2. To understand research papers and prepare presentation material
3. To understand about new technologies in the modern era.
4. To improve oral communication skills through presentation
5. To prepare original technical write up on the presentation

Methodology

1. To choose the area of interest
2. To consult guide for topic selection
3. To identify current literatures
4. To choose state of the art survey paper/research paper
5. To consult and get confirmed with Seminar Coordinator (Faculty)
6. To prepare the PPT
7. To present as per schedule drawn by Seminar Coordinator
8. To prepare a technical write up and submit to Seminar Coordinator

Expected Outcomes

Students will be able to,

1. Improve their in proficiency in English.
2. Improve their presentation skill.
3. Improve their theoretical knowledge of field related to computer science and engineering.
4. Improve their analytical and reasoning ability.
5. Improve their technical writing skills.

Internal work assessment

1. Evaluation by the supervisor/s : 30 %

2. Presentation & evaluation by the Committee: 40 %

3. Evaluation of the Report: 20%

4. Regular Attendance : 10 %

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10CS6111	**ADVANCED NETWORKING LAB**	**0-0-2-1**	**2015**

Course Prerequisites

Basic knowledge of computer networking at UG.

Course Objectives

The course is designed to provide students a strong background in the working principles of different protocols and networks using Network simulators.

Syllabus

Introduction to Network Simulator, Simulation of different network layer protocols, Simulation of different networks.

Expected Outcomes

After the completion of this course student will be able to,

1. Demonstrate the working of different network layer protocols.
2. Design and simulate Local Area Networks.
3. Examine performance of different Networks.
4. Design and simulate Wireless Networks.

References

1. TeerawatIssariyakul, Ekram Hossain, Introduction to Network Simulator NS2, Springer, 2nd Edition.
2. http://www.isi.edu/nsnam/ns/doc/index.html.
3. Kevin R. Fall,W. Richard Stevens, TCP/IP Illustrated, Volume 1: The protocol, Addison Wesley, 2nd Edition.
4. Gary R. Wright,W. Richard Stevens, TCP/IP Illustrated: The Implementation, Addison Wesley, Vol. 2.

Course plan

Experiments	Semester Exam Marks (%)
1. Implementation of Remote command Execution 2. Basic Network Simulation using simulator. (Eg. NS2/NS3) 3. Exercise using Network Simulator NS2/NS3 4. Basic Network layer protocol simulation using NS2/NS3. 5. Simulating Local Area Network 6. Measuring Network Performance 7. Simulating Wireless Networks (Eg. WiFi,WiMAX, Adhoc, WSN)	50

Assessment :

1. Practical Records /outputs 40%
2. Regular Class Viva-Voce 20%
3. Final Test (Objective) 40%

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No.10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Electronics & Communication Engineering

M. Tech.

in

Signal Processing and Embedded Systems

(No. of Credits : 65)

FIRST SEMESTER

Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC6101	Linear Algebra	3	1	-	40	3	60	4
B	10EC6103	Random Processes and Applications	3	-	-	40	3	60	3
C	10EC6105	Advanced Digital Signal Processing	3	-	-	40	3	60	3
D	10EC6205	Advanced Embedded Processers	3	-	-	40	3	60	3
E		Elective-I	3	-	-	40	3	60	3
F	10GN6001	Research Methodology	-	2	-	100	-	0	2
G	10EC6409	Seminar-1	-	-	2	100	-	0	2
H	10EC6111	Digital Signal Processing Laboratory	-	-	2	100	-	0	1
	TOTAL		**15**	**3**	**4**	**500**		**300**	**21**

ELECTIVE-I

10EC6401 Multi-rate Signal Processing

10EC6113 DSP Processors and Architecture

10EC6203 CMOS VLSI Design

10EC6201 High Speed Digital Design

10EC6313 Design of Analog MOS ICs

10EC6119 Transform Theory

SECOND SEMESTER

Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC6102	Digital Image Processing	3	-	-	40	3	60	3
B	10EC6302	Wavelet Theory	3	-	-	40	3	60	3
C	10EC6304	Embedded System Design	3	-	-	40	3	60	3
D		Elective-II	3	-	-	40	3	60	3
E		Elective-III	3	-	-	40	3	60	3
F	10EC6308	Mini Project	-	-	4	100	-	0	2
G	10EC6312	VLSI & Embedded Systems Laboratory	-	-	2	100	-	0	1
	TOTAL		**15**	**0**	**6**	**400**		**300**	**18**

ELECTIVES II & III

10EC6404 Adaptive Signal Processing

10EC6114 Biomedical Signal Processing

10EC6202 Advanced Digital System Design

10EC6314 Optical Signal Processing

10EC6218 VLSI System Design

10EC6402 VLSI Signal Processing

10EC6118 Statistical Signal Processing

10EC6316 Multidimensional Signal Processing

10EC6318 Mixed Signal Circuit Design

10EC6216 Low Power VLSI Design

THIRD SEMESTER

Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A		Elective-IV	3	-	-	40	3	60	3
B		Elective-V	3	-	-	40	3	60	3
C	10EC7301	Seminar-2	-	-	2	50	-	0	2
D	10EC7303	Project - Phase 1	-	-	12	100	-	0	6
	TOTAL		**6**	**-**	**14**	**230**		**120**	**14**

ELECTIVES IV & V

10EC7105 Audio Processing

10EC7205 Biometric Processing

10EC7109 Array Signal Processing

10EC7305 Computer Vision

10EC7209 Embedded Networks

10EC7113 Pattern Recognition

10EC7307 Multimedia Systems

10EC7117 Information Hiding and Data Encryption

10EC7215 ASIC Design

10EC7213 Introduction to Nano Electronics

FOURTH SEMESTER

Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC7304	Project - Phase 2	-	-	23	70	1	30	12
	TOTAL		**-**	**-**	**23**	**70**		**30**	**12**

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6101	**LINEAR ALGEBRA**	**3 - 1 - 0 – 4**	**2015**

Course Prerequisites

(1) Basic knowledge in Matrix Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives

(1) To have an advanced level knowledge in linear algebra
(2) To throw light into the applications of linear algebra, like Multi-resolution analysis, Wavelets etc.

Syllabus

Sets, Functions, Groups, Rings, Fields, Vector spaces, Subspaces, Linear Transformations, Rank-nullity theorem, Isomorphism, Matrix representation of Linear Transformations, Linear functional, Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Banach space, L^p space and l^p space, Inner product space, Hilbert space, Signal space, Gramm-Schmidt orthonormalization process, Matrix rank, Solving linear system of equations using matrices, Eigen values, Eigen vectors and spectrum, Diagonalizability, Normal matrices, Unitary matrices, Multi-resolution analysis and wavelets.

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge in linear algebra;
(2) Know how the theory of linear algebra could be applied in specific domains, like Multi-resolution analysis, Wavelets etc.

References

1. Hoffman Kenneth and Kunze Ray, *Linear Algebra,* Prentice Hall of India.
2. Strang G, *Linear Algebra and its Applications*, 3rd edition, Saunders, 1988.
3. Erwin Kreyzig, *Introductory Functional Analysis with Applications*, John Wiley, 2006.
4. G.F.Simmons, *Topology and Modern Analysis* , McGraw Hill.
5. Frazier, Michael W., *An Introduction to Wavelets through Linear Algebra,* Springer Publications.
6. Jin Ho Kwak & Sungpyo Hong, *Linear Algebra*, Springer International, 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Sets, Functions, Cardinality of sets, Groups, Rings, Fields.	4	15
	Vector spaces, Subspaces, Basis and dimension, Finite and infinite dimensional vector spaces.	4	
II	Linear Transformations, Sum, product and inverse of Linear Transformations, Rank-nullity theorem, Isomorphism.	5	15
	Matrix representation of Linear Transformations, Four fundamental subspaces of Linear Transformations, Change of bases, Linear functional.	5	
First Internal Examination			
III	Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Convergence, Completeness, Continuous mappings, Normed space, Banach space, L^p space and l^p space.	10	15
IV	Inner product space, Hilbert space, Signal space, Properties of inner product space, Orthogonal compliments and direct sums, Orthonormal sets, Gramm-Schmidt orthonormalization process, Projections.	10	15

Second Internal Examination			
V	Matrix rank, Solving linear system of equations using matrices, LDU factorization, QR decomposition, Least square approach.	5	20
	Eigen values, Eigen vectors and spectrum, Diagonalizability, Orthogonal diagonalization.	4	
VI	Properties of Eigen values and Eigen vectors of Hermitian matrices, Normal matrices, Unitary matrices.	4	20
	Multi-resolution analysis and Wavelets.	5	
Cluster Level End Semester Examination			

<table>
<tr><th>Course No.</th><th>Course Name</th><th>L - T - P - Credits</th><th>Year of Introduction</th></tr>
<tr><td>10EC6103</td><td>RANDOM PROCESSES AND APPLICATIONS</td><td>3 - 0 - 0 – 3</td><td>2015</td></tr>
<tr><td colspan="4">Course Prerequisites
(1) Basic knowledge in Probability Theory at UG level
(2) Basic knowledge in Set Theory at UG level</td></tr>
<tr><td colspan="4">Course Objectives
(1) To impose in-depth knowledge in probability theory.
(2) To throw light into the applications of probability and random processes.</td></tr>
<tr><td colspan="4">Syllabus
Review of Set Theory, Random experiment, Sample space, Cumulative Distribution Function, Probability Density Function, conditional distribution, Expectation, moments, correlation and covariance, Random Vector, Convergence - Markov and Chebyshev inequalities, convergence in probability, convergence in mean square, Weak law of large numbers, strong law of large numbers, Central Limit Theorem for sequences of independent random variables, Random process, IID process, Poisson counting process, Markov process, Wiener process. Stationarity, power spectral density, Discrete time Markov chains, conditional independence, DTMC, Recurrence analysis, Chapman-Kolmogov theorem, Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.</td></tr>
<tr><td colspan="4">Expected Outcomes
The students are expected to :
(1) Have an advanced level knowledge in probability theory;
(2) Know how the theory of probability and random processes could be applied in specific domains</td></tr>
<tr><td colspan="4">References
1. A. Papoulis and S. UnnikrishnaPillai. Probability, Random Variables and Stochastic Processes, TMH
2. B. Hajek, An Exploration of Random Processes for Engineers, 2005.
3. D.P. Bertsekas and J. N. Tsitsiklis, Introduction to Probability, 2000.
4. Gray, R. M. and Davisson L. D., An Introduction to Statistical Signal Processing. Cambridge University Press, 2004.
5. Stark Henry, Probability and Random Processes With Application to Signal Processing, 3/e, Pearson Education India.
6. Steven Kay, Intuitive probability and random processes using MATLAB, Springer, 2006.
7. Dr. Kishor S. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications, John Wiley and Sons, New York, 2001.</td></tr>
</table>

<table>
<tr><th colspan="4">Course plan</th></tr>
<tr><th>Module</th><th>Content</th><th>Hours</th><th>Semester Exam Marks (%)</th></tr>
<tr><td rowspan="2">I</td><td>Review of Set Theory - Set operations, functions, countable and uncountable sets, Random experiment, Sample space, Sigma algebra, Event space, Measure, Probability measure, Borel sigma field</td><td>4</td><td rowspan="2">15</td></tr>
<tr><td>Cumulative Distribution Function (CDF), Probability Density Function (PDF), PMF, Joint CDF, Joint PDF, conditional distribution.</td><td>4</td></tr>
<tr><td rowspan="2">II</td><td>Expectation - Fundamental Theorem of expectation, moments, characteristic function, correlation and covariance</td><td>4</td><td rowspan="2">15</td></tr>
<tr><td>Random Vector - Definition, Joint statistics, Covariance and correlation matrix, Gaussian random vectors.</td><td>4</td></tr>
<tr><th colspan="4">First Internal Examination</th></tr>
</table>

III	Convergence - Markov and Chebyshev inequalities, Convergence of sequences of random variables- almost sure convergence, convergence in probability, convergence in mean square, Weak law of large numbers, Random sums, Borel Cantelli lemma, strong law of large numbers, Central Limit Theorem for sequences of independent random variables.	8	15
IV	Random process - Definition of Random process, IID process, Poisson counting process, Markov process, birth-death process, Wiener process. Stationarity, Correlation functions of random processes in linear systems, power spectral density.	8	15
Second Internal Examination			
V	Discrete time Markov chains - conditional independence, DTMC, Recurrence analysis, Foster's Theorem, Chapman-Kolmogov theorem, Stopping time.	6	20
VI	classification of states: absorbing, recurrent, transient. Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6105	**ADVANCED DIGITAL SIGNAL PROCESSING**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in signals and systems at UG level;
(2) Basic knowledge in transforms at UG level.

Course Objectives

(1) To attain a good analytical ability in digital filter design;
(2) To investigate the applications of digital signal processing.

Syllabus

Review of transforms, Z-Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT), LTI systems as frequency selective filters, Invertibility of LTI systems, Design of digital filters by placement of poles and zeros, FIR filter structures, IIR filter structures, Design of FIR filters, Linear Phase Systems, Window method, Frequency sampling method, Finite word length effects, Design of IIR filters, Pole zero placement, Impulse invariance, Bilinear Z transformation, Finite word length effects, Adaptive Digital Filters, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Power Spectrum Estimation, Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.

Expected Outcomes

The students are expected to :
(1) Attain a good analytical ability in digital filter design;
(2) Know various applications of digital signal processing.

References

1. Proakis and Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications,* 4/e, Pearson Education.
2. Ifeachor and Jervis, *Digital Signal Processing, A practical Approach,* 2/e, Pearson Education.
3. Johnny R. Johnson, *Introduction to Digital Signal Processing,* PHI, 1992.
4. Ashok Ambardar, *Digital Signal Processing: A Modern Introduction,* Thomson, IE, 2007.
5. Douglas F. Elliott*, Handbook of Digital Signal Processing- Engineering Application,* Academic Press.
6. Robert J. Schilling and Sandra L. Harris, *Fundamentals of Digital Signal Processing using MATLAB,* Thomson, 2005.
7. Ingle and J. G. Proakis, *Digital Signal Processing Using MATLAB,* Thomson, 1/e.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of transforms** : Z-Transform, ROC, Poles & Zeros, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), DFT as a linear transformation, Frequency analysis of signals and systems using DFT, Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT).	4	15
	LTI systems as filters : Invertibility of LTI systems, Minimum phase, Maximum phase and mixed phase systems, All-pass filters, Design of digital filters by placement of poles and zeros, Linear filtering methods based on DFT.	5	
II	**Digital Filter Structures** : Generalized input-output relationship, IIR	6	15

	Transfer Function, FIR Transfer Function, Signal Flow Graphs, FIR filter structures, Direct Form-I, Direct Form-II, Frequency Sampling, Cascade, Lattice, IIR filter structures, Direct Form-I, Transposed, Direct Form-II, Canonical, Parallel, Cascade, Lattice-Ladder structures.		
First Internal Examination			
III	**Design of FIR filters** : Linear Phase Systems, Specifications, Coefficient calculation methods, Desired impulse responses, Window method, Frequency sampling method, Comparison of methods, Filter realization, Finite word length effects, Implementation examples, FIR filter design using Octave/ MATLAB.	8	15
IV	**Design of IIR filters** : Specifications, Coefficient calculation method, Pole zero placement, Transformation rules, Impulse invariance, Bilinear Z transformation (BZT), Buttorworth and Chebyschev approximations, Filter realization, Finite word length effects, Implementation examples, IIR filter design using Octave/ MATLAB.	8	15
Second Internal Examination			
V	**Adaptive Digital Filters** : Concepts, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Lattice Ladder filters, Application of Adaptive filters.	6	20
VI	**Power Spectrum Estimation** : Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.	5	20
Cluster Level End Semester Examination			

<table>
<tr><th>Course No.</th><th>Course Name</th><th>L - T - P - Credits</th><th>Year of Introduction</th></tr>
<tr><td>10EC6205</td><td>ADVANCED EMBEDDED PROCESSORS</td><td>3 - 0 - 0 - 3</td><td>2015</td></tr>
<tr><td colspan="4">Course Prerequisites
(1) Basic knowledge in digital electronics at UG level;
(2) Basic knowledge in microprocessors at UG level.</td></tr>
<tr><td colspan="4">Course Objectives
(1) To attain a thorough knowledge in embedded processors;
(2) To develop skills in designing complex systems using different processor architectures.</td></tr>
<tr><td colspan="4">Syllabus
Introduction to Embedded systems - Embedded system examples, Parts of Embedded System, Typical Processor architecture, Simple interfacing examples, Memory Technologies, Introduction to PIC microcontrollers, CPU architecture, Serial EEPROM, PWM, Analog to digital converter, UART, SPI, ARM architecture, ARM organization and Implementation, Memory Hierarchy, Assembly Language Programming, High- Level Language Programming, System Development using ARM, Digital Signal Processing on ARM, Peripheral Programming and system design for a specific ARM processor, Embedded System product Development, Embedded System product Development Life cycle (EDLC), Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly, Product enclosure design and development, Concept of firmware, operating system and application programs, Power supply Design, External Interfaces, Embedded System Development Environment, IDE, Cross compilation, Simulators/Emulators, Hardware Debugging, Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc., Bus architecture like I^2C, SPI, AMBA, CAN etc.</td></tr>
<tr><td colspan="4">Expected Outcomes
The students are expected to :
(1) Attain a thorough knowledge in embedded processors;
(2) Develop skills in designing complex systems using different processor architectures.</td></tr>
<tr><td colspan="4">References
1. Shibu K.V. Introduction to Embedded Systems, Tata McGraw Hill, 2009.
2. Tim, Design with PIC microcontrollers, John B Peatman Pearson Education Asia, 2002.
3. Van Ess, Currie and Doboli, Laboratory Manual for Introduction to Mixed-Signal, Embedded Design, Alphagraphics, USA.
4. Steve Furber, ARM System-on-chip Architecture, Second Edition Pearson Education, 2007.
5. William Hohl, ARM Assembly Language Programming, CRC Press, 2009.
6. Andrew Sloss, Dominic Symes, Christ Wright, ARM System Developer’s guide – Designing and optimizing software, Elseiver Publishers, 2008.</td></tr>
</table>

<table>
<tr><th colspan="4">Course plan</th></tr>
<tr><th>Module</th><th>Content</th><th>Hours</th><th>Semester Exam Marks (%)</th></tr>
<tr><td>I</td><td>Introduction to Embedded systems : Embedded system examples, Parts of Embedded System, Typical Processor architecture, Power supply, clock, memory interface, interrupt, I/O ports, Buffers, Programmable Devices, ASIC, etc. Simple interfacing examples, Memory Technologies, EPROM, Flash, OTP, SRAM, DRAM, SDRAM etc.</td><td>8</td><td>15</td></tr>
<tr><td>II</td><td>Introduction to PIC microcontrollers : CPU architecture, registers, memory, instruction sets , addressing modes, timers, Interrupts, I/O, I</td><td>8</td><td>15</td></tr>
</table>

	2C Bus Operation, Serial EEPROM, PWM, Analog to digital converter, UART, SPI.		
First Internal Examination			
III	**ARM architecture** : ARM organization and Implementation, Memory Hierarchy, ARM Instruction Set and Thumb Instruction set, Assembly Language Programming, High- Level Language Programming, System Development using ARM, Digital Signal Processing on ARM, Peripheral Programming and system design for a specific ARM processor (ARM7/9).	8	15
IV	**Embedded System product Development** : Embedded System product Development Life cycle (EDLC), Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly.	6	15
Second Internal Examination			
V	**Product enclosure design and development** : Concept of firmware, operating system and application programs, Power supply Design, External Interfaces.	6	20
VI	**Embedded System Development Environment** : IDE, Cross compilation, Simulators/Emulators, Hardware Debugging. Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc., Bus architecture like I^2C, SPI, AMBA, CAN etc.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6401	**MULTIRATE SIGNAL PROCESSING**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge on Digital Signal Processing at UG level
(2) Basic knowledge on Digital Filters at UG level

Course Objectives

(1) To have an advanced level knowledge on Multirate systems
(2) To Apply the mutirate signal processing techniques to the systems which are working in different rates.

Syllabus

Fundamentals of Multirate Theory The sampling theorem Basic Multirate operations- Maximally decimated filter M-channel perfect reconstruction filter banks Polyphase representation- perfect reconstruction systems Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Quantization Effects filter banks Cosine Modulated filter banks Polyphase structure- PR Systems

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge on multirate mignal processing;
(2) Know how the theory of multirate signal processing could be applied in specific domains, like multi-rate systems.

References

1. P.P. Vaidyanathan, *Multirate systems and filter banks*, Prentice Hall PTR, 1993.
2. N.J. Fliege, *Multirate digital signal processing*, John Wiley, 1994.
3. Sanjit K. Mitra, *Digital Signal Processing: A computer based approach*, McGraw Hill, 1998.
4. R.E. Crochiere. L. R., *Multirate Digital Signal Processing*, Prentice Hall Inc., 1983.
5. J.G. Proakis and D.G. Manolakis, *Digital Signal Processing: Principles. Algorithms and Applications*, 3rd Edn., Prentice Hall India, 1999.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**The sampling theorem** : Sampling at sub nyquist rate - Basic Formulations and schemes.	5	15
	Basic Multirate operations : Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation.	6	
II	**Maximally decimated filter banks** : Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank.	6	15
First Internal Examination			
III	**M-channel perfect reconstruction filter banks** : Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems.	6	15
IV	**Perfect reconstruction (PR) filter banks** : Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary	7	15

	conditions for Linear phase property.		
Second Internal Examination			
V	**Quantization Effects** : Types of quantization effects in filter banks, coefficient sensitivity effects, dynamic range and scaling.	6	20
VI	**Cosine Modulated filter banks** : Cosine Modulated pseudo QMF Bank, Alas cancellation, phase, Phase distortion, Closed form expression, Polyphase structure, PR Systems.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6113	DSP PROCESSORS AND ARCHITECTURE	3 - 0 - 0 - 3	2015

Course Prerequisites

Basic knowledge in DSP and microprocessors at UG level

Course Objectives

To have an in depth knowledge in DSP at processor level

Syllabus

Review of Pipelined RISC Architecture and Instruction Set Design- Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks. Basic Pipeline: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch). Instruction Level Parallelism (ILP): Concepts, Dynamic Scheduling - Dynamic Hardware Prediction- Limitations of ILP. Review of Memory Hierarchy: Cache design, Cache Performance Issues & Improving Techniques. Computer arithmetic- Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System(LNS, RNS). Index Multiplier – Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic(DA), CORDIC Algorithm and architecture. Case studies, TMS 320 C 6X Processor –sample program. Overview of Black Fin processor.

Expected Outcomes

References

1. J. L. Hennesy and D. A. Patterson, *Computer Architecture A Quantitative Approach,* 3/e, Elsevier India, Chapter 1, Appendix A, Chapter 3, Chapter 5.
2. U. Mayer-Baese*, Digital Signal Processing with FPGAs*, Springer, 2001.
3. Rulph Chassaing, *Digital signal Processing and Applications with the C6713 and C6416 DSK*, Wiley Inter Science.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Pipelined RISC Architecture and Instruction Set Design.	5	15
	Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks.	2	
II	**Basic Pipeline**: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch)- structural hazards-data hazards-control hazards-branch prediction	6	15
First Internal Examination			
III	**Instruction Level Parallelism (ILP)**: Concepts, Dynamic Scheduling – Tomasulo's algorithm -Reducing Data hazards	4	15
	Dynamic Hardware Prediction - Reducing Branch Hazards. Multiple Issue-Hardware-based speculation	4	
	Limitations of ILP	1	
IV	**Review of Memory Hierarchy:** Cache design	3	15
	Cache Performance Issues & Improving Techniques	4	
Second Internal Examination			

V	**Computer arithmetic:** Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System(LNS, RNS)	3	20
	Index Multiplier –Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic(DA), CORDIC Algorithm and architecture**.**	3	
VI	**Case studies:** Introduction to TMS 320 C 6X Processor – Architecture – Functional units - pipelining –Registers	3	20
	Linear and Circular addressing modes –Types of instructions – sample program	3	
	Overview of Black Fin processor	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P- Credits	Year of Introduction
10EC6203	**CMOS VLSI DESIGN**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge about Microelectronics technology at UG level

Course Objectives

To have an advanced knowledge about design and fabrication of CMOS ICs.

Syllabus

MOS Transistor Theory, CMOS Processing Technology, CMOS Circuit Characteristics, Performance Estimation, Circuit and Logic Design, Subsystem Design

Expected Outcomes

The students who takes this course is expected to develop competence to design CMOS circuits for any functionality using different logic structures.

References

1. Neil.H.E. Weste and K.Eshragian, *Principles of CMOS VLSI Design*, 2nd Edition. Addison Wesley, 2000.
2. Douglas A. Pucknell and K.Eshragian, *Basic VLSI Design*, 3rd Edition. PHI, 2000.
3. R. Jacob Baker, Harry W. LI., & David K. Boyce., *CMOS Circuit Design*, 3rd Indian reprint, PHI, 2000.
4. John P. Uyemura*, Introduction to VLSI circuits and Systems*, John Wiley and sons, 2010.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**MOS Transistor Theory:** Introduction to I.C Technology. Basic MOS transistors. Threshold Voltage. Body effect. Basic D.C. Equations. Second order effects. MOS models. Small signal A.C characteristics. The complementary CMOS inverter. DCcharacteristics. Static Load MOS inverters. The differential inverters. Transmission gate. VLSI Design flow.	7	15
II	**CMOS Processing Technology :**Silicon semiconductor technology. Wafer processing, Oxidation, epitaxy, deposition, Ion implantation.CMOS technology. nwell, pwell process, Twin tub processes. Silicon on insulator. CMOS process enhancement. Interconnect and circuit elements. Stick diagrams and Layout diagram, Layout design rules, Latch up in CMOS circuits	8	15
First Internal Examination			
III	**CMOS Circuit Characteristics :** Resistance estimation. Capacitance estimation. MOS capacitor characteristics. Device capacitances. Diffusion capacitance. SPICE modeling of MOS capacitance. Routing capacitance. Distributed RC effects. Inductance.	7	15
IV	**Performance Estimation:** Switching characteristics. Rise time. Fall time. Delay time. Empirical delay models. Gate delays. CMOS gate transistor sizing. Power dissipation, Design margining. Scaling of MOS transistor dimensions.	6	15
Second Internal Examination			

V	**Circuit and Logic Design:** CMOS Logic gate design. Fan in and fan out. Typical CMOS NAND and NOR delays. Transistor sizing. CMOS logic structures. Complementary logic, BICMOS logic, Pseudo NMOS logic, Dynamic CMOS logic, Clocked CMOS logic, Pass transistor logic, CMOS domino logic. NP domino logic, Cascade voltage switch logic, Source follower pull up Logic (SFPL), Clocking strategies, I/O structures	8	20
VI	**Subsystem Design:** Data path operations. Addition/subtraction, Parity generators, Comparators, Zero/one detectors, Binary Counters, ALUs, Multiplication, Array, Radix -n, Wallace Tree and Serial Multiplication, Shifters. Memory elements, RWM, Rom, Content Addressable Memory, Control: FSM, PLA Control Implementation	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6201	**HIGH SPEED DIGITAL DESIGN**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge in Digital Electronics and Electromagnetic waves and transmission lines.

Course Objectives

(1) To attain good analytical skills in digital integrated circuits;
(2) To identify sources affecting the speed of digital circuits;
(3) To introduce methods to improve the signal transmission characteristics.

Syllabus

High Speed Digital Design: Fundamentals: Frequency and time, Time and distance, Lumped versus distributed systems, High Speed properties of Logic gates: Power, Input power, drive circuit dissipation, speed, packaging. Measurement Techniques, Infinite Uniform transmission line, Termination: End , Source , middle terminators, Power system: Stable voltage reference, choosing a bypass capacitor. Clock Distribution: Timing margin, Clock skew delay adjustments, Differential distribution.

Expected Outcomes

Students are expected to

1. Attain good analytical skills in digital integrated circuits;
2. Identify sources affecting the speed of digital circuits;
3. Understand the methods to improve the signal transmission characteristics

References

1. Howard Johnson & Martin Graham; High Speed Digital Design: A Handbook of Black Magic, Prentice Hall PTR, 1993.
2. William S. Dally & John W. Poulton, Digital Systems Engineering, Cambridge University Press, 1998.
3. Masakazu Shoji; High Speed Digital Circuits, Addison Wesley Publishing Company, 1996.
4. Jan M, Rabaey, et all; Digital Integrated Circuits: A Design perspective, Second Edition, 2003.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	**High Speed Digital Design**: Fundamentals: Frequency and time, Time and distance,	4	15
	Lumped versus distributed systems, four kinds of reactance- ordinary capacitance and inductance, mutual capacitance and inductance, Relation of mutual capacitance and mutual inductance to cross talk.	4	
II	**High Speed properties of Logic gates**: Power, Quicent vs active dissipation, Active power driving a capacitive load, Input power,	4	15
	Internal dissipation, drive circuit dissipation: Totem pole , Emitter follower, open collector, current source, Speed, Packaging.	4	
First Internal Examination			
III	**Measurement Techniques:** Rise time and bandwidth of oscilloscope probes, self inductance of probe ground loop, spurious signal pick up from probe ground loops, special probing fixtures, Avoiding pickup from probe shield currents, slowing down of a system clock, observing metastable states.	8	15
IV	**Transmission Lines**: Problems of point to point wiring, signal	4	15

	distortion, EMI, cross talk.		
	Infinite Uniform transmission line; ideal distortion less lossless transmission line, RC transmission line, Skin effect, Proximity effect, Dielectric loss. Effects of source and load impedance.	4	
Second Internal Examination			
V	**Termination**: End terminator, Source terminators, middle terminators, AC biasing for end terminators, Resistor selection, Cross talk in terminators.	6	20
VI	**Power system**: Stable voltage reference, Uniform voltage distribution, distribution problems, choosing a bypass capacitor.	3	20
	Clock Distribution: Timing margin, Clock skew, Using low impedance drivers, using low impedance distribution lines, delay adjustments, Differential distribution, Clock signal duty cycle, Decoupling clock receivers from the clock bus.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6313	**DESIGN OF ANALOG MOS ICs**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in Solid State Devices at UG level;
(2) Basic knowledge in Linear Integrated Circuits at UG level.

Course Objectives

(1) To attain a thorough knowledge in analog MOS ICs;
(2) To develop good analytical skills in analog MOS IC design.

Syllabus

Introduction MOSFET, Threshold voltage, current, Channel length modulation, body bias effect, MOSFET models in saturation, linear and cutoff regions-, current sources and sinks, current mirrors, voltage references, Supply independent and temperature independent references, MOS amplifiers, Common source with resistive, diode connected, current source and triode loads, CS with source degeneration, common gate and source follower stages, MOS differential amplifiers, Common mode response, differential pair with MOS loads, Noise in differential pair, CMOS operational amplifiers, One-stage op-amps and two stage op-amps, CMOS oscillators, Ring oscillators, LC oscillators, Colpitts and one-port oscillators, Voltage controlled oscillators, Stability and Frequency Compensation, Multi-pole systems, Phase Margin, Frequency Compensation, Noise, Noise Spectrum, Sources, Noise Bandwidth, Noise Figure, Switched Capacitor Circuits, Sampling Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers.

Expected Outcomes

The students are expected to :
(1) Attain a profound knowledge in analog MOS ICs;
(2) Develop good analytical skills in analog MOS IC design.

References

1. David A Johns & Ken Martin, *Analog Integrated Circuit Design*, John Wiley and Sons, 2008.
2. Behzad Razavi, *Design of Analog CMOS Integrated Circuit*, Tata-Mc Graw Hill, 2002.
3. Philip Allen & Douglas Holberg, *CMOS Analog Circuit Design*, Oxford University Press, 2002.
4. Gregorian and Temes, *Analog MOS Integrated Circuits for Signal Processing*, John Wiley, 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction MOSFET** : Threshold voltage, current, Channel length modulation, body bias effect, MOSFET models in saturation, linear and cutoff regions, current sources and sinks, current mirrors, cascode, Wilson current mirrors, voltage references, Supply independent and temperature independent references, Band gap references.	8	15
II	**MOS amplifiers** : Common source with resistive, diode connected, current source and triode loads, CS with source degeneration, common gate and source follower stages, cascade and folded cascade structures, frequency response of CS, CD and CG configurations, noise in single stage amplifiers.	8	15
First Internal Examination			
III	**MOS differential amplifiers** : Common mode response, differential pair with MOS loads, Noise in differential pair, CMOS operational	8	15

	amplifiers, One-stage op-amps and two stage op-amps, gain boosting, Miller, Nulling resistor compensation.		
IV	**CMOS oscillators** : Ring oscillators, LC oscillators, Colpitts and one-port oscillators, Voltage controlled oscillators, Tuning in oscillators.	6	15
Second Internal Examination			
V	**Stability and Frequency Compensation** : Multi-pole systems, Phase Margin, Frequency Compensation, Compensation Techniques, Noise, Noise Spectrum, Sources, Types, Thermal and Flicker noise, Representation in circuits, Noise Bandwidth, Noise Figure.	8	20
VI	**Switched Capacitor Circuits** : Sampling Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers, Switched-Capacitor Integrator, Switched-Capacitor Common-Mode Feedback.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6119	**TRANSFORM THOERY**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in transforms at UG level;
(2) Basic knowledge in digital signal processing at UG level.

Course Objectives

(1) To attain a thorough knowledge in various transforms used in signal processing;
(2) To apply transforms in various fields like coding, compression, etc.

Syllabus

Introduction on the integral and discrete transforms and their applications, Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Relations between the transforms, Short Term Fourier Transform (STFT), Heisenbergs uncertainty principle, Continuous wavelet transform (CWT), Hilbert Transforms, Radon Transform, Abel Transform, Sine transform, Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform, Discrete Transforms and Applictions, Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Discrete Wavelet Transform (DWT), lifting, Applications, image compression (JPEG 2000), Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).

Expected Outcomes

The students are expected to :

1. Attain a sound knowledge in various transforms like Lapalce transform, Z-transform, Fourier transforms, Wavelet transform, DCT, etc.
2. Apply these transforms in different areas line image compression, coding etc.
3. Understand new transforms like CTT and WBCT.

References

1. Alexander D. Poularikas, *The Transforms and Applications Handbook*, Second Edition, CRC Press.
2. Abdul Jerri, *Integral and Discrete transforms with applications and error analysis*, Marcel Dekker Inc.
3. Lokenath Debnath, Dambaru Bhatta, *Integral Transforms and Their Applications*, Taylor & Francis Inc.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility- basis – Requirements of transforms- (Linear algebraic approach) - Review of Laplace Transform, Z transform.	7	15
II	Review of Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms- Integral Transforms: Short Term Fourier Transform (STFT) – Limitations of STFT -Heisenbergs uncertainty principle - Continuous wavelet transform (CWT) - Hilbert Transforms	7	15
First Internal Examination			
III	Radon Transform, Abel Transform, Sine transform,,Cosine Transform, The Mellin Transform, Hankel Transform, Hartley	7	15

	Transform		
IV	Discrete Transforms and Applications : Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Application of DSTFT in audio signal processing, Discrete Wavelet Transform (DWT), lifting applied to DWT	7	15
Second Internal Examination			
V	Applications of DWT in audio signal processing, image compression (JPEG 2000), At least one application of each transform in one dimensional, Two-dimensional or Three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking, steganography, denoising, signal separation, signal classification), Limitations of DWT in image processing	6	20
VI	New Transforms and Applications : Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	RESEARCH METHODOLOGY	0 - 2 - 0 - 2	2015

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.

17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6409	**SEMINAR - 1**	**0 - 0 - 2 - 2**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;
(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :
(1) Be motivated in reading which enhances the literature review required for doing project work;
(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6111	**DIGITAL SIGNAL PROCESSING LABORATORY**	**0 - 0 - 2 - 1**	**2015**

Course Prerequisites

(1) Knowledge in Digital Signal Processing at UG level;
(2) Programming ability in Octave/MATLAB and knowledge about DSP kits like TMS320C6X or AD.

Course Objectives

(1) To have a thorough understanding of Digital Signal Processing through software programming;
(2) To investigate Digital Signal Processing through DSP Kits like TMS320C6X or AD.

Experiments

1. Review of MATLAB Programming Practice
2. Low-pass FIR filter using Hamming Window
3. High-pass FIR filter using Hamming Window
4. Low-pass IIR filter using Butterworth Approximation
5. High-pass IIR filter using Butterworth Approximation
6. Convolution and Correlation of sequences
7. Laplace Transform and Z-Transform using MATLAB Symbolic Toolbox
8. Normal Density Estimation
9. Wiener Filter for 1-D Signals
10. Two Channel Quadrature Mirror Filter (QMF) Bank
11. Wiener Filter for Images with Defocus Blur
12. Wiener Filter for Images with Motion Blur
13. Introduction to C-based embedded design using Code Composer Studio (CCS) and the TI6713 DSK
14. Familiarization of creating, building, and testing some simple projects in the CCS integrated development environment (IDE)
15. Implementation of DFT, FFT programs using CCS
16. Implementation of real-time FIR filtering on the TMS320C6713 with CCS using C
17. Implementation of real-time IIR filtering on the TMS320C6713 with CCS using C.
18. Interfacing of multimedia data to the 6713 DSK

Expected Outcomes

The students are expected to :
(1) Attain a thorough understanding of Digital Signal Processing through software programming;
(2) Develop skills for programming and doing real time DSP using kits like TMS320C6X or AD.

References

1. E. S. Gopi, *Algorithm Collections for DSP Applications using MATLAB*, Springer, 2007.
2. Vinay K. Ingle and John. G. Proakis, *Digital Signal Processing Using MATLAB*, PWS Publishing Company, 1997.
3. G. Blanchet and M. Charbit, *Digital Signal and Image Processing using MATLAB,* ISTE Ltd, 2006
4. Paul M. Embree, *C Algorithms for Real-time DSP*, Prentice Hall PTR, 1995.

Course plan

Item	Description	Time	
1	Octave/MATLAB based Experiments	4 Weeks	
2	CCS and TMS kits based Experiments	4 Weeks	
3	Preparation of Laboratory Record	2 Weeks	
4	Internal Examination	2 Weeks	
5	Publishing Grades	2 Weeks	

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No. 10 for PG Programs

(Engineering Colleges in Kannur, Wayand&Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015-'16

Electronics & Communication Engineering (ECE)

M. Tech.

in

VLSI Design and Signal Processing

(Total Credits: 65)

FIRST SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC6501	Applied Engineering Mathematics	3	1	-	40	3	60	4
B	10EC6203	CMOS VLSI Design	3	-	-	40	3	60	3
C	10EC6105	Advanced Digital Signal Processing	3	-	-	40	3	60	3
D	10EC6503	Signal Compression	3	-	-	40	3	60	3
E	10EC6XXX	Elective-I	3	-	-	40	3	60	3
	10GN6001	Research Methodology	-	2	-	100	-	0	2
	10EC6509	Seminar-1	-	-	2	100	-	0	2
	10EC6511	Digital Signal Processing Laboratory	-	-	3	100	-	0	1
	TOTAL		**15**	**3**	**5**	**500**		**300**	**21**

ELECTIVE-I

10EC6513 Digital Systems Design

10EC6515 VLSI Physical Design and Automation

10EC6517 Design of Analog Integrated Circuits

10EC6201 High Speed Digital Design

10EC6519 Solid State Modeling & Simulation

10EC6119 Transform Theory

SECOND SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC6102	Digital Image Processing	3	-	-	40	3	60	3
B	10EC6402	VLSI Signal processing	3	-	-	40	3	60	3
C	10EC6502	VLSI CAD	3	-	-	40	3	60	3
D	10EC6XXX	Elective-II	3	-	-	40	3	60	3
E	10EC6XXX	Elective-III	3	-	-	40	3	60	3
	10EC6508	Mini Project	-	-	4	100	-	0	2
	10EC6512	VLSI Design Lab	-	-	3	100	-	0	1
	TOTAL		**15**	**-**	**7**	**400**		**300**	**18**

ELECTIVE II & III

10EC6404 Adaptive Signal Processing

10EC6114 Biomedical Signal Processing

10EC6302 Wavelet Theory

10EC6314 Optical Signal Processing

10EC6514 DSP System Design

10EC6516 Embedded and Real Time Operating Systems

10EC6518 VLSI Testing and Testability

10EC6522 Signal Integrity for High Speed Design

10EC6318 Mixed Signal Circuit Design

10EC6216 Low Power VLSI Design

THIRD SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC7XXX	Elective-IV	3	-	-	40	3	60	3
B	10EC7XXX	Elective-V	3	-	-	40	3	60	3
	10EC7501	Seminar-2	-	-	2	100	-	0	2
	10EC7503	Project - Phase 1	-	-	12	50	-	0	6
	TOTAL		**6**	**-**	**14**	**230**		**120**	**14**

ELECTIVE-IV&V

10EC7105 Audio Processing

10EC7505 Sparse Representations and Compressive Sensing

10EC7305 Computer Vision

10EC7507 Soft Computing

10EC7509 VLSI for Wireless Communications

10EC7113 Pattern Recognition

10EC7115 Wireless Sensor Networks

10EC7117 Information Hiding and Data Encryption

10EC7215 ASIC Design

10EC7213 Introduction to Nano Electronics

FOURTH SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
10EC	10EC7504	Project - Phase 2	-	-	23	70	1	30	12
	TOTAL		**-**	**-**	**23**	**70**		**30**	**12**

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6501	APPLIED ENGINEERING MATHEMATICS	3 - 1 - 0 - 4	2015

Course Prerequisites

Basic knowledge in Matrix Theory, Probability and Random Process at UG level

Course Objectives

To have advanced level knowledge in linear algebra and probability

Syllabus

Linear Algebraic Equations & Transformations, Metric space and Hilbert space, Random Variables, Random process & Queuing theory

Expected Outcomes

The students are expected to develop a deeper level of understanding in linear algebra and probability so that they will be able to appreciate the application of these concepts in the signal processing – VLSI applications. Hence they will be able to apply these in various problems in these domains.

References

1. Erwin Kreyzig, *Introductory Functional Analysis with Applications*, John Wiley, 2006.
2. Hoffman Kenneth and Kunze Ray, *Linear Algebra*, Prentice Hall of India.
3. Jain M.K. Iyengar, S.R.K. & Jain R.K., *International Methods for Scientific and Engineering Computation*, New Age International (P) Ltd, Publishers 2003.
4. Taha. H.A., *Operations Research - An Introduction,* 6th Edition, PHI, 1997.
5. B. Hajek, *An Exploration of Random Processes for Engineers*, 2005.
6. D.P. Bertsekas and J. N. Tsitsiklis, *Introduction to Probability*, 2000.
7. Stark Henry, *Probability and Random Processes with Application to Signal Processing,* 3/e, Pearson Education India.
8. Steven Kay, *Intuitive probability and random processes using Matlab*, Springer, 2006.
9. Frazier, Michael W. *An Introduction to Wavelets through Linear Algebra,* Springer Publications

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	System of equations- Solution by Gauss - Jordan and LU decomposition method, Jacobi, Gauss-Seidal iteration method, Eigen values of a matrix by Jacobi and Power method. Rank-nullity theorem, Isomorphism, Matrix representation of Linear Transformations, Four fundamental subspaces of Linear Transformations, Change of bases, Linear functional.	10	15
II	Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Convergence, Completeness, Continuous mappings, Normed space, Banach space, *Lp* space and *lp* space	8	15
First Internal Examination			

III	Inner product space, Hilbert space, Signal space, Properties of inner product space, Orthogonal compliments and direct sums, Orthonormal sets, Gramm-Schmidt orthonormalization process, Projections.	8	15
IV	One dimensional Random Variable , Moments and MGF , Binomial, Poisson, Geometrical, Normal Distributions, Two dimensional Random Variables, Marginal and Conditional Distributions , Covariance and Correlation Coefficient, Functions of Two dimensional random variable.	10	15
Second Internal Examination			
V	Definition of Random process, IID process, Poisson counting process, Markov process, birth-death process, Wiener process. Stationarity, Correlation functions of random processes in linear systems, power spectral density.	10	20
VI	Single and Multiple server Markovian queuing models, Steady state system size probabilities, Little’s formula, Priority queues, M/G/1 queuing system, P.K. formula.	10	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6203	CMOS VLSI DESIGN	3 - 0 - 0 - 3	2015

Course Prerequisites

Basic knowledge about Microelectronics technology at UG level

Course Objectives

To have an advanced knowledge about design and fabrication of CMOS ICs.

Syllabus

MOS Transistor Theory, CMOS Processing Technology, CMOS Circuit Characteristics, Performance Estimation, Circuit and Logic Design, Subsystem Design

Expected Outcomes

The students who takes this course is expected to develop competence to design CMOS circuits for any functionality using different logic structures.

References

1. Neil.H.E. Weste and K.Eshragian, *Principles of CMOS VLSI Design*, 2nd Edition. Addison Wesley, 2000.
2. Douglas A. Pucknell and K.Eshragian, *Basic VLSI Design*, 3rd Edition. PHI, 2000.
3. R. Jacob Baker, Harry W. LI., & David K. Boyce., *CMOS Circuit Design*, 3rd Indian reprint, PHI,2000.
4. John P.Uyemura*, Introduction to VLSI circuits and Systems*, John Wiley and sons, 2010.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**MOS Transistor Theory:** Introduction to I.C Technology. Basic MOS transistors. Threshold Voltage. Body effect. Basic D.C. Equations. Second order effects. MOS models. Small signal A.C characteristics. The complementary CMOS inverter. DC characteristics. Static Load MOS inverters. The differential inverters. Transmission gate. VLSI Design flow.	7	15
II	**CMOS Processing Technology :**Silicon semiconductor technology. Wafer processing, Oxidation, epitaxy, deposition, Ion implantation. CMOS technology. nwell, pwell process, Twin tub processes. Silicon on insulator. CMOS process enhancement. Interconnect and circuit elements. Stick diagrams and Layout diagram, Layout design rules, Latch up in CMOS circuits	9	15
First Internal Examination			
III	**CMOS Circuit Characteristics :** Resistance estimation. Capacitance estimation. MOS capacitor characteristics. Device capacitances. Diffusion capacitance. SPICE modeling of MOS capacitance. Routing capacitance. Distributed RC effects. Inductance.	6	15

IV	**Performance Estimation:** Switching characteristics. Rise time. Fall time. Delay time. Empirical delay models. Gate delays. CMOS gate transistor sizing. Power dissipation, Design margining. Scaling of MOS transistor dimensions.	6	15
Second Internal Examination			
V	**Circuit and Logic Design:** CMOS Logic gate design. Fan in and fan out. Typical CMOS NAND and NOR delays. Transistor sizing. CMOS logic structures. Complementary logic, BICMOS logic, Pseudo NMOS logic, Dynamic CMOS logic, Clocked CMOS logic, Pass transistor logic, CMOS domino logic. NP domino logic, Cascade voltage switch logic, Source follower pull up Logic (SFPL), Clocking strategies, I/O structures	8	20
VI	**Subsystem Design:** Data path operations. Addition/subtraction, Parity generators, Comparators, Zero/one detectors, Binary Counters, ALUs, Multiplication, Array, Radix -n, Wallace Tree and Serial Multiplication, Shifters. Memory elements, RWM, Rom, Content Addressable Memory, Control: FSM, PLA Control Implementation	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6105	**ADVANCED DIGITAL SIGNAL PROCESSING**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

1. Basic knowledge in signals and systems at UG level;

Course Objectives

1. To attain a good analytical ability in digital filter design;
2. To investigate the applications of digital signal processing.

Syllabus

Review of transforms, Z-Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT), LTI systems as frequency selective filters, Invertibility of LTI systems, Design of digital filters by placement of poles and zeros, FIR filter structures, IIR filter structures, Design of FIR filters, Linear Phase Systems, Window method, Frequency sampling method, Finite word length effects, Design of IIR filters, Pole zero placement, Impulse invariance, Bilinear Z transformation, Finite word length effects, Adaptive Digital Filters, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Power Spectrum Estimation, Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.

Expected Outcomes

The students are expected to :

1. Attain a good analytical ability in digital filter design;
2. Know various applications of digital signal processing.

References

1. Proakis and Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications,* 4/e, Pearson Education.
2. Ifeachor and Jervis, *Digital Signal Processing, A practical Approach,* 2/e, Pearson Education.
3. Johnny R. Johnson, *Introduction to Digital Signal Processing,* PHI, 1992.
4. Ashok Ambardar, *Digital Signal Processing: A Modern Introduction,* Thomson, IE, 2007.
5. Douglas F. Elliott, *Handbook of Digital Signal Processing- Engineering Application,* Academic Press.
6. Robert J. Schilling and Sandra L. Harris, *Fundamentals of Digital Signal Processing using MATLAB,* Thomson, 2005.
7. Ingle and J. G. Proakis, *Digital Signal Processing Using MATLAB,* Thomson, 1/e.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of transforms** : Z-Transform, ROC, Poles & Zeros, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), DFT as a linear transformation, Frequency	4	15

	analysis of signals and systems using DFT, Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT).		
	LTI systems as filters : Invertibility of LTI systems, Minimum phase, Maximum phase and mixed phase systems, All-pass filters, Design of digital filters by placement of poles and zeros, Linear filtering methods based on DFT.	4	
II	**Digital Filter Structures** : Generalized input-output relationship, IIR Transfer Function, FIR Transfer Function, Signal Flow Graphs, FIR filter structures, Direct Form-I, Direct Form-II, Frequency Sampling, Cascade, Lattice, IIR filter structures, Direct Form-I, Transposed, Direct Form-II, Canonical, Parallel, Cascade, Lattice-Ladder structures.	6	15
First Internal Examination			
III	**Design of FIR filters** : Linear Phase Systems, Specifications, Coefficient calculation methods, Desired impulse responses, Window method, Frequency sampling method, Comparison of methods, Filter realization, Finite word length effects, Implementation examples, FIR filter design using Octave/ MATLAB.	7	15
IV	**Design of IIR filters** : Specifications, Coefficient calculation method, Pole zero placement, Transformation rules, Impulse invariance, Bilinear Z transformation (BZT), Buttorworth and Chebyschev approximations, Filter realization, Finite word length effects, Implementation examples, IIR filter design using Octave/ MATLAB.	7	15
Second Internal Examination			
V	**Adaptive Digital Filters** : Concepts, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Lattice Ladder filters, Application of Adaptive filters.	7	20
VI	**Power Spectrum Estimation** : Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.	7	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6503	**SIGNAL COMPRESSION**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge of signals and systems

Course Objectives

To have knowledge on different signal compression techniques

Syllabus

Review of Information Theory, Quantisation, Data Compression, Data compression, Speech and Audio Compression techniques, Image Compression and Video Compression

Expected Outcomes

The students are expected to have thorough knowledge about various compression techniques in different domains.

References

1. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann Publishers., Second Edn. 2005.
2. David Salomon, *Data Compression: The Complete Reference*, Springer Publications, 4th Edn. 2006.
3. K.R.Rao, P.C.Yip, *The Transform and Data Compression Handbook*, CRC Press. 2001.
4. R.G.Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, Inc., 1968.
5. Ali N. Akansu, Richard A. Haddad, *Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets*, Academic Press., 1992
6. Martin Vetterli, JelenaKovacevic, *Wavelets and Subband Coding*, Prentice Hall Inc., 1995.
7. N. Jayant and P. Noll, *Digital Coding of Waveforms: Principles and Applications to Speech and Video*, Prentice Hall, USA, 1984.
8. Z. Li and M.S. Drew, *Fundamentals of Multimedia*, Pearson Education (Asia) Pte. Ltd., 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Information Theory, Compression Techniques, Lossless and Lossy Compression, Huffman Coding, its variants, Optimality, Arithmetic Coding and its variants, Run Length Coding, Dictionary Techniques , Lempel-Ziv coding, Predictive Coding, Burrows Wheeler Transform, Dynamic Markov Compression. Golomb codes, Rice codes, Tunstall codes, Facsimile encoding	8	15
II	Quantization, Uniform & Non-uniform, optimal and adaptive quantization, vector quantization, structures for VQ, Optimality conditions for VQ, Predictive Coding , Differential Encoding	6	15

First Internal Examination			
III	Image compression: Predictive techniques, DM, PCM, DPCM: Optimal Predictors and Optimal Quantization, Contour based compression, Transform Coding, JPEG Standard, Sub-band coding algorithms: Design of Filter banks, Wavelet based compression, EZW, SPIHT, JPEG 2000 standards, JBIG, JBIG2, JPEG-LS, CALIC.	10	15
IV	Audio compression techniques, Standards for audio compression in multimedia applications, MPEG audio encoding and decoding, Dolby AC-3 standard.	6	15
Second Internal Examination			
V	Speech compression techniques, Vocoders, Speech compression - quality measures, waveform coding, source coders, Speech compression standards for personal communication systems	8	20
VI	Video compression techniques and standards, Motion estimation and compensation techniques, H.261, Dolby AC-3.	4	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6513	**DIGITAL SYSTEMS DESIGN**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge in digital electronics and digital systems at UG level

Course Objectives

For the student,

- To have an advanced level knowledge on digital system design.
- To write the VHDL code for various modules which forms part of various system

Syllabus

System Design Using VHDL, Clocked Synchronous Sequential Networks, Asynchronous Sequential Networks, Fault Diagnosis Programmable Logic Devices**.**

Expected Outcomes

Students will have a thorough knowledge of various issues in digital system design, its testing and implementation in various PLDs

References

1. Donald G. Givone, *Digital principles and Design*, Tata McGraw Hill 2002.
2. John M Yarbrough, *Digital Logic applications and Design*, Thomson Learning, 2001.
3. Nripendra N Biswas, *Logic Design Theory*, Prentice Hall of India, 2001.
4. Charles H. Roth Jr., *Digital System Design using VHDL*, Thomson Learning, 1998.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**System Design Using VHDL:** VHDL Description of Combinational Circuits, Arrays, VHDL Operators, Compilation and Simulation of VHDL Code, Modelling using VHDL , Flip Flops, Registers, Counters, Sequential Machine,.	7	15
II	**VHDL Design Examples :** Combinational Logic Circuits, VHDL Code for Serial Adder, Binary Multiplier, Binary Divider, Design of a Simple Microprocessor, Design of Vending Machine	7	15
First Internal Examination			
III	**Clocked Synchronous Sequential Networks:** Structure and operation of clocked synchronous sequential networks, Analysis of Clocked Synchronous Sequential Networks (CSSN), Modeling of Clocked Synchronous Sequential Network behavior, State Stable Assignment and Reduction , Design of CSSN , Design of Iterative Circuits , ASM Chart , ASM Realization.	9	15
IV	**Asynchronous Sequential Networks :** Structure and operation of asynchronous sequential networks, Analysis of Asynchronous Sequential Circuit (ASC), Flow Table Reduction, Races in ASC, State Assignment, Problem and the Transition Table , Design of	7	15

	ASC, Static and Dynamic Hazards, Essential Hazards, Data Synchronizers		
Second Internal Examination			
V	**Fault Diagnosis :** Fault Table Method, Path Sensitization Method, Boolean Difference Method, Fault in PLA,DFT Schemes, Built-in Self Test	6	20
VI	**Programmable Logic Devices** : Designing a Synchronous Sequential Circuit using a GAL , EPROM , Realization State machine using PLD , FPGA , Xilinx FPGA , Xilinx 2000 , Xilinx 3000, Xilinx 4000	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6515	**VLSI PHYSICAL DESIGN AND AUTOMATION**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge in microelectronics technology at UG level

Course Objectives

To give the Student an advanced level knowledge on VLSI physical design and automation.

Syllabus

Introduction to VLSI Technology, Placement Using Top-Down Approach, Routing Using Top Down Approach, Performance Issues in Circuit Layout.

Expected Outcomes

Students who successfully complete this course will have demonstrated an ability to understand the various steps and processes involved in physical design of an VLSI chip and the automated process behind VLSI chip manufacturing.

References

1. Sarafzadeh, C.K. Wong, *An Introduction to VLSI Physical Design*, McGraw Hill International Edition 1995
2. Preas M. Lorenzatti, *Physical Design and Automation of VLSI systems*, The Benjamin Cummins Publishers, 1998.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to VLSI Technology:** Layout Rules, Circuit abstraction Cell generation using programmable logic array transistor chaining, Wein Berger arrays and gate matrices, layout of standard cells gate arrays and sea of gates, field programmable gate array(FPGA),layout methodologies, Packaging-Computational Complexity, Algorithmic Paradigms.	9	15
II	**Placement Using Top-Down Approach :** Partitioning: Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic, Ratio cut- partition with capacity and I/O constraints,	5	15
	First Internal Examination		
III	**Floor planning**: Rectangular dual floor planning, hierarchical approach, simulated annealing, Floor plan sizing. Placement: Cost function, force directed method, placement by simulated annealing, partitioning placement, module placement on a resistive network, regular placement linear placement.	6	15
IV	**Routing Using Top Down Approach:** Fundamentals: Maze Running, line searching, Steiner trees Global Routing: Sequential Approaches, hierarchical approaches, multi	8	15

	commodity flow based techniques, Randomised Routing, One Step approach, Integer Linear Programming. Detailed Routing: Channel Routing, Switch box routing, Routing in FPGA: Array based FPGA, Row based FPGAs.		
Second Internal Examination			
V	**Performance Issues in Circuit Layout :** Delay Models: Gate Delay Models, Models for interconnected Delay, Delay in RC trees. Timing, Driven Placement: Zero Stack Algorithm, Weight based placement, Linear Programming Approach Timing Driving Routing: Delay Minimization, Clock Skew Problem, Buffered Clock Trees. Minimization: constrained via Minimization unconstrained via Minimization, Other issues in minimization.	8	20
VI	**Advanced topics**: Single Layer Global Routing, Single Layer detailed Routing, Wire length and bend minimization technique , Over The Cell (OTC) Routing, Multiple chip modules (MCM), 1D compaction, 2D compaction.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6517	**DESIGN OF ANALOG MOS INTEGRATED CIRCUITS**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

1. Basic knowledge in Solid State Devices at UG level;
2. Basic knowledge in Linear Integrated Circuits at UG level.

Course Objectives

1. To attain a thorough knowledge in analog MOS ICs;
2. To develop good analytical skills in analog MOS IC design.

Syllabus

Introduction MOSFET, Threshold voltage, current, Channel length modulation, body bias effect, MOSFET models in saturation, linear and cutoff regions-, current sources and sinks, current mirrors, voltage references, Supply independent and temperature independent references, MOS amplifiers, Common source with resistive, diode connected, current source and triode loads, CS with source degeneration, common gate and source follower stages, MOS differential amplifiers, Common mode response, differential pair with MOS loads, Noise in differential pair, CMOS operational amplifiers, One-stage op-amps and two stage op-amps, CMOS oscillators, Ring oscillators, LC oscillators, Colpitts and one-port oscillators, Voltage controlled oscillators, Stability and Frequency Compensation, Multi-pole systems, Phase Margin, Frequency Compensation, Noise, Noise Spectrum, Sources, Noise Bandwidth, Noise Figure, Switched Capacitor Circuits, Sampling Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers.

Expected Outcomes

The students are expected to :

1. Attain a profound knowledge in analog MOS ICs;
2. Develop good analytical skills in analog MOS IC design.

References

1. David A Johns & Ken Martin, *Analog Integrated Circuit Design*, John Wiley and Sons, 2008.
2. BehzadRazavi, *Design of Analog CMOS Integrated Circuit*, Tata-McGraw Hill, 2002.
3. Philip Allen & Douglas Holberg, *CMOS Analog Circuit Design*, Oxford University Press, 2002.
4. Gregorian and Temes, *Analog MOS Integrated Circuits for Signal Processing*, John Wiley, 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction MOSFET** : Threshold voltage, current, Channel length modulation, body bias effect, MOSFET models in saturation, linear and cutoff regions, current sources and sinks, current mirrors, cascode, Wilson current mirrors, voltage	7	15

	references, Supply independent and temperature independent references, Band gap references.		
II	**MOS amplifiers** : Common source with resistive, diode connected, current source and triode loads, CS with source degeneration, common gate and source follower stages, cascade and folded cascade structures, frequency response of CS, CD and CG configurations, noise in single stage amplifiers.	7	15
First Internal Examination			
III	**MOS differential amplifiers** : Common mode response, differential pair with MOS loads, Noise in differential pair, CMOS operational amplifiers, One-stage op-amps and two stage op-amps, gain boosting, Miller, Nulling resistor compensation.	8	15
IV	**CMOS oscillators** : Ring oscillators, LC oscillators, Colpitts and one-port oscillators, Voltage controlled oscillators, Tuning in oscillators.	6	15
Second Internal Examination			
V	**Stability and Frequency Compensation** : Multi-pole systems, Phase Margin, Frequency Compensation, Compensation Techniques, Noise, Noise Spectrum, Sources, Types, Thermal and Flicker noise, Representation in circuits, Noise Bandwidth, Noise Figure.	8	20
VI	**Switched Capacitor Circuits** :Sampling Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers, Switched-Capacitor Integrator, Switched-Capacitor Common-Mode Feedback.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6201	**HIGH SPEED DIGITAL DESIGN**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge in Digital Electronics and Electromagnetic waves and transmission lines.

Course Objectives

1. To attain good analytical skills in digital integrated circuit.
2. To identify sources affecting the speed of digital circuits.
3. To introduce methods to improve the signal transmission characteristics

Syllabus

High Speed Digital Design: Fundamentals: Frequency and time, Time and distance, Lumped versus distributed systems, High Speed properties of Logic gates: Power, Input power, drive circuit dissipation, speed, packaging.Measurement Techniques, Infinite Uniform transmission line, Termination: End,Source , middle terminators, Power system: Stable voltage reference, choosing a bypass capacitor. Clock Distribution: Timing margin, Clock skew delay adjustments, Differential distribution.

Expected Outcomes

The student, after this course will be able to design digital circuits which can operate in high frequency operations.

References

1. Howard Johnson & Martin Graham; *High Speed Digital Design: A Handbook of Black Magic*, Prentice Hall PTR, 1993.
2. William S. Dally & John W. Poulton, *Digital Systems Engineering*, Cambridge University Press, 1998.
3. Masakazu Shoji; *High Speed Digital Circuits*, Addison Wesley Publishing Company, 1996.
4. Jan M, Rabaey, et all; *Digital Integrated Circuits*: A Design perspective, Second Edition, 2003.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**High Speed Digital Design**: Fundamentals: Frequency and time, Time and distance,	2	15
	Lumped versus distributed systems, four kinds of reactance-ordinary capacitance and inductance, mutual capacitance and inductance, Relation of mutual capacitance and mutual inductance to cross talk.	5	
II	**High Speed properties of Logic gates**: Power, Quicentvs active dissipation, Active power driving a capacitive load, Input power.	5	15
	Internal dissipation, drive circuit dissipation: Totem pole ,Emitter follower, open collector, current source, Speed,		

	Packaging.		
First Internal Examination			
III	**Measurement Techniques:** Rise time and bandwidth of oscilloscope probes, self inductance of probe ground loop, spurious signal pick up from probe ground loops, special probing fixtures, Avoiding pickup from probe shield currents, slowing down of a system clock, observing metastable states.	8	15
IV	**Transmission Lines**: Problems of point to point wiring, signal distortion, EMI, cross talk.	3	15
	Infinite Uniform transmission line; ideal distortion less lossless transmission line, RC transmission line, Skin effect, Proximity effect, Dielectric loss. Effects of source and load impedance.	4	
Second Internal Examination			
V	**Termination**: End terminator, Source terminators, middle terminators , AC biasing for end terminators, Resistor selection, Cross talk in terminators.	8	20
VI	**Power system**: Stable voltage reference, Uniform voltage distribution, distribution problems, choosing a bypass capacitor.	3	20
	Clock Distribution: Timing margin, Clock skew, Using low impedance drivers, using low impedance distribution lines, delay adjustments, Differential distribution, Clock signal duty cycle, Decoupling clock receivers from the clock bus.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6519	SOLID STATE MODELING AND SIMULATION	3 - 0 - 0 - 3	2015

Course Prerequisites

Basic Knowledge of Solid Stae devices at UG level

Course Objectives

To have advanced level knowledge in modeling and simulation of solid state devices

Syllabus

MOSFET Capacitor, MOS transistor, Noise Sources and Distortion in MOS Circuits, Various Models of MOS devices

Expected Outcomes

The students are expected to develop concepts of solid state devices and their models so as to have a better understanding of the working of the devices under various operating conditions.

References

1. TrondYtterdal, Yuhua Cheng and Tor A. Fjeldly, *Device Modeling for Analog and RF CMOS Circuit Design*, John Wiley & Sons Ltd.
2. NarainArora. *MOSFET Modeling for VLSI Simulation: Theory and Practice*, World Scientific.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**MOSFET capacitor**: Basic operation, Basic modeling, Advanced MOSFET modeling, RF modeling of MOS transistors, Equivalent circuit representation of MOS transistor, High frequency behavior of MOS transistor and A.C small signal modeling, model parameter extraction, modeling parasitic BJT, Resistors, Capacitors, Inductors.	8	15
II	**Noise sources in MOSFET**: Flicker noise modeling, Thermal noise modeling, model for accurate distortion analysis, nonlinearities in CMOS devices and modeling, calculation of distortion in analog CMOS circuits.	7	15
First Internal Examination			
III	**MOS Models** : Gate dielectric model, Enhanced model for effective DC and AC channel length and width, Threshold voltage model, Channel charge model, mobility model, Source/drain resistance model, I-V model, gate tunneling current model, substrate current models.	8	15
IV	Capacitance models, High speed model, RF model, noise model, junction diode models, Layout-dependent parasitics model. Modeling of process variation-Influence of process variation, modeling of device mismatch for Analog/RF Applications.	7	15

Second Internal Examination			
V	The EKV model, model features, long channel drain current model, modeling second order effects of the drain current, modeling of charge storage effects	6	20
VI	Nonquasi- static modeling, noise model temperature effects, MOS model 9, MOSAI model. Benchmark circuits for quality assurance, Automation of the tests.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6119	**TRANSFORM THOERY**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

1. Basic knowledge in transforms at UG level;
2. Basic knowledge in digital signal processing at UG level.

Course Objectives

1. To attain a thorough knowledge in various transforms used in signal processing;
2. To apply transforms in various fields like coding, compression, etc.

Syllabus

Introduction on the integral and discrete transforms and their applications, Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Relations between the transforms, Short Term Fourier Transform (STFT), Heisenbergs uncertainty principle, Continuous wavelet transform (CWT), Hilbert Transforms, Radon Transform, Abel Transform, Sine transform, Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform, Discrete Transforms and Applictions, Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Discrete Wavelet Transform (DWT), lifting, Applications, image compression (JPEG 2000), Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).

Expected Outcomes

The students are expected to :

1. Attain a sound knowledge in various transforms like Lapalce transform, Z-transform, Fourier transforms, Wavelet transform, DCT, etc.
2. Apply these transforms in different areas line image compression, coding etc.
3. Understand new transforms like CTT and WBCT.

References

1. Alexander D. Poularikas, *The Transforms and Applications Handbook*, Second Edition, CRC Press.
2. Abdul Jerri, *Integral and Discrete transforms with applications and error analysis*, Marcel Dekker Inc.
3. LokenathDebnath, DambaruBhatta, *Integral Transforms and Their Applications*, Taylor & Francis Inc.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility- basis – Requirements of transforms- (Linear algebraic approach) - Review of Laplace Transform, Z transform,	7	15
II	Review of Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms- Integral Transforms: Short Term Fourier Transform (STFT) – Limitations of STFT -Heisenbergs uncertainty principle - Continuous wavelet transform (CWT)	7	15

	-Hilbert Transforms		
First Internal Examination			
III	Radon Transform, Abel Transform, Sine transform,,Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform	7	15
IV	Discrete Transforms and Applications : Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Application of DSTFT in audio signal processing, Discrete Wavelet Transform (DWT), lifting applied to DWT	7	15
Second Internal Examination			
V	Applications of DWT in audio signal processing, image compression (JPEG 2000), At least one application of each transform in one dimensional, Two-dimensional or Three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking, steganography, denoising, signal separation, signal classification), Limitations of DWT in image processing	6	20
VI	New Transforms and Applications : Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	RESEARCH METHODOLOGY	0 - 2 - 0 - 2	2015

Course Prerequisites

1. Basic knowledge in data analysis earned through the project work at UG level;
2. Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

1. To attain a perspective of the methodology of doing research;
2. To develop skills regarding communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role.

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :

1. Be motivated for research through the attainment of a perspective of research methodology;
2. Analyze and evaluate research works and to formulate a research problem to pursue research;
3. Develop skills related to professional communication, technical report writing and publishing papers

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, AppaIyerSivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson

Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation**: Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20

VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6509	SEMINAR - 1	0 - 0 - 2 - 2	2015

Course Prerequisites

1. The habit of reading technical magazines, conference proceedings and journals;
2. Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

1. To enhance the reading ability required for the literature review regarding the project work;
2. To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :

1. Be motivated in reading which enhances the literature review required for doing project work;
2. Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	3 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6511	**DIGITAL SIGNAL PROCESSING LABORATORY**	**0 - 0 - 3 - 1**	**2015**

Course Prerequisites

Basic knowledge in digital signal processing at UG level

Course Objectives

1. To have a practical exposure on the design real time DSP systems
2. To perform signal processing and basic image processing operations in MATLAB

Experiments

1. Properties of Discrete Time Systems - Impulse Response, Step response, Frequency Response and Stability of Systems
2. Linear & Circular Convolution, DFT and IDFT Implementation
3. Digital Filter Design – FIR (Hamming window), IIR (Butterworth)
4. Real time implementation of Discrete time filter circuits
5. Implementation of various speech compression algorithms - DPCM, Adaptive Quantization, ADPCM, Transform Coding
6. Image Processing – Image Enhancement, Edge detection, 2-D transforms, Image restoration
7. Implementation of DSP algorithms/filters using FPGA.
8. IIR Filtering Experiments : Signal Enhancement and Noise Reduction.

Expected Outcomes

The students are expected to :

1. develop a sound knowledge in designing and implementing DSP and Image processing algorithms
2. develop realtime DSP applications

References

1. S. J. Orfanidis, *Introduction to Signal Processing, online book, 2010*, available from:http://www.ece.rutgers.edu/~orfanidi/intro2sp/
2. RulphChassing, *Digital Signal Processing and Applications with C6713 and C6416 DSK*, Wiley Interscience, 2005.
3. V. Oppenheim, R. W. Schafer, *Discrete-Time Signal Processing*, 3/e, Prentice Hall, Englewood Cliffs,NJ, 2009

Course plan

Item	Description	Time	
1	Octave/MATLAB based signal processing experiments	3 Weeks	
2	Octave/MATLAB based image processing experiments	2 Weeks	
3	TMS/FPGA kits based Experiments	3 Weeks	
4	Preparation of Laboratory Record	2 Weeks	
5	Internal Examination	2 Weeks	
6	Publishing Grades	2 Weeks	

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No.10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Electronics & Communication Engineering

M. Tech.

in

Signal Processing

(Total credits: 65)

Curriculum Structure for M. Tech. in Signal Processing under KTU

FIRST SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
10EC6101	Linear Algebra	3	1	-	40	3	60	3
10EC6103	Random Process and Applications	3	-	-	40	3	60	3
10EC6105	Advanced Digital Signal Processing	3	-	-	40	3	60	3
10EC6401	Multi rate Signal Processing	3	-	-	40	3	60	3
xxxxx	Elective-I	3	-	-	40	3	60	3
10GN6001	Research Methodology	1	1	-	100	-	0	2
10EC6409	Seminar 1			2	100	-	0	2
10EC6111	Digital Signal Processing Lab	-	-	2	100	-	0	1
TOTAL		**16**	**2**	**4**	**500**		**300**	**21**

ELECTIVE-I

10EC6503 Signal Compression
10EC6113 Digital signal processors and Architecture
10EC6107 Advanced Digital Communication
10EC6201 High Speed Digital Design
10EC6119 Transform Theory

SECOND SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
10EC6102	Digital Image Processing	3	-	-	40	3	60	3
10EC6402	VLSI Signal processing	3	-	-	40	3	60	3
10EC6404	Adaptive Signal Processing	3	-	-	40	3	60	3
xxxxxx	Elective-II	3	-	-	40	3	60	3
xxxxxx	Elective-III	3	-	-	40	3	60	3
10EC6408	Mini Project	-	-	4	100	-	0	2
10EC6412	Image processing lab	-	-	2	100	-	0	1
TOTAL		**15**	**-**	**6**	**400**		**300**	**18**

ELECTIVE II

10EC6414 Principles of Digital System Design
10EC6114 Biomedical Signal Processing
10EC6302 Wavelet theory
10EC6314 Optical Signal processing
10EC6104 Estimation & Detection
10EC6118 Statistical Signal Processing
10EC6316 Multi dimensional signal processing
10EC6106 Coding Theory

THIRD SEMESTER

ELECTIVE-IV

Code	**Subject**	**Hours/Week**			**Internal Marks**	**End Semester Examination**		**Credit**
		L	**T**	**P**		**Hrs**	**Marks**	
xxxxxxxx	Elective-IV	3	-	-	40	3	60	3
xxxxxxxx	Elective-V	3	-	-	40	3	60	3
10EC7401	Seminar 2	-	-	2	100	-	0	2
10EC7403	Project - Phase 1	-	-	12	50	-	0	6
TOTAL		**6**	**-**	**14**	**230**		**120**	**14**

10EC7105 Audio Processing
10EC7405 Spectral estimation
10EC7109 Array signal processing
10EC7305 Computer Vision
10AE7113 Digital control system Design
10EC7113 Pattern Recognition
10EC7307 Multimedia systems
10EC7117 Information hiding & data encryption
10EC7213 Introduction to nano electronics

FOURTH SEMESTER

Code	**Subject**	**Hours/Week**			**Internal Marks**	**End Semester Examination**		**Credit**
		L	SP	**P**		**Hrs**	**Marks**	
10EC7404	Project - Phase 2	-	-	23	70	1	30	12
TOTAL		**-**	**-**	**23**	**70**		**30**	**12**

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6101	**LINEAR ALGEBRA**	**3 - 1 - 0 - 4**	**2015**

Course Prerequisites

(1) Basic knowledge in Matrix Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives

(1) To have an advanced level knowledge in linear algebra
(2) To throw light into the applications of linear algebra, like Multi-resolution analysis, Wavelets etc.

Syllabus

Sets, Functions, Groups, Rings, Fields, Vector spaces, Subspaces, Linear Transformations, Rank-nullity theorem, Isomorphism, Matrix representation of Linear Transformations, Linear functional, Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Banach space, L^p space and l^p space, Inner product space, Hilbert space, Signal space, Gramm-Schmidt orthonormalization process, Matrix rank, Solving linear system of equations using matrices, Eigen values, Eigen vectors and spectrum, Diagonalizability, Normal matrices, Unitary matrices, Multi-resolution analysis and wavelets.

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge in linear algebra;
(2) Know how the theory of linear algebra could be applied in specific domains, like Multi-resolution analysis, Wavelets etc.

References

1. Hoffman Kenneth and Kunze Ray, *Linear Algebra,* Prentice Hall of India.
2. Strang G, *Linear Algebra and its Applications*, 3rd edition, Saunders, 1988.
3. Erwin Kreyzig, *Introductory Functional Analysis with Applications*, John Wiley, 2006.
4. G.F.Simmons, *Topology and Modern Analysis* , McGraw Hill.
5. Frazier, Michael W., *An Introduction to Wavelets through Linear Algebra,* Springer Publications.
6. Jin Ho Kwak & Sungpyo Hong, *Linear Algebra*, Springer International, 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Sets, Functions, Cardinality of sets, Groups, Rings, Fields.	4	15
	Vector spaces, Subspaces, Basis and dimension, Finite and infinite dimensional vector spaces.	4	
II	Linear Transformations, Sum, product and inverse of Linear Transformations, Rank-nullity theorem, Isomorphism.	5	15
	Matrix representation of Linear Transformations, Four fundamental subspaces of Linear Transformations, Change of bases, Linear functional.	5	
First Internal Examination			
III	Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Convergence, Completeness, Continuous mappings, Normed space, Banach space, L^p space and l^p space.	10	15

IV	Inner product space, Hilbert space, Signal space, Properties of inner product space, Orthogonal compliments and direct sums, Orthonormal sets, Gramm-Schmidt orthonormalization process, Projections.	10	15
Second Internal Examination			
V	Matrix rank, Solving linear system of equations using matrices, LDU factorization, QR decomposition, Least square approach.	5	20
	Eigen values, Eigen vectors and spectrum, Diagonalizability, Orthogonal diagonalization.	4	
VI	Properties of Eigen values and Eigen vectors of Hermitian matrices, Normal matrices, Unitary matrices.	4	20
	Multi-resolution analysis and Wavelets.	5	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6103	**RANDOM PROCESSES AND APPLICATIONS**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in Probability Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives

(1) To impose in-depth knowledge in probability theory.
(2) To throw light into the applications of probability and random processes.

Syllabus

Review of Set Theory, Random experiment, Sample space, Cumulative Distribution Function, Probability Density Function, conditional distribution, Expectation, moments, correlation and covariance, Random Vector, Convergence - Markov and Chebyshev inequalities, convergence in probability, convergence in mean square, Weak law of large numbers, strong law of large numbers, Central Limit Theorem for sequences of independent random variables, Random process, IID process, Poisson counting process, Markov process, Wiener process. Stationarity, power spectral density, Discrete time Markov chains, conditional independence, DTMC, Recurrence analysis, Chapman-Kolmogov theorem, Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge in probability theory;
(2) Know how the theory of probability and random processes could be applied in specific domains

References

1. A. Papoulis and S. UnnikrishnaPillai. *Probability, Random Variables and Stochastic Processes,* TMH
2. B. Hajek, *An Exploration of Random Processes for Engineers*, 2005.
3. D.P. Bertsekas and J. N. Tsitsiklis, *Introduction to Probability*, 2000.
4. Gray, R. M. and Davisson L. D., *An Introduction to Statistical Signal Processing.* Cambridge University Press, 2004.
5. Stark Henry, *Probability and Random Processes With Application to Signal Processing,* 3/e, Pearson Education India.

6. Steven Kay, *Intuitive probability and random processes using MATLAB*, Springer, 2006.   6. Dr. Kishor S. Trivedi. *Probability and Statistics with Reliability, Queuing, and Computer Science Applications,* John Wiley and Sons, New York, 2001.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Review of Set Theory - Set operations, functions, countable and uncountable sets, Random experiment, Sample space, Sigma algebra, Event space, Measure, Probability measure, Borel sigma field	4	15
	Cumulative Distribution Function (CDF), Probability Density Function (PDF), PMF, Joint CDF, Joint PDF, conditional distribution.	4	
II	Expectation - Fundamental Theorem of expectation, moments, characteristic function, correlation and covariance	4	15
	Random Vector - Definition, Joint statistics, Covariance and correlation matrix, Gaussian random vectors.	4	
First Internal Examination			
III	Convergence - Markov and Chebyshev inequalities, Convergence of sequences of random variables- almost sure convergence, convergence in probability, convergence in mean square, Weak law of large numbers, Random sums, Borel Cantelli lemma, strong law of large numbers, Central Limit Theorem for sequences of independent random variables.	8	15
IV	Random process - Definition of Random process, IID process, Poisson counting process, Markov process, birth-death process, Wiener process. Stationarity, Correlation functions of random processes in linear systems, power spectral density.	8	15
Second Internal Examination			
V	Discrete time Markov chains - conditional independence, DTMC, Recurrence analysis, Foster's Theorem, Chapman-Kolmogov theorem, Stopping time.	6	20
VI	classification of states: absorbing, recurrent, transient. Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.	6	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L - T - P - Credits**	**Year of Introduction**
10EC6105	**ADVANCED DIGITAL SIGNAL PROCESSING**	**3 - 0 - 0 - 3**	**2015**
Course Prerequisites (1) Basic knowledge in signals and systems at UG level; (2) Basic knowledge in transforms at UG level.			
Course Objectives (1) To attain a good analytical ability in digital filter design;			

(2) To investigate the applications of digital signal processing.

Syllabus

Review of transforms, Z-Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT), LTI systems as frequency selective filters, Invertibility of LTI systems, Design of digital filters by placement of poles and zeros, FIR filter structures, IIR filter structures, Design of FIR filters, Linear Phase Systems, Window method, Frequency sampling method, Finite word length effects, Design of IIR filters, Pole zero placement, Impulse invariance, Bilinear Z transformation, Finite word length effects, Adaptive Digital Filters, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Power Spectrum Estimation, Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.

Expected Outcomes

The students are expected to :

(1) Attain a good analytical ability in digital filter design;

(2) Know various applications of digital signal processing.

References

1. Proakis and Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications,* 4/e, Pearson Education.
2. Ifeachor and Jervis, *Digital Signal Processing, A practical Approach,* 2/e, Pearson Education.
3. Johnny R. Johnson, *Introduction to Digital Signal Processing,* PHI, 1992.
4. Ashok Ambardar, *Digital Signal Processing: A Modern Introduction,* Thomson, IE, 2007.
5. Douglas F. Elliott*, Handbook of Digital Signal Processing- Engineering Application,* Academic Press.
6. Robert J. Schilling and Sandra L. Harris, *Fundamentals of Digital Signal Processing using MATLAB,* Thomson, 2005.
7. Ingle and J. G. Proakis, *Digital Signal Processing Using MATLAB,* Thomson, 1/e.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of transforms** : Z-Transform, ROC, Poles & Zeros, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), DFT as a linear transformation, Frequency analysis of signals and systems using DFT, Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT).	4	15
	LTI systems as filters : Invertibility of LTI systems, Minimum phase, Maximum phase and mixed phase systems, All-pass filters, Design of digital filters by placement of poles and zeros, Linear filtering methods based on DFT.	5	
II	**Digital Filter Structures** : Generalized input-output relationship, IIR Transfer Function, FIR Transfer Function, Signal Flow Graphs, FIR filter structures, Direct Form-I, Direct Form-II, Frequency Sampling, Cascade, Lattice, IIR filter structures, Direct Form-I, Transposed, Direct Form-II, Canonical, Parallel, Cascade, Lattice-Ladder structures.	6	15
First Internal Examination			
III	**Design of FIR filters** : Linear Phase Systems, Specifications,	8	15

	Coefficient calculation methods, Desired impulse responses, Window method, Frequency sampling method, Comparison of methods, Filter realization, Finite word length effects, Implementation examples, FIR filter design using Octave/ MATLAB.		
IV	**Design of IIR filters** : Specifications, Coefficient calculation method, Pole zero placement, Transformation rules, Impulse invariance, Bilinear Z transformation (BZT), Buttorworth and Chebyschev approximations, Filter realization, Finite word length effects, Implementation examples, IIR filter design using Octave/ MATLAB.	8	15
Second Internal Examination			
V	**Adaptive Digital Filters** : Concepts, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Lattice Ladder filters, Application of Adaptive filters.	6	20
VI	**Power Spectrum Estimation** : Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.	5	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6401	**MULTIRATE SIGNAL PROCESSING**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Digital Signal Processing
(2) Digital Filters

Course Objectives

(1) To have an advanced level knowledge on Multirate systems
(2) To Apply the mutirate signal processing techniques to the systems which are working in different rates.

Syllabus

Fundamentals of Multirate Theory The sampling theorem Basic Multirate operations- Maximally decimated filter M-channel perfect reconstruction filter banks Polyphase representation- perfect reconstruction systems Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Quantization Effects filter banksCosine Modulated filter banks Polyphase structure- PR Systems

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge on Multirate Signal Processing;
(2) Know how the theory of Multirate Signal Processing could be applied in specific domains, like Multi-rate systems.

References

1. P.P. Vaidyanathan. “Multirate systems and filter banks.” Prentice Hall. PTR. 1993.
2. N.J. Fliege. “Multirate digital signal processing .” John Wiley 1994.
3. Sanjit K. Mitra. “ Digital Signal Processing: A computer based approach.” McGraw Hill.

1998.
4. R.E. Crochiere. L. R. “Multirate Digital Signal Processing”, Prentice Hall. Inc.1983.
5. J.G. Proakis. D.G. Manolakis. “Digital Signal Processing: Principles. Algorithms and Applications”, 3rd Edn. Prentice Hall India, 1999.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	The sampling theorem - sampling at sub nyquist rate - Basic Formulations and schemes.	5	15
	Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation	6	
II	Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank	6	15
First Internal Examination			
III	M-channel perfect reconstruction filter banks -Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems	6	15
IV	**Perfect reconstruction (PR) filter banks** Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property-	7	15
Second Internal Examination			
V	Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.	6	20
VI	**Cosine Modulated filter banks** Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase distortion- Closed form expression- Polyphase structure- PR Systems	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;

(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;

(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :

(1) Be motivated for research through the attainment of a perspective of research methodology;

(2) Analyze and evaluate research works and to formulate a research problem to pursue research;

(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.

8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15

Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6503	**SIGNAL COMPRESSION**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge of signals and systems

Course Objectives

To have knowledge on different signal compression techniques

Syllabus

Review of Information Theory, Quantization, Data Compression, Data compression, Speech and Audio Compression techniques, Image Compression and Video Compression

Expected Outcomes

The students are expected to have thorough knowledge about various compression techniques in different domains.

References

1. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann Publishers., Second Edn. 2005.
2. David Salomon, *Data Compression: The Complete Reference*, Springer Publications, 4th Edn. 2006.
3. K.R.Rao, P.C.Yip, *The Transform and Data Compression Handbook*, CRC Press. 2001.
4. R.G.Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, Inc., 1968.
5. Ali N. Akansu, Richard A. Haddad, *Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets*, Academic Press., 1992

6. Martin Vetterli, Jelena Kovacevic, *Wavelets and Subband Coding*, Prentice Hall Inc., 1995.
7. N. Jayant and P. Noll, *Digital Coding of Waveforms: Principles and Applications to Speech and Video*, Prentice Hall, USA, 1984.
8. Z. Li and M.S. Drew, *Fundamentals of Multimedia*, Pearson Education (Asia) Pte. Ltd., 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Information Theory, Compression Techniques, Lossless and Lossy Compression, Huffman Coding, its variants, Optimality, Arithmetic Coding and its variants, Run Length Coding, Dictionary Techniques , Lempel-Ziv coding, Predictive Coding, Burrows Wheeler Transform, Dynamic Markov Compression. Golomb codes, Rice codes, Tunstall codes, Facsimile encoding	8	15
II	Quantization, Uniform & Non-uniform, optimal and adaptive quantization, vector quantization, structures for VQ, Optimality conditions for VQ, Predictive Coding , Differential Encoding	6	15
First Internal Examination			
III	Image compression: Predictive techniques, DM, PCM, DPCM: Optimal Predictors and Optimal Quantization, Contour based compression, Transform Coding, JPEG Standard, Sub-band coding algorithms: Design of Filter banks, Wavelet based compression, EZW, SPIHT, JPEG 2000 standards, JBIG, JBIG2, JPEG-LS, CALIC.	10	15
IV	Audio compression techniques, Standards for audio compression in multimedia applications, MPEG audio encoding and decoding, Dolby AC-3 standard.	6	15
Second Internal Examination			
V	Speech compression techniques, Vocoders, Speech compression - quality measures, waveform coding, source coders, Speech compression standards for personal communication systems	8	20
VI	Video compression techniques and standards, Motion estimation and compensation techniques, H.261, Dolby AC-3.	4	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P -	Year of

		Credits	Introduction
10EC6113	**DSP PROCESSORS AND ARCHITECTURE**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge in DSP and microprocessors at UG level

Course Objectives

To have an in depth knowledge in DSP at processor level

Syllabus

Review of Pipelined RISC Architecture and Instruction Set Design- Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks. Basic Pipeline: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch). Instruction Level Parallelism (ILP): Concepts, Dynamic Scheduling -Dynamic Hardware Prediction- Limitations of ILP. Review of Memory Hierarchy: Cache design, Cache Performance Issues & Improving Techniques. Computer arithmetic- Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System(LNS, RNS). Index Multiplier –Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic(DA), CORDIC Algorithm and architecture. Case studies:TMS 320 C 6X Processor –sample program. Overview of BlackFin processo

Expected Outcomes

Students are expected to

1.understand pipelining hazards, resolving techniques

2.understand dsp processors and will be able to develop programs for dsp

References

1. J. L. Hennesy and D. A. Patterson, *Computer Architecture A Quantitative Approach,* 3/e, Elsivier India, Chapter 1, Appendix A, Chapter 3, Chapter 5.
2. U. Mayer-Baese, Digital Signal Processing with FPGAs, Springer, 2001.
3. RulphChassaing, Digital signal Processing and Applications with the C6713 and C6416 DSK – Wiley Interscience.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of Pipelined RISC Architecture and Instruction Set Design.**	5	15
	Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks.	2	
II	**Basic Pipeline**: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch)- structural hazards-data hazards-control hazards-branch prediction	6	15

First Internal Examination			
III	**Instruction Level Parallelism (ILP):** Concepts, Dynamic Scheduling – Tomasulo's algorithm -Reducing Data hazards	4	15
	Dynamic Hardware Prediction - Reducing Branch Hazards. Multiple Issue-Hardware-based speculation	4	
	Limitations of ILP	1	
IV	**Review of Memory Hierarchy:** Cache design	3	15
	Cache Performance Issues & Improving Techniques	4	
Second Internal Examination			
V	**Computer arithmetic:** Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System(LNS, RNS)	3	20
	Index Multiplier –Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic(DA), CORDIC Algorithm and architecture .	3	
VI	**Case studies:** Introduction to TMS 320 C 6X Processor – Architecture – Functional units - pipelining –Registers	3	20
	Linear and Circular addressing modes –Types of instructions –sample program,	3	
	Overview of BlackFin processor	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EC6107	**ADVANCED DIGITAL COMMUNICATION**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of Digital Communication at UG Level.

Course Objectives

The course is designed to provide students a strong background in Modern Digital communication techniques emphasizing on Optimized Detection, Security and Bandwidth efficiency.

Syllabus

Introduction to Signal Space, Complex envelop representation of band pass signal, Digital modulation techniques, Optimum receiver structures for AWGN channel, , Band limited channel, ISI, Pulse shaping, Adaptive Equalization techniques, Code Division Multiple Access, Random Access techniques, ALOHA protocols, CSMA. Multicarrier modulation, OFDM

Expected Outcomes

The students are expected to understand modern digital communication technologies and acquire design capabilities for the future needs.

References

1. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems,Pearson Education, 2005.

2. S. Haykins, Communication Systems, 5th ed., John wiley, 2008.
3. Andrea Goldsmith, Wireless Communications, Cambridge University press.
4. S. Benedetto and E. Biglieri, Principles of Digital Transmission with Wireless Applications, Kluwer Academic/Plenum Publishers, 1999.
5. 1. Viterbi, A. J. and J. K. Omura. Principles of Digital Communication and Coding. NY: McGraw-Hill, 1979.
6. Marvin K Simon, Sami M Hinedi, William C Lindsey - Digital Communication Techniques – Signal Design & Detection, PHI
7. MIT OpenCourseWare, Electrical Engineering and Computer Science,Principles of Digital Communication II, Spring 2006
8. Aazhang B. Digital Communication Systems [Connexions Web site]. January 22, 2004. available at: http://cnx.rice.edu/content/col10134/1.3/

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to Signal Space:** Concepts of basis, norm, inner product, signal constellation diagram. M-ary orthogonal signals.-Gram Schmidt Ortho normalization Procedure. Representations of Band pass signals: Complex baseband representation of signals. Representation Band pass Stationary Stochastic Signals.	6	15
II	**Digital Modulation Techniques:** Carrier modulation (M-ary ASK, PSK, FSK, DPSK). Continuous phase modulation (QPSK and variants, MSK, GMSK).	5	15
First Internal Examination			
III	**Optimum Receivers for additive white Gaussian noise channels:** Correlation receiver. Matched filter receiver. Maximum Likelihood sequence detector. Performance characteristics of detectors.	6	15
IV	**Optimum Receiver for Signals with random phase in AWGN Channels**: Optimum receiver for Binary Signals- Optimum receiver for M-ary orthogonal signals- Optimum waveform receiver for coloured Gaussian noise channels- Karhunen Loeve expansion approach-whitening.	7	15
Second Internal Examination			
V	**Band limited Channel:** Inter Symbol Interference (ISI).Pulse Shape designing -Nyquist Pulse, Raised Cosine Pulse.	4	20
	Adaptive Equalization: Adaptive Linear Equalizers—Zero forcing algorithm, LMS algorithm. Adaptive Decision feedback equalizers-adaptive equalization of trellis coded signal. Blind Equalizer based on maximum likelihood criterion.	5	
VI	**Multiple Access techniques:** Code Division Multiple Access –CDMA signal and Channel Model-The optimum receivers-sub optimum receivers.	3	20
	Random access methods: ALOHA system and protocols. Carrier Sense Multiple Access.	3	
	Multi Carrier Modulation: Orthogonal Frequency Division Multiplexing(OFDM), Discrete implementation of OFDM	3	

Cluster Level End Semester Examination

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6201	**HIGH SPEED DIGITAL DESIGN**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

Basic knowledge in Digital Electronics and Electromagnetic waves and transmission lines.

Course Objectives

To attain good analytical skills in digital integrated circuit.

To identify sources affecting the speed of digital circuits.

To introduce methods to improve the signal transmission characteristics

Syllabus

High Speed Digital Design: Fundamentals: Frequency and time, Time and distance, Lumped versus distributed systems, High Speed properties of Logic gates: Power, Input power, drive circuit dissipation, speed, packaging. Measurement Techniques, Infinite Uniform transmission line, Termination: End , Source , middle terminators, Power system: Stable voltage reference, choosing a bypass capacitor. Clock Distribution: Timing margin, Clock skew delay adjustments, Differential distribution.

Expected Outcomes

References

1. Howard Johnson & Martin Graham; High Speed Digital Design: A Handbook of Black Magic, Prentice Hall PTR, 1993.
2. William S. Dally & John W. Poulton, Digital Systems Engineering, Cambridge University Press, 1998.
3. Masakazu Shoji; High Speed Digital Circuits, Addison Wesley Publishing Company, 1996.
4. Jan M, Rabaey, et all; Digital Integrated Circuits: A Design perspective, Second Edition, 2003.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**High Speed Digital Design**: Fundamentals: Frequency and time, Time and distance,	4	15
	Lumped versus distributed systems, four kinds of reactance- ordinary capacitance and inductance, mutual capacitance and inductance, Relation of mutual capacitance and mutual inductance to cross talk.	4	
II	**High Speed properties of Logic gates**: Power, Quicent vs active dissipation, Active power driving a capacitive load, Input power,	4	15
	Internal dissipation, drive circuit dissipation: Totem pole , Emitter follower, open collector, current source, Speed, Packaging.	4	

First Internal Examination			
III	**Measurement Techniques:** Rise time and bandwidth of oscilloscope probes, self inductance of probe ground loop, spurious signal pick up from probe ground loops, special probing fixtures, Avoiding pickup from probe shield currents, slowing down of a system clock, observing metastable states.	8	15
IV	**Transmission Lines**: Problems of point to point wiring, signal distortion, EMI, cross talk.	4	15
	Infinite Uniform transmission line; ideal distortion less lossless transmission line, RC transmission line, Skin effect, Proximity effect, Dielectric loss. Effects of source and load impedance.	4	
Second Internal Examination			
V	**Termination**: End terminator, Source terminators, middle terminators , AC biasing for end terminators, Resistor selection, Cross talk in terminators.	6	20
VI	**Power system**: Stable voltage reference, Uniform voltage distribution, distribution problems, choosing a bypass capacitor.	3	20
	Clock Distribution: Timing margin, Clock skew, Using low impedance drivers, using low impedance distribution lines, delay adjustments, Differential distribution, Clock signal duty cycle, Decoupling clock receivers from the clock bus.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6119	**TRANSFORM THOERY**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in transforms at UG level;
(2) Basic knowledge in digital signal processing at UG level.

Course Objectives

(1) To attain a thorough knowledge in various transforms used in signal processing;
(2) To apply transforms in various fields like coding, compression, etc.

Syllabus

Introduction on the integral and discrete transforms and their applications, Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Relations between the transforms, Short Term Fourier Transform (STFT), Heisenbergs uncertainty principle, Continuous wavelet transform (CWT), Hilbert Transforms, Radon Transform, Abel Transform, Sine transform, Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform, Discrete Transforms and Applictions, Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Discrete Wavelet Transform (DWT), lifting, Applications, image compression (JPEG 2000), Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and

CTT such as wavelet Based Contourlet Transform (WBCT).
Expected Outcomes The students are expected to : 1. Attain a sound knowledge in various transforms like Lapalce transform, Z-transform, Fourier transforms, Wavelet transform, DCT, etc. 2. Apply these transforms in different areas line image compression, coding etc. 3. Understand new transforms like CTT and WBCT.
References 1. Alexander D. Poularikas, *The Transforms and Applications Handbook*, Second Edition, CRC Press. 2. Abdul Jerri, *Integral and Discrete transforms with applications and error analysis*, Marcel Dekker Inc. 3. Lokenath Debnath, Dambaru Bhatta, *Integral Transforms and Their Applications*, Taylor & Francis Inc.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility-basis – Requirements of transforms- (Linear algebraic approach) - Review of Laplace Transform, Z transform,	7	15
II	Review of Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms- Integral Transforms: Short Term Fourier Transform (STFT) – Limitations of STFT -Heisenbergs uncertainty principle - Continuous wavelet transform (CWT) - Hilbert Transforms	7	15
First Internal Examination			
III	Radon Transform, Abel Transform, Sine transform,,Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform	7	15
IV	Discrete Transforms and Applications : Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Application of DSTFT in audio signal processing, Discrete Wavelet Transform (DWT), lifting applied to DWT	7	15
Second Internal Examination			
V	Applications of DWT in audio signal processing, image compression (JPEG 2000), At least one application of each transform in one dimensional, Two-dimensional or Three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking, steganography, denoising, signal separation, signal classification), Limitations of DWT in image processing	6	20
VI	New Transforms and Applications : Contourlet transform	8	20

	(CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).		
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6409	**SEMINAR - 1**	**0 - 0 - 2 - 2**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;
(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :
(1) Be motivated in reading which enhances the literature review required for doing project work;
(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction

10EC6111	**DIGITAL SIGNAL PROCESSING LABORATORY**	**0 - 0 - 2 - 1**	**2015**

Course Prerequisites

(1) Knowledge in Digital Signal Processing at UG level;
(2) Programming ability in Octave/MATLAB and knowledge about DSP kits like TMS320C6X or AD.

Course Objectives

(1) To have a thorough understanding of Digital Signal Processing through software programming;
(2) To investigate Digital Signal Processing through DSP Kits like TMS320C6X or AD.

Experiments

1. Review of MATLAB Programming Practice
2. Low-pass FIR filter using Hamming Window
3. High-pass FIR filter using Hamming Window
4. Low-pass IIR filter using Butterworth Approximation
5. High-pass IIR filter using Butterworth Approximation
6. Convolution and Correlation of sequences
7. Laplace Transform and Z-Transform using MATLAB Symbolic Toolbox
8. Normal Density Estimation
9. Wiener Filter for 1-D Signals
10. Two Channel Quadrature Mirror Filter Bank
11. Wiener Filter for Images with Defocus Blur
12. Wiener Filter for Images with Motion Blur
13. Introduction to C-based embedded design using Code Composer Studio (CCS) and the TI6713 DSK
14. Familiarization of creating, building, and testing some simple projects in the CCS integrated development environment (IDE)
15. Implementation of DFT, FFT programs using CCS
16. Implementation of real-time FIR filtering on the TMS320C6713 with CCS using C
17. Implementation of real-time IIR filtering on the TMS320C6713 with CCS using C.
18. Interfacing of multimedia data to the 6713 DSK

Expected Outcomes

The students are expected to :
(1) Attain a thorough understanding of Digital Signal Processing through software programming;
(2) Develop skills for programming and doing real time DSP using kits like TMS320C6X or AD.

References

1. E. S. Gopi, *Algorithm Collections for Digital Signal Processing Applications using MATLAB*, Springer, 2007.

2. Vinay K. Ingle and John. G. Proakis, *Digital Signal Processing Using MATLAB*, PWS Publishing Company, 1997.
3. Gerard Blanchet and Maurice Charbit*, Digital Signal and Image Processing using MATLAB,* ISTE Ltd, 2006
4. Paul M. Embree, *C Algorithms for Real-time DSP*, Prentice Hall PTR, 1995.

Course plan

Item	Description	Time	
1	Octave/MATLAB based Experiments	4 Weeks	
2	CCS and TMS kits based Experiments	4 Weeks	
3	Preparation of Laboratory Record	2 Weeks	
4	Internal Examination	2 Weeks	
5	Publishing Grades	2 Weeks	

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No.10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Electronics & Communication Engineering

M. Tech.

in

Communication and Signal Processing

(Total credits: 65)

Curriculum Structure for M. Tech. in Communication & Signal Processing (CSP) under KTU

FIRST SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
10EC6101	Linear Algebra	3	1	-	40	3	60	4
10EC6103	Random Processes and Applications	3	-	-	40	3	60	3
10EC6105	Advanced Digital Signal Processing	3	-	-	40	3	60	3
10EC6107	Advanced Digital Communication	3	-	-	40	3	60	3
	Elective-I	3	-	-	40	3	60	3
10GN6001	Research Methodology	1	1	-	100	-	0	2
10EC6109	Seminar-1	-	-	2	100	-	0	2
10EC6111	Digital Signal Processing Laboratory	-	-	2	100	-	0	1
TOTAL		**16**	**1**	**4**	**600**		**300**	**21**

ELECTIVE-I

10EC6401 Multi-rate Signal Processing

10EC6113 DSP Processors and Architecture

10EC6115 Radio Frequency Integrated circuit

10EC6117 Wireless Communication 1

10EC6119 Transform Theory

SECOND SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
10EC6102	Digital Image Processing	3	-	-	40	3	60	3
10EC6104	Estimation and Detection Theory	3	-	-	40	3	60	3
10EC6106	Coding Theory	3	-	-	40	3	60	3
	Elective-II	3	-	-	40	3	60	3
	Elective-III	3	-	-	40	3	60	3
10EC6108	Mini Project	-	-	4	100	-	0	2
10EC6112	Advanced Communication Lab	-	-	2	100	-	0	1
TOTAL		**15**	**-**	**6**	**400**		**300**	**18**

ELECTIVE – II & III

10EC6302 Wavelet Theory
10EC6114 Biomedical Signal Processing
10EC6404 Adaptive Signal Processing
10EC 6116 Fiber optic communication
10EC6402 VLSI Signal Processing
10EC6122 Wireless Communication II
10EC6118 Statistical Signal Processing

10EC6124 Data Communication System

THIRD SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
	Elective-IV	3	-	-	40	3	60	3
	Elective-V	3	-	-	40	3	60	3
10EC7101	Seminar-2	-	-	2	100	-	0	2
10EC7103	Project - Phase 1	-	-	8	50	-	0	6
TOTAL		**6**	**-**	**10**	**230**		**120**	**14**

ELECTIVE- IV & V

10EC7105 Audio Processing
10EC7107 Spread Spectrum & CDMA System
10EC7109 Array Signal Processing
10EC7111 Adhoc networks
10EC7113 Pattern Recognition
10EC7117 Information Hiding and Data Encryption
10EC7115 Wireless sensor networks
10EC7119 Numerical methods in Electromagnetics

FOURTH SEMESTER

Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
		L	T	P		Hrs	Marks	
10EC7104	Project - Phase 2	-	-	21	70	1	30	12
TOTAL		**-**	**-**	**21**	**70**		**30**	**12**

Note:
1. **Assignments can be home work, projects to improve problem solving skills, group discussions, quiz, literature survey, seminar, course project, software exercises, etc.**
2. **In each module of the courses, students should take up *"Open ended problems related to the contents of the course, and this should NOT be included for university/internal evaluation, but to sharpen the problem solving skills of students.*.**

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6101	**LINEAR ALGEBRA**	**3- 1-0 -4**	**2015**

Course Prerequisites
(1) Basic knowledge in Matrix Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives
(1) To have an advanced level knowledge in linear algebra
(2) To throw light into the applications of linear algebra, like Multi-resolution analysis, Wavelets etc.

Syllabus
Sets, Functions, Groups, Rings, Fields, Vector spaces, Subspaces, Linear Transformations, Rank-nullity

theorem, Isomorphism, Matrix representation of Linear Transformations, Linear functional, Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Banach space, L^p space and l^p space, Inner product space, Hilbert space, Signal space, Gramm-Schmidt orthonormalization process, Matrix rank, Solving linear system of equations using matrices, Eigen values, Eigen vectors and spectrum, Diagonalizability, Normal matrices, Unitary matrices, Multi-resolution analysis and wavelets.

Expected Outcomes

The students are expected to :

(1) Have an advanced level knowledge in linear algebra;

(2) Know how the theory of linear algebra could be applied in specific domains, like Multi-resolution analysis, Wavelets etc.

References

1. Hoffman Kenneth and Kunze Ray, *Linear Algebra,* Prentice Hall of India.
2. Strang G, *Linear Algebra and its Applications*, 3rd edition, Saunders, 1988.
3. Erwin Kreyzig, *Introductory Functional Analysis with Applications*, John Wiley, 2006.
4. G.F.Simmons, *Topology and Modern Analysis* , McGraw Hill.
5. Frazier, Michael W., *An Introduction to Wavelets through Linear Algebra,* Springer Publications.
6. Jin Ho Kwak & Sungpyo Hong, *Linear Algebra*, Springer International, 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Sets, Functions, Cardinality of sets, Groups, Rings, Fields.	4	15
	Vector spaces, Subspaces, Basis and dimension, Finite and infinite dimensional vector spaces.	4	
II	Linear Transformations, Sum, product and inverse of Linear Transformations, Rank-nullity theorem, Isomorphism.	5	15
	Matrix representation of Linear Transformations, Four fundamental subspaces of Linear Transformations, Change of bases, Linear functional.	5	
First Internal Examination			
III	Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Convergence, Completeness, Continuous mappings, Normed space, Banach space, L^p space and l^p space.	10	15
IV	Inner product space, Hilbert space, Signal space, Properties of inner product space, Orthogonal compliments and direct sums, Orthonormal sets, Gramm-Schmidt orthonormalization process, Projections.	10	15
Second Internal Examination			
V	Matrix rank, Solving linear system of equations using matrices, LDU factorization, QR decomposition, Least square approach.	5	20
	Eigen values, Eigen vectors and spectrum, Diagonalizability, Orthogonal diagonalization.	4	
VI	Properties of Eigen values and Eigen vectors of Hermitian matrices, Normal matrices, Unitary matrices.	4	20
	Multi-resolution analysis and Wavelets.	5	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6103	**RANDOM PROCESSES AND APPLICATIONS**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in Probability Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives

(1) To impose in-depth knowledge in probability theory.
(2) To throw light into the applications of probability and random processes.

Syllabus

Review of Set Theory, Random experiment, Sample space, Cumulative Distribution Function, Probability Density Function, conditional distribution, Expectation, moments, correlation and covariance, Random Vector, Convergence - Markov and Chebyshev inequalities, convergence in probability, convergence in mean square, Weak law of large numbers, strong law of large numbers, Central Limit Theorem for sequences of independent random variables, Random process, IID process, Poisson counting process, Markov process, Wiener process. Stationarity, power spectral density, Discrete time Markov chains, conditional independence, DTMC, Recurrence analysis, Chapman-Kolmogov theorem, Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge in probability theory;
(2) Know how the theory of probability and random processes could be applied in specific domains

References

1. A. Papoulis and S. UnnikrishnaPillai. *Probability, Random Variables and Stochastic Processes,* TMH
2. B. Hajek, *An Exploration of Random Processes for Engineers*, 2005.
3. D.P. Bertsekas and J. N. Tsitsiklis, *Introduction to Probability*, 2000.
4. Gray, R. M. and Davisson L. D., *An Introduction to Statistical Signal Processing.* Cambridge University Press, 2004.
5. Stark Henry, *Probability and Random Processes With Application to Signal Processing,* 3/e, Pearson Education India.
6. Steven Kay, *Intuitive probability and random processes using MATLAB*, Springer, 2006.
6. Dr. Kishor S. Trivedi. *Probability and Statistics with Reliability, Queuing, and Computer Science Applications,* John Wiley and Sons, New York, 2001.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Set Theory - Set operations, functions, countable and uncountable sets, Random experiment, Sample space, Sigma algebra, Event space, Measure, Probability measure, Borel sigma field	4	15
	Cumulative Distribution Function (CDF), Probability Density Function (PDF), PMF, Joint CDF, Joint PDF, conditional distribution.	5	
II	Expectation - Fundamental Theorem of expectation, moments, characteristic function, correlation and covariance	4	15
	Random Vector - Definition, Joint statistics, Covariance and correlation matrix, Gaussian random vectors.	4	
First Internal Examination			
III	Convergence - Markov and Chebyshev inequalities, Convergence of sequences of random variables- almost sure convergence, convergence in probability, convergence in mean square, Weak law of large numbers, Random sums, Borel Cantelli lemma, strong law of large numbers, Central Limit Theorem for sequences of independent random variables.	8	15
IV	Random process - Definition of Random process, IID process, Poisson	8	15

	counting process, Markov process, birth-death process, Wiener process. Stationarity, Correlation functions of random processes in linear systems, power spectral density.		
Second Internal Examination			
V	Discrete time Markov chains - conditional independence, DTMC, Recurrence analysis, Foster's Theorem, Chapman-Kolmogov theorem, Stopping time.	6	20
VI	classification of states: absorbing, recurrent, transient. Communicating classes, Continuous time Markov chains, Poisson process, simple Markovian queues.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6105	**ADVANCED DIGITAL SIGNAL PROCESSING**	**3 - 0 - 0 - 3**	**2015**

Course Prerequisites

(1) Basic knowledge in signals and systems at UG level;
(2) Basic knowledge in transforms at UG level.

Course Objectives

(1) To attain a good analytical ability in digital filter design;
(2) To investigate the applications of digital signal processing.

Syllabus

Review of transforms, Z-Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT), LTI systems as frequency selective filters, Invertibility of LTI systems, Design of digital filters by placement of poles and zeros, FIR filter structures, IIR filter structures, Design of FIR filters, Linear Phase Systems, Window method, Frequency sampling method, Finite word length effects, Design of IIR filters, Pole zero placement, Impulse invariance, Bilinear Z transformation, Finite word length effects, Adaptive Digital Filters, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Power Spectrum Estimation, Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.

Expected Outcomes

The students are expected to :
(1) Attain a good analytical ability in digital filter design;
(2) Know various applications of digital signal processing.

References

1. Proakis and Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications,* 4/e, Pearson Education.
2. Ifeachor and Jervis, *Digital Signal Processing, A practical Approach,* 2/e, Pearson Education.
3. Johnny R. Johnson, *Introduction to Digital Signal Processing,* PHI, 1992.
4. Ashok Ambardar, *Digital Signal Processing: A Modern Introduction,* Thomson, IE, 2007.
5. Douglas F. Elliott*, Handbook of Digital Signal Processing- Engineering Application,* Academic Press.
6. Robert J. Schilling and Sandra L. Harris, *Fundamentals of Digital Signal Processing using MATLAB,* Thomson, 2005.
7. Ingle and J. G. Proakis, *Digital Signal Processing Using MATLAB,* Thomson, 1/e.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Review of transforms** : Z-Transform, ROC, Poles & Zeros, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), DFT as a linear transformation, Frequency analysis of signals and systems using DFT, Discrete Cosine Transform (DCT), Short Time Fourier Transform (STFT).	4	15
	LTI systems as filters : Invertibility of LTI systems, Minimum phase, Maximum phase and mixed phase systems, All-pass filters, Design of digital filters by placement of poles and zeros, Linear filtering methods based on DFT.	5	
II	**Digital Filter Structures** : Generalized input-output relationship, IIR Transfer Function, FIR Transfer Function, Signal Flow Graphs, FIR filter structures, Direct Form-I, Direct Form-II, Frequency Sampling, Cascade, Lattice, IIR filter structures, Direct Form-I, Transposed, Direct Form-II, Canonical, Parallel, Cascade, Lattice-Ladder structures.	6	15

First Internal Examination			
III	**Design of FIR filters** : Linear Phase Systems, Specifications, Coefficient calculation methods, Desired impulse responses, Window method, Frequency sampling method, Comparison of methods, Filter realization, Finite word length effects, Implementation examples, FIR filter design using Octave/ MATLAB.	8	15
IV	**Design of IIR filters** : Specifications, Coefficient calculation method, Pole zero placement, Transformation rules, Impulse invariance, Bilinear Z transformation (BZT), Buttorworth and Chebyschev approximations, Filter realization, Finite word length effects, Implementation examples, IIR filter design using Octave/ MATLAB.	8	15
Second Internal Examination			
V	**Adaptive Digital Filters** : Concepts, Wiener filter, LMS adaptive algorithm, Recursive least squares algorithm, Lattice Ladder filters, Application of Adaptive filters.	6	20
VI	**Power Spectrum Estimation** : Estimation of spectra from finite-duration signals, Non-parametric and Parametric methods for Power Spectrum Estimation.	5	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EC6107	**ADVANCED DIGITAL COMMUNICATION**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of Digital Communication at UG Level.

Course Objectives

The course is designed to provide students a strong background in Modern Digital communication techniques emphasizing on Optimized Detection, Security and Bandwidth efficiency.

Syllabus

Introduction to Signal Space, Complex envelop representation of band pass signal, Digital modulation techniques, Optimum receiver structures for AWGN channel, , Band limited channel, ISI, Pulse shaping, Adaptive Equalization techniques, Code Division Multiple Access, Random Access techniques, ALOHA protocols, CSMA. Multicarrier modulation, OFDM

Expected Outcomes

The students are expected to understand modern digital communication technologies and acquire design capabilities for the future needs.

References

1. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems,Pearson Education, 2005.
2. S. Haykins, Communication Systems, 5th ed., John wiley, 2008.
3. Andrea Goldsmith, Wireless Communications, Cambridge University press.
4. S. Benedetto and E. Biglieri, Principles of Digital Transmission with Wireless Applications, Kluwer Academic/Plenum Publishers, 1999.
5. 1. Viterbi, A. J. and J. K. Omura. Principles of Digital Communication and Coding. NY: McGraw-Hill, 1979.
6. Marvin K Simon, Sami M Hinedi, William C Lindsey - Digital Communication Techniques – Signal Design & Detection, PHI
7. MIT OpenCourseWare, Electrical Engineering and Computer Science,Principles of Digital Communication II, Spring 2006
8. Aazhang B. Digital Communication Systems [Connexions Web site]. January 22, 2004. available at: http://cnx.rice.edu/content/col10134/1.3/

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to Signal Space:** Concepts of basis, norm, inner product, signal constellation diagram. M-ary orthogonal signals.-Gram Schmidt Ortho normalization Procedure. Representations of Band pass signals: Complex baseband representation of signals. Representation Band pass Stationary Stochastic Signals.	6	15
II	**Digital Modulation Techniques:** Carrier modulation (M-ary ASK, PSK, FSK, DPSK). Continuous phase modulation (QPSK and variants, MSK, GMSK).	5	15
	First Internal Examination		
III	**Optimum Receivers for additive white Gaussian noise channels:** Correlation receiver. Matched filter receiver. Maximum Likelihood sequence detector. Performance characteristics of detectors.	6	15
IV	**Optimum Receiver for Signals with random phase in AWGN Channels**: Optimum receiver for Binary Signals- Optimum receiver for M-ary orthogonal signals- Optimum waveform receiver for coloured Gaussian noise channels- Karhunen Loeve expansion approach-whitening.	7	15
	Second Internal Examination		
V	**Band limited Channel:** Inter Symbol Interference (ISI).Pulse Shape designing -Nyquist Pulse, Raised Cosine Pulse.	4	20
	Adaptive Equalization: Adaptive Linear Equalizers—Zero forcing algorithm, LMS algorithm. Adaptive Decision feedback equalizers-adaptive equalization of trellis coded signal. Blind Equalizer based on maximum likelihood criterion.	5	
VI	**Multiple Access techniques:** Code Division Multiple Access –CDMA signal and Channel Model-The optimum receivers-sub optimum receivers.	3	20
	Random access methods: ALOHA system and protocols. Carrier Sense Multiple Access.	3	
	Multi Carrier Modulation: Orthogonal Frequency Division Multiplexing(OFDM), Discrete implementation of OFDM	3	
	Cluster Level End Semester Examination		

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6109	SEMINAR - 1	0 - 0 - 2 - 2	2015

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;

(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;

(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :

(1) Be motivated in reading which enhances the literature review required for doing project work;

(2) Develop skills regarding professional communication and technical report writing.
References 1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005 2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989 3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6111	**DIGITAL SIGNAL PROCESSING LABORATORY**	**0 - 0 - 2 - 1**	**2015**

Course Prerequisites
(1) Knowledge in Digital Signal Processing at UG level;
(2) Programming ability in Octave/MATLAB and knowledge about DSP kits like TMS320C6X or AD.

Course Objectives
(1) To have a thorough understanding of Digital Signal Processing through software programming;
(2) To investigate Digital Signal Processing through DSP Kits like TMS320C6X or AD.

Experiments

1. Review of MATLAB Programming Practice
2. Low-pass FIR filter using Hamming Window
3. High-pass FIR filter using Hamming Window
4. Low-pass IIR filter using Butterworth Approximation
5. High-pass IIR filter using Butterworth Approximation
6. Convolution and Correlation of sequences
7. Laplace Transform and Z-Transform using MATLAB Symbolic Toolbox
8. Normal Density Estimation
9. Wiener Filter for 1-D Signals
10. Two Channel Quadrature Mirror Filter Bank
11. Wiener Filter for Images with Defocus Blur
12. Wiener Filter for Images with Motion Blur
13. Introduction to C-based embedded design using Code Composer Studio (CCS) and the TI6713 DSK
14. Familiarization of creating, building, and testing some simple projects in the CCS integrated development environment (IDE)
15. Implementation of DFT, FFT programs using CCS
16. Implementation of real-time FIR filtering on the TMS320C6713 with CCS using C
17. Implementation of real-time IIR filtering on the TMS320C6713 with CCS using C.
18. Interfacing of multimedia data to the 6713 DSK

Expected Outcomes

The students are expected to :

(1) Attain a thorough understanding of Digital Signal Processing through software programming;

(2) Develop skills for programming and doing real time DSP using kits like TMS320C6X or AD.

References

1. E. S. Gopi, *Algorithm Collections for Digital Signal Processing Applications using MATLAB*, Springer, 2007.
2. Vinay K. Ingle and John. G. Proakis, *Digital Signal Processing Using MATLAB*, PWS Publishing Company, 1997.
3. Gerard Blanchet and Maurice Charbit*, Digital Signal and Image Processing using MATLAB,* ISTE Ltd, 2006
4. Paul M. Embree, *C Algorithms for Real-time DSP*, Prentice Hall PTR, 1995.

Course plan

Item	Description	Time	
1	Octave/MATLAB based Experiments	4 Weeks	
2	CCS and TMS kits based Experiments	4 Weeks	
3	Preparation of Laboratory Record	2 Weeks	
4	Internal Examination	2 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction

10EC6401	MULTIRATE SIGNAL PROCESSING	3 - 0 - 0 - 3	2015

Course Prerequisites

(1) Digital Signal Processing
(2) Digital Filters

Course Objectives

(1) To have an advanced level knowledge on Multirate systems
(2) To Apply the mutirate signal processing techniques to the systems which are working in different rates.

Syllabus

Fundamentals of Multirate Theory The sampling theorem Basic Multirate operations- Maximally decimated filter M-channel perfect reconstruction filter banks Polyphase representation- perfect reconstruction systems Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Quantization Effects filter banksCosine Modulated filter banks Polyphase structure-PR Systems

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge on Multirate Signal Processing;
(2) Know how the theory of Multirate Signal Processing could be applied in specific domains, like Multi-rate systems.

References

1. P.P. Vaidyanathan. “Multirate systems and filter banks.” Prentice Hall. PTR. 1993.
2. N.J. Fliege. “Multirate digital signal processing .” John Wiley 1994.
3. Sanjit K. Mitra. “ Digital Signal Processing: A computer based approach.” McGraw Hill. 1998.
4. R.E. Crochiere. L. R. “Multirate Digital Signal Processing”, Prentice Hall. Inc.1983.
5. J.G. Proakis. D.G. Manolakis. “Digital Signal Processing: Principles. Algorithms and Applications”, 3rd Edn. Prentice Hall India, 1999.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	The sampling theorem - sampling at sub nyquist rate - Basic Formulations and schemes.	5	15
	Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation	6	
II	Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank	6	15
First Internal Examination			
III	M-channel perfect reconstruction filter banks -Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems	6	15
IV	**Perfect reconstruction (PR) filter banks**	7	15

	Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property-		
Second Internal Examination			
V	Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.	6	20
VI	**Cosine Modulated filter banks** Cosine Modulated pseudo QMF Bank- Alas cancellation- phase -Phase distortion- Closed form expression- Polyphase structure-PR Systems	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6113	DSP PROCESSORS AND ARCHITECTURE	3 - 0 - 0 3	2015

Course Prerequisites

Basic knowledge in DSP and microprocessors at UG level

Course Objectives

To have an in depth knowledge in DSP at processor level

Syllabus

Review of Pipelined RISC Architecture and Instruction Set Design- Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks. Basic Pipeline: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch). Instruction Level Parallelism (ILP): Concepts, Dynamic Scheduling -Dynamic Hardware Prediction- Limitations of ILP. Review of Memory Hierarchy: Cache design, Cache Performance Issues & Improving Techniques. Computer arithmetic- Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System (LNS, RNS). Index Multiplier – Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic (DA), CORDIC Algorithm and architecture. Case studies: TMS 320 C 6X Processor –sample program. Overview of Blackfin processor

Expected Outcomes

Students are expected to

1.Understand pipelining hazards, resolving techniques

2.Understand DSP processors and will be able to develop programs for DSP

References

1. J. L. Hennesy and D. A. Patterson, *Computer Architecture A Quantitative Approach,* 3/e, Elsivier India, Chapter 1, Appendix A, Chapter 3, Chapter 5.
2. U. Mayer-Baese, Digital Signal Processing with FPGAs, Springer, 2001.
3. RulphChassaing, Digital signal Processing and Applications with the C6713 and C6416 DSK – Wiley Interscience.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Pipelined RISC Architecture and Instruction Set Design.	5	15
	Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks.	2	
II	**Basic Pipeline**: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch)- structural hazards-data hazards-control hazards-branch prediction	6	15
First Internal Examination			
III	**Instruction Level Parallelism (ILP):** Concepts, Dynamic	4	15

	Scheduling – Tomasulo's algorithm -Reducing Data hazards		
	Dynamic Hardware Prediction - Reducing Branch Hazards. Multiple Issue-Hardware-based speculation	4	
	Limitations of ILP	1	
IV	**Review of Memory Hierarchy:** Cache design	3	15
	Cache Performance Issues & Improving Techniques	4	
Second Internal Examination			
V	**Computer arithmetic:** Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System(LNS, RNS)	3	20
	Index Multiplier –Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic(DA), CORDIC Algorithm and architecture .	3	
VI	**Case studies:** Introduction to TMS 320 C 6X Processor – Architecture – Functional units - pipelining –Registers	3	20
	Linear and Circular addressing modes –Types of instructions – sample program,	3	
	Overview of BlackFin processor	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10EC6115	**RADIO FREQUENCY INTEGRATED CIRCUITS**	**3-0-0- 3**	**2015**

Course Prerequisites

Basic knowledge of demand for a course on the present technology for Telecommunicationsat UG/PG Level.

Course Objectives

The course is designed to provide students a strong background in the concept of microwave engineering fundamental, basic concepts of passive and active circuits, antennas and numerical electromagnetic techniques.

Syllabus

Introduction to Microstrip Lines, MEMS technologies and components for RF applications, Non-Reciprocal Components and Active Devices for MICs, Different types of microwave components, antennas, tubes, transistors, diodes, and parametric devices, Introduction to wireless systems, Waveguide implementations,

Expected Outcomes

The students are expected to apply the general principles of RFICs include radar and communications, although it might be applied to any integrated electrical circuit operating in a frequency range suitable for wireless transmission.

References

1. D. M. Pozar, *Microwave and RF wireless Systems.*S. K. Duggal, Earthquake Resistant Design of Structures, Oxford University Press, New Delhi.
2. T. H. Lee*, The design of CMOS Radio Frequency Integrated Circuits.*Murthy C. V. R, "Earthquake tips, Building Materials and Technology Promotion Council", New Delhi, India
3. V. K. Varadan, K. J. Vinoy, K. A. Jose.*, RF MEMS and their Applications.*Masonry Buildings", John Wiley and sons Inc.
4. Hoffman R.K, "Handbook of Microwave Integrated Circuits", Artech House,Boston,1987.
5. Gupta.K.C and Amarjit Singh, "Microwave Integrated Circuits" John Wiley, New York, 1975.
6. K.C Gupta, Ramesh Garg, InderBahl and PrakashBhartia, 'Microstrip lines and slot lines", second edition, Artech House, London
7. Terence Charles Edwards, "Foundations For Microstrip Circuit Design", Wiley, 1981
8. Jia-Sheng Hong, M. J. Lancaster, "Microstrip filters for RF/microwave applications", John Wiley and Sons, 2001

Module	Content	Hours	Semester Exam Marks (%)

I	**Microstrip Lines :**Introduction, types of MICs and their technology, Microstrip field configuration, analysis of microstrip line by conformal transformation,	4	15
	Introduction to microstrip discontinuities, equivalent circuits (open ends, gap in microstrip, steps in width, bends & T junction) and compensation techniques. losses in microstrip, introduction to slot line and coplanar wave guide	4	
II	**MEMS technologies and components for RF applications:** RF MEMS switches, varactors, inductors and filters. Introduction to microwave antennas, definitions and basic principles	4	15
	Power Amplifier design-Various classes of power amplifiers, oscillators, linear oscillators, tuned oscillators, negative resistance oscillator system aspects in wireless trans-receiver design.	4	
First Internal Examination			
III	**Non-Reciprocal Components and Active Devices for MICs:** Ferromagnetic substrates and inserts, microstrip circulators, phase shifters, microwave transistors, parametric diodes and amplifiers, PIN diodes, transferred electron devices,IMPATT, BARITT, avalanche diodes, microwave transistors circuits.	4	15
IV	Introduction to wireless systems,personal communication systems,high frequency effects in circuits and systems.Review of transmission line theory,terminated transmission lines,Smith chart, impedance matching,microstrip and coplanar waveguide implementations, microwave network analysis, ABCD parameters, S parameters	4	15
Second Internal Examination			
V	**Coupled Microstrip Circuit, Couplers and Lumped Elements for MICs**: Introduction to coupled microstrip, even and odd mode analysis, directional couplers, branch line couplers,	4	20
	Design and fabrication of lumped elements for MICs, comparison with distributed circuits, MICs in satellite and radar	5	
VI	Basics of high frequency amplifier design, device technologies, biasing techniques ,	3	20
	Simultaneous tuning of 2 port circuits, noise and distortion.	3	
	Feedback systems, phase locked loops, LNA design, designs based on impedance match	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6117	WIRELESS COMMUNICATION I	3 - 0 - 0 - 3	2015

Course Prerequisites

(1) Basic knowledge in Digital Communication Techniques
(2) Basic knowledge in wireless channels

Course Objectives

To provide the knowledge of wireless communication systems to the students from basic to advance level, so that they can have successful career in their respective professional fields and other related engineering fields

Syllabus

Overview of wireless communication systems, Current wireless systems in detail, Wireless spectrum standards, Wireless Channels, properties, models and challenges ,Statistical Multipath Channels- Time varying channel impulse response, Narrowband fading models, Wideband fading Models, Coding for wireless channels, Capacity of wireless channels in AWGN, Fading Channels, Diversity, Receiver diversity, Transmitter Diversity, channel equalization techniques.

Expected Outcomes

The students are expected to :

(1) identify, formulate, analyze and solve engineering problems related to wireless communication systems.
(2) technically assess and review the research work related to wireless communication engineering.
(3) design and conduct experimental and/or analytical work in their respective professional field using modern mathematical as well as scientific methods.

References

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press (2005).
2. Tse, David and Viswanath, Pramod, Fundamentals of Wireless *Communication*, Cambridge University Press (2006).

3. Simon Haykin and Michael Moher, *Modern Wireless Communications*, Pearson Education.
4. Kamilo Feher, *Wireless digital communication*, PHI.
5. Rappaport, *Wireless Communications*, Pearson Education (2007) 2nd ed.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Current wireless systems: Cellular Telephone Systems, Wireless LANs, Broadband Wireless access, Paging Systems, Satellite Networks, Bluetooth, Ultra wideband, Spectrum Allocations for Systems, Cellular System Fundamentals, Channel Reuse, SIR and User Capacity, Dynamic Channel Assignment, Shannon Capacity of Cellular Systems, Area Spectral Efficiency.	6	15
II	Path Loss and Shadowing: Radio Wave Propagation, Free-Space Path Loss, Ray Tracing, Two-Ray Model, Ten-Ray Model (Dielectric Canyon), General Ray Tracing, Okumura Model, Hata Model, Indoor Attenuation.	6	15
First Internal Examination			
III	Statistical Multipath Channel Models: Time-Varying Channel Impulse Response, Narrow band Fading Models- Autocorrelation, Cross correlation and power spectral density, Wideband Fading Models- Power delay profile, Coherence bandwidth, Doppler power spectrum and channel coherence time.	7	15
IV	Coding for wireless channels: Linear Block codes, Convolution codes, Turbo Codes, LDPC codes, Interleaving for Fading channels, Unequal error protection codes. (Questions preferably in analytic nature)	7	15
Second Internal Examination			
V	Capacity of Wireless Channels- Analysis: Capacity in AWGN, Capacity of Flat-Fading Channels, Channel and System Model, Channel Distribution Information (CDI) Known, Channel Side Information at Receiver, Channel Side Information at Transmitter and Receiver, Capacity with Receiver Diversity, Capacity Comparisons, Capacity of Frequency-Selective Fading Channels- Time invariant channels, Time varying channels. (Questions preferably in analytic nature)	8	20
VI	Diversity-Receiver Diversity, System Model, Combining techniques Transmitter Diversity, Channel Known and unknown at Transmitter, Non-coherent and Differentially Coherent Modulation.	4	20
	Equalization-Types, Linear Equalizers-ZF, MMSE, Maximum likelihood sequence estimation, Decision feedback equalizer, Adaptive equalizers.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6119	TRANSFORM THOERY	3 - 0 - 0 - 3	2015

Course Prerequisites

(1) Basic knowledge in transforms at UG level;

(2) Basic knowledge in digital signal processing at UG level.

Course Objectives

(1) To attain a thorough knowledge in various transforms used in signal processing;

(2) To apply transforms in various fields like coding, compression, etc.

Syllabus

Introduction on the integral and discrete transforms and their applications, Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Relations between the transforms, Short Term Fourier Transform (STFT), Heisenbergs uncertainty principle, Continuous wavelet transform (CWT), Hilbert Transforms, Radon Transform, Abel Transform, Sine transform, Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform, Discrete Transforms and Applictions, Discrete Cosine transform

and applications in JPEG, Discrete STFT (DSTFT), Discrete Wavelet Transform (DWT), lifting, Applications, image compression (JPEG 2000), Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).
Expected Outcomes The students are expected to : 1. Attain a sound knowledge in various transforms like Lapalce transform, Z-transform, Fourier transforms, Wavelet transform, DCT, etc. 2. Apply these transforms in different areas line image compression, coding etc. 3. Understand new transforms like CTT and WBCT.
References 1. Alexander D. Poularikas, *The Transforms and Applications Handbook*, Second Edition, CRC Press. 2. Abdul Jerri, *Integral and Discrete transforms with applications and error analysis*, Marcel Dekker Inc. 3. Lokenath Debnath, Dambaru Bhatta, *Integral Transforms and Their Applications*, Taylor & Francis Inc.

Course plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility-basis – Requirements of transforms- (Linear algebraic approach) - Review of Laplace Transform, Z transform,	7	15
II	Review of Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms- Integral Transforms: Short Term Fourier Transform (STFT) – Limitations of STFT -Heisenbergs uncertainty principle - Continuous wavelet transform (CWT) - Hilbert Transforms	7	15
First Internal Examination			
III	Radon Transform, Abel Transform, Sine transform,,Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform	7	15
IV	Discrete Transforms and Applications : Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Application of DSTFT in audio signal processing, Discrete Wavelet Transform (DWT), lifting applied to DWT	7	15
Second Internal Examination			
V	Applications of DWT in audio signal processing, image compression (JPEG 2000), At least one application of each transform in one dimensional, Two-dimensional or Three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking, steganography, denoising, signal separation, signal classification), Limitations of DWT in image processing	6	20
VI	New Transforms and Applications : Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).	8	20
Cluster Level End Semester Examination			

<table>
<tr><th>Course No.</th><th>Course Name</th><th>L - T - P - Credits</th><th>Year of Introduction</th></tr>
<tr><td>10GN6001</td><td>RESEARCH METHODOLOGY</td><td>0 - 2 - 0 - 2</td><td>2015</td></tr>
<tr><td colspan="4">Course Prerequisites
(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.</td></tr>
<tr><td colspan="4">Course Objectives
(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.</td></tr>
</table>

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :

(1) Be motivated for research through the attainment of a perspective of research methodology;

(2) Analyze and evaluate research works and to formulate a research problem to pursue research;

(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15

First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

KERALA TECHNOLOGICAL UNIVERSITY

Cluster No.10 for PG Programs

(Engineering Colleges in Kannur, Wayand & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Electronics & Communication Engineering

M. Tech.

in

Digital Electronics

(Total credits: 65)

FIRST SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC6101	Linear Algebra	3	1	-	40	3	60	4
B	10EC6201	High Speed Digital Design	3	-	-	40	3	60	3
C	10EC6203	CMOS VLSI Design	3	-	-	40	3	60	3
D	10EC6205	Advanced Embedded Processers	3	-	-	40	3	60	3
E	10EC6XXX	Elective-I	3	-	-	40	3	60	3
	10GN6001	Research Methodology	-	2	-	100	-	0	2
	10EC6209	Seminar-1	-	-	2	100	-	0	2
	10EC6211	Embedded systems and DSP Lab	-	-	3	100	-	0	1
	TOTAL		**15**	**3**	**5**	**500**		**300**	**21**

ELECTIVE-I

10EC6113 DSP Processors and Architecture

10EC6119 Transform Theory

10EC6213 Wireless and ATM networks

10EC6401 Multi-rate Signal Processing

10EC6503 Signal Compression

SECOND SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semeste Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC6202	Advanced Digital System Design	3	-	-	40	3	60	3
B	10EC6204	Digital System Design Using VHDL	3	-	-	40	3	60	3
C	10EC6206	Synthesis and Optimization of Digital circuits	3	-	-	40	3	60	3
D	10EC6XXX	Elective-II	3	-	-	40	3	60	3
E	10EC6XXX	Elective-III	3	-	-	40	3	60	3
	10EC6208	Mini Project	-	-	4	100	-	0	2
	10EC6212	VHDL based FPGA Lab	-	-	3	100	-	0	1
	TOTAL		**15**	**0**	**7**	**400**		**300**	**18**

ELECTIVE II & III

10EC6102 Digital Image Processing

10EC6114 Biomedical Signal Processing

10EC6118 Statistical Signal Processing

10EC6214 Advanced Computer Architecture

10EC6216 Low Power VLSI Design

10EC6218 VLSI System Design

10EC6302 Wavelet Theory

10EC6404 Adaptive Signal Processing

THIRD SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
A	10EC7XXX	Elective-IV	3	-	-	40	3	60	3
B	10EC7XXX	Elective-V	3	-	-	40	3	60	3
	10EC7201	Seminar-2	-	-	2	100	-	0	2
	10EC7203	Project - Phase 1	-	-	12	50	-	0	6
	TOTAL		**6**	**-**	**14**	**230**		**120**	**14**

ELECTIVE-IV & V

10EC7105	Audio Processing	10EC7209	Embedded Networks
10EC7113	Pattern Recognition	10EC7211	Digital circuits and Logic Design
10EC7205	Biometric Processing	10EC7213	Introduction to Nanoelctronics
10EC7207	Micro Electro Mechanical Systems	10EC7215	ASIC Design

FOURTH SEMESTER

Exam Slot	Code	Subject	Hours/Week			Internal Marks	End Semester Examination		Credit
			L	T	P		Hrs	Marks	
	10EC7204	Project - Phase 2	-	-	23	70	1	30	12
	TOTAL		**-**	**-**	**23**	**70**		**30**	**12**

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6101	**LINEAR ALGEBRA**	**3 - 1 - 0 4**	**2015**

Course Prerequisites

(1) Basic knowledge in Matrix Theory at UG level
(2) Basic knowledge in Set Theory at UG level

Course Objectives

(1) To have an advanced level knowledge in linear algebra
(2) To throw light into the applications of linear algebra, like Multi-resolution analysis, Wavelets etc.

Syllabus

Sets, Functions, Groups, Rings, Fields, Vector spaces, Subspaces, Linear Transformations, Rank-nullity theorem, Isomorphism, Matrix representation of Linear Transformations, Linear functional, Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Banach space, L^p space and l^p space, Inner product space, Hilbert space, Signal space, Gramm-Schmidt orthonormalization process, Matrix rank, Solving linear system of equations using matrices, Eigen values, Eigen vectors and spectrum, Diagonalizability, Normal matrices, Unitary matrices, Multi-resolution analysis and wavelets.

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge in linear algebra;
(2) Know how the theory of linear algebra could be applied in specific domains, like Multi-resolution analysis, Wavelets etc.

References

1. Hoffman Kenneth and Kunze Ray, *Linear Algebra,* Prentice Hall of India.
2. Strang G, *Linear Algebra and its Applications*, 3rd edition, Saunders, 1988.
3. Erwin Kreyzig, *Introductory Functional Analysis with Applications*, John Wiley, 2006.
4. G.F.Simmons, *Topology and Modern Analysis* , McGraw Hill.
5. Frazier, Michael W., *An Introduction to Wavelets through Linear Algebra,* Springer Publications.
6. Jin Ho Kwak & Sungpyo Hong, *Linear Algebra*, Springer International, 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Sets, Functions, Cardinality of sets, Groups, Rings, Fields.	4	15
	Vector spaces, Subspaces, Basis and dimension, Finite and infinite dimensional vector spaces.	4	
II	Linear Transformations, Sum, product and inverse of Linear Transformations, Rank-nullity theorem, Isomorphism.	5	15
	Matrix representation of Linear Transformations, Four fundamental subspaces of Linear Transformations, Change of bases, Linear functional.	5	
First Internal Examination			

III	Metric space, Open sets, Closed sets, Neighborhoods, Sequences, Convergence, Completeness, Continuous mappings, Normed space, Banach space, L^p space and l^p space.	10	15
IV	Inner product space, Hilbert space, Signal space, Properties of inner product space, Orthogonal compliments and direct sums, Orthonormal sets, Gramm-Schmidt orthonormalization process, Projections.	10	15
Second Internal Examination			
V	Matrix rank, Solving linear system of equations using matrices, LDU factorization, QR decomposition, Least square approach.	5	20
	Eigen values, Eigen vectors and spectrum, Diagonalizability, Orthogonal diagonalization.	4	
VI	Properties of Eigen values and Eigen vectors of Hermitian matrices, Normal matrices, Unitary matrices.	4	20
	Multi-resolution analysis and Wavelets.	5	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6201	HIGH SPEED DIGITAL DESIGN	3 - 0 - 0 3	2015

Course Prerequisites

1. Basic knowledge in Digital Electronics and Electromagnetic waves and transmission lines.

Course Objectives

1. To attain good analytical skills in digital integrated circuit.
2. To identify sources affecting the speed of digital circuits.
3. To introduce methods to improve the signal transmission characteristics

Syllabus

High Speed Digital Design: Fundamentals: Frequency and time, Time and distance, Lumped versus distributed systems, High Speed properties of Logic gates: Power, Input power, drive circuit dissipation, speed, packaging. Measurement Techniques, Infinite Uniform transmission line, Termination: End , Source , middle terminators, Power system: Stable voltage reference, choosing a bypass capacitor. Clock Distribution: Timing margin, Clock skew delay adjustments, Differential distribution.

Expected Outcomes

The students are able to:

- Understand the properties and fundamental limitations of high speed electronic systems.
- Quantitatively model and analyze high speed electronic systems and interconnect in both the digital and analogue design.
- Conduct basic test procedures for high speed signals and systems.

References

1. Howard Johnson & Martin Graham; High Speed Digital Design: A Handbook of Black Magic, Prentice Hall PTR, 1993.
2. William S. Dally & John W. Poulton, Digital Systems Engineering, Cambridge University Press, 1998.
3. Masakazu Shoji; High Speed Digital Circuits, Addison Wesley Publishing Company, 1996.
4. Jan M, Rabaey; Digital Integrated Circuits: A Design perspective, Second Edition, 2003.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**High Speed Digital Design**: Fundamentals: Frequency and time, Time and distance,	4	15
	Lumped versus distributed systems, four kinds of reactance- ordinary capacitance and inductance, mutual capacitance and inductance, Relation of mutual capacitance and mutual inductance to cross talk.	4	
II	**High Speed properties of Logic gates**: Power, Quiescent vs active dissipation, Active power driving a capacitive load, Input power,	4	15
	Internal dissipation, drive circuit dissipation: Totem pole, Emitter follower, open collector, current source, Speed, Packaging.	4	

First Internal Examination			
III	**Measurement Techniques:** Rise time and bandwidth of oscilloscope probes, self inductance of probe ground loop, spurious signal pick up from probe ground loops, special probing fixtures, Avoiding pickup from probe shield currents, slowing down of a system clock, observing metastable states.	8	15
IV	**Transmission Lines**: Problems of point to point wiring, signal distortion, EMI, cross talk.	4	15
	Infinite Uniform transmission line; ideal distortion less lossless transmission line, RC transmission line, Skin effect, Proximity effect, Dielectric loss. Effects of source and load impedance.	4	
Second Internal Examination			
V	**Termination**: End terminator, Source terminators, middle terminators, AC biasing for end terminators, Resistor selection, Cross talk in terminators.	6	20
VI	**Power system**: Stable voltage reference, Uniform voltage distribution, distribution problems, choosing a bypass capacitor.	3	20
	Clock Distribution: Timing margin, Clock skew, Using low impedance drivers, using low impedance distribution lines, delay adjustments, Differential distribution, Clock signal duty cycle, Decoupling clock receivers from the clock bus.	4	
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P Credits	Year of Introduction
10EC6203	CMOS VLSI DESIGN	3-0-0 3	2015

Course Prerequisites

1. Basic knowledge about Microelectronics technology at UG level

Course Objectives

1. To have an advanced knowledge about design and fabrication of CMOS ICs.

Syllabus

MOS Transistor Theory, CMOS Processing Technology, CMOS Circuit Characteristics, Performance Estimation, Circuit and Logic Design, Subsystem Design

Expected Outcomes

The student who takes this course is expected to develop competence to design CMOS circuits for any functionality using different logic structures.

References

1. Neil.H.E. Weste and K.Eshragian, *Principles of CMOS VLSI Design*, 2nd Edition. Addison Wesley, 2000.
2. Douglas A. Pucknell and K.Eshragian, *Basic VLSI Design*, 3rd Edition. PHI, 2000.
3. R. Jacob Baker, Harry W. LI., & David K. Boyce., *CMOS Circuit Design*, 3rd Indian reprint, PHI,2000.
4. John P.Uyemura*, Introduction to VLSI circuits and Systems*, John Wiley and sons, 2010.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**MOS Transistor Theory:** Introduction to I.C Technology. Basic MOS transistors. Threshold Voltage. Body effect. Basic D.C. Equations. Second order effects. MOS models. Small signal A.C characteristics. The complementary CMOS inverter. DC characteristics. Static Load MOS inverters. The differential inverters. Transmission gate. VLSI Design flow.	7	15
II	**CMOS Processing Technology:** Silicon semiconductor technology. Wafer processing, Oxidation, epitaxy, deposition, Ion implantation. CMOS technology. nwell, pwell process, Twin tub processes. Silicon on insulator. CMOS process enhancement. Interconnect and circuit elements. Stick diagrams and Layout diagram, Layout design rules, Latch up in CMOS circuits	8	15
First Internal Examination			
III	**CMOS Circuit Characteristics:** Resistance estimation. Capacitance estimation. MOS capacitor characteristics. Device capacitances. Diffusion capacitance. SPICE modeling of MOS capacitance. Routing capacitance. Distributed RC effects. Inductance.	7	15
IV	**Performance Estimation:** Switching characteristics. Rise time. Fall time. Delay time. Empirical delay models. Gate delays. CMOS gate	6	15

	transistor sizing. Power dissipation, Design margining. Scaling of MOS transistor dimensions.		
Second Internal Examination			
V	**Circuit and Logic Design:** CMOS Logic gate design. Fan in and fan out. Typical CMOS NAND and NOR delays. Transistor sizing. CMOS logic structures. Complementary logic, BICMOS logic, Pseudo NMOS logic, Dynamic CMOS logic, Clocked CMOS logic, Pass transistor logic, CMOS domino logic. NP domino logic, Cascade voltage switch logic, Source follower pull up Logic (SFPL), Clocking strategies, I/O structures	8	20
VI	**Subsystem Design:** Data path operations. Addition/subtraction, Parity generators, Comparators, Zero/one detectors, Binary Counters, ALUs, Multiplication, Array, Radix -n, Wallace Tree and Serial Multiplication, Shifters. Memory elements, RWM, Rom, Content Addressable Memory, Control: FSM, PLA Control Implementation	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6205	**ADVANCED EMBEDDED PROCESSORS**	**3-0-0 3**	**2015**

Course Prerequisites

(1) Basic knowledge in digital electronics at UG level;
(2) Basic knowledge in microprocessors at UG level.

Course Objectives

(1) To attain a thorough knowledge in embedded processors;
(2) To develop skills in designing complex systems using different processor architectures.

Syllabus

Introduction to Embedded systems - Embedded system examples, Parts of Embedded System, Typical Processor architecture, Simple interfacing examples, Memory Technologies, Introduction to PIC microcontrollers, CPU architecture, Serial EEPROM, PWM, Analog to digital converter, UART, SPI, ARM architecture, ARM organization and Implementation, Memory Hierarchy, Assembly Language Programming, High- Level Language Programming, System Development using ARM, Digital Signal Processing on ARM, Peripheral Programming and system design for a specific ARM processor, Embedded System product Development, Embedded System product Development Life cycle (EDLC), Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly, Product enclosure design and development, Concept of firmware, operating system and application programs, Power supply Design, External Interfaces, Embedded System Development Environment, IDE, Cross compilation, Simulators/Emulators, Hardware Debugging, Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc., Bus architecture like I^2C, SPI, AMBA, CAN etc.

Expected Outcomes

The students are expected to :
(1) Attain a thorough knowledge in embedded processors;
(2) Develop skills in designing complex systems using different processor architectures.

References

1. Shibu K.V. *Introduction to Embedded Systems*, Tata McGraw Hill, 2009.
2. Tim, *Design with PIC microcontrollers*, John B Peatman Pearson Education Asia, 2002.
3. Van Ess, Currie and Doboli, *Laboratory Manual for Introduction to Mixed-Signal, Embedded Design*, Alphagraphics, USA.
4. Steve Furber, *ARM System-on-chip Architecture***,** Second Edition Pearson Education, 2007.
5. William Hohl, *ARM Assembly Language Programming*, CRC Press, 2009.
6. Andrew Sloss, Dominic Symes, Christ Wright, *ARM System Developer's guide – Designing and optimizing software,* Elseiver Publishers, 2008.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to Embedded systems**: Embedded system examples, Parts of Embedded System, Typical Processor architecture, Power supply, clock, memory interface, interrupt, I/O ports, Buffers,	8	15

	Programmable Devices, ASIC, etc. Simple interfacing examples, Memory Technologies, EPROM, Flash, OTP, SRAM, DRAM, SDRAM etc.		
II	**Introduction to PIC microcontrollers**: CPU architecture, registers, memory, instruction sets, addressing modes, timers, Interrupts, I/O, I 2C Bus Operation, Serial EEPROM, PWM, Analog to digital converter, UART, SPI.	8	15
First Internal Examination			
III	**ARM architecture**: ARM organization and Implementation, Memory Hierarchy, ARM Instruction Set and Thumb Instruction set, Assembly Language Programming, High- Level Language Programming, System Development using ARM, Digital Signal Processing on ARM, Peripheral Programming and system design for a specific ARM processor (ARM7/9).	8	15
IV	**Embedded System product Development**: Embedded System product Development Life cycle (EDLC), Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly.	6	15
Second Internal Examination			
V	**Product enclosure design and development**: Concept of firmware, operating system and application programs, Power supply Design, External Interfaces.	6	20
VI	**Embedded System Development Environment**: IDE, Cross compilation, Simulators/Emulators, Hardware Debugging. Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc., Bus architecture like I^2C, SPI, AMBA, CAN etc.	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P Credits	Year of Introduction
10EC6401	MULTIRATE SIGNAL PROCESSING	3 - 0 - 0 3	2015

Course Prerequisites

1. Digital Signal Processing
2. Digital Filters

Course Objectives

1. To have an advanced level knowledge on Multirate systems
2. To apply the mutirate signal processing techniques to the systems which are working in different rates.

Syllabus

Fundamentals of Multirate Theory The sampling theorem Basic Multirate operations- Maximally decimated filter M-channel perfect reconstruction filter banks Polyphase representation- perfect reconstruction systems Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Quantization Effects filter banksCosine Modulated filter banks Polyphase structure- PR Systems

Expected Outcomes

The students are expected to :
(1) Have an advanced level knowledge on Multirate Signal Processing;
(2) Know how the theory of Multirate Signal Processing could be applied in specific domains, like Multi-rate systems.

References

1. P.P. Vaidyanathan. "Multirate systems and filter banks." Prentice Hall. PTR. 1993.
2. N.J. Fliege. "Multirate digital signal processing" John Wiley 1994.
3. Sanjit K. Mitra, " Digital Signal Processing: A computer based approach." McGraw Hill. 1998.
4. R.E. Crochiere. L. R. "Multirate Digital Signal Processing", Prentice Hall. Inc.1983.
5. J.G. Proakis. D.G. Manolakis. "Digital Signal Processing: Principles. Algorithms and Applications", 3rd Edn. Prentice Hall India, 1999.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	The sampling theorem - sampling at sub nyquist rate - Basic Formulations and schemes.	5	15
	Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation	6	
II	Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank	6	15
First Internal Examination			
III	M-channel perfect reconstruction filter banks -Uniform band and non	6	15

	uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems		
IV	**Perfect reconstruction (PR) filter banks** Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property-	7	15
Second Internal Examination			
V	Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.	6	20
VI	**Cosine Modulated filter banks** Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase distortion- Closed form expression- Polyphase structure- PR Systems	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6113	DSP PROCESSORS AND ARCHITECTURE	3 - 0 - 0 3	2015

Course Prerequisites

1. Basic knowledge in DSP and microprocessors at UG level

Course Objectives

1. To have an in depth knowledge in DSP at processor level

Syllabus

Review of Pipelined RISC Architecture and Instruction Set Design- Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks. Basic Pipeline: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch). Instruction Level Parallelism (ILP): Concepts, Dynamic Scheduling -Dynamic Hardware Prediction- Limitations of ILP. Review of Memory Hierarchy: Cache design, Cache Performance Issues & Improving Techniques. Computer arithmetic- Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System (LNS, RNS). Index Multiplier –Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic (DA), CORDIC Algorithm and architecture. Case studies: TMS 320 C 6X Processor –sample program. Overview of Blackfin processor

Expected Outcomes

Students are expected to

1.Understand pipelining hazards, resolving techniques

2.Understand DSP processors and will be able to develop programs for DSP

References

1. J. L. Hennesy and D. A. Patterson, *Computer Architecture A Quantitative Approach,* 3/e, Elsivier India, Chapter 1, Appendix A, Chapter 3, Chapter 5.
2. U. Mayer-Baese, Digital Signal Processing with FPGAs, Springer, 2001.
3. Rulph Chassaing, Digital signal Processing and Applications with the C6713 and C6416 DSK – Wiley Interscience.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Pipelined RISC Architecture and Instruction Set Design.	5	15
	Performance and Benchmarks - SPEC CPU 2000, EEMBC DSP benchmarks.	2	
II	**Basic Pipeline**: Implementation Details - Pipeline Hazards (based on MIPS 4000 arch)- structural hazards-data hazards-control hazards-branch prediction	6	15
First Internal Examination			

III	**Instruction Level Parallelism (ILP):** Concepts, Dynamic Scheduling – Tomasulo's algorithm -Reducing Data hazards	4	15
	Dynamic Hardware Prediction - Reducing Branch Hazards. Multiple Issue-Hardware-based speculation	4	
	Limitations of ILP	1	
IV	**Review of Memory Hierarchy:** Cache design	3	15
	Cache Performance Issues & Improving Techniques	4	
Second Internal Examination			
V	**Computer arithmetic:** Signed Digit Numbers (SD) - Multiplier Adder Graph - Logarithmic and Residue Number System(LNS, RNS)	3	20
	Index Multiplier –Architecture for Pipelined Adder, Modulo Adder & Distributed Arithmetic(DA), CORDIC Algorithm and architecture .	3	
VI	**Case studies:** Introduction to TMS 320 C 6X Processor – Architecture – Functional units - pipelining –Registers	3	20
	Linear and Circular addressing modes –Types of instructions – sample program,	3	
	Overview of BlackFin processor	3	
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6213	WIRELESS AND ATM NETWORKS	3 - 0 - 0 3	2015

Course Prerequisites

1. Basic knowledge in wireless communication and networking.

Course Objectives

1. To impart knowledge about the wireless communication principles and fundamentals
2. To equip the students with various kinds of wireless networks and its operations
3. To know about various generations of wireless networks

Syllabus

PCS Architecture: Cellular telephony, Cordless telephony and low tier PCS, Third and Fourth generation wireless systems, channel assignment, hard Handoff soft handoff, IS-41 Signaling, Handoff and Authentication: CDPD architecture, Roaming management, GSM architecture, International Roaming for GSM, GSM on the net, The iGSM wireless VoIP solution, GPRS Functional Groups, Wireless Geolocation system architecture: Geolocation standards for E-911 Services, Introduction to wireless LANS: IEEE 802.11 WLANs, the PHY layer and MAC sub-layers, Wireless ATM and HIPERLAN, IEEE 802.15 WPAN, Third Generation Mobile services: W-CDMA and CDMA 2000: QOS in 3G, paging network architectures, wireless local loop architectures, Bluetooth-Bluetooth core Protocols.

Expected Outcomes

An ability to understand the basic functioning of Wireless transmission ,telecommunication Systems, , wireless LAN, ATM and medium access control.

References

1. Yi-Bing Lin, Imrich Chlamtac, Wireless and mobile network architectures, John Wiley, 2001
2. Kaveh Pablavan, P. Krishnamurthy, Principles of wireless networks, Pearson education, 2002
3. P. Venkataram, S. S. Manvi, B. P. Vijaykumar, WLANs: Architectures, Protocols and Applications, Pearson education (In Press), 2005
4. Marlyn Mallick, Mobile and wireless design essentials, Wiley, 2003

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**PCS Architecture:** Cellular telephony-AMPS,GSM, EIA/TIA IS-136, EIA/TIA IS-95 Digital cellular system, Cordless telephony and low tier PCS -CT2,DECT,PHS,PACS, Third and Fourth generation wireless systems.	3	15
	Mobility Management: Handoff, roaming management under SS & roaming management for CT2, handoff Detection, strategies for handoff detection, channel assignment, link transfer types, hard Handoff soft handoff.	5	
II	**IS-41 Signaling, Handoff and Authentication:** CDPD architecture,	4	15

	CDPD air Interface, radio resource allocation, Roaming management.		
	GSM architecture: Location tracking, data services, HSCPD, GPRS, GSM network signaling, GSM mobility management, GSM short message service, International Roaming for GSM.	5	
First Internal Examination			
III	**VoIP for GSM networks:** GSM on the net, The iGSM wireless VoIP solution, The iGSM procedures and message flows, Implementation issues.	5	15
	GPRS Functional Groups: Architecture, network nodes, interfaces, procedures, billing, evolving from GSM to GPRS,WAP protocols	5	
IV	**Wireless geolocation system architecture:** Geolocation standards for E-911 Services, performance measures	5	15
Second Internal Examination			
V	**Introduction to wireless LANS:** IEEE 802.11 WLANs, the PHY layer and MAC sub-layers, Wireless ATM and HIPERLAN, IEEE 802.15 WPAN, Bluetooth, interference between Bluetooth and 802.11	6	20
VI	**Third Generation Mobile services:** W-CDMA and CDMA 2000: QOS in 3G, paging network architectures, wireless local loop architectures, Bluetooth-Bluetooth core Protocols.	5	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P Credits	Year of Introduction
10EC6503	SIGNAL COMPRESSION	3 - 0 - 0 3	2015

Course Prerequisites

1. Basic knowledge of signals and systems

Course Objectives

1. To have knowledge on different signal compression techniques

Syllabus

Review of Information Theory, Quantization, Data Compression, Data compression, Speech and Audio Compression techniques, Image Compression and Video Compression

Expected Outcomes

The students are expected to have thorough knowledge about various compression techniques in different domains.

References

1. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann Publishers., Second Edn. 2005.
2. David Salomon, *Data Compression: The Complete Reference*, Springer Publications, 4th Edn. 2006.
3. K.R.Rao, P.C.Yip, *The Transform and Data Compression Handbook*, CRC Press. 2001.
4. R.G.Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, Inc., 1968.
5. Ali N. Akansu, Richard A. Haddad, *Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets*, Academic Press., 1992
6. Martin Vetterli, JelenaKovacevic, *Wavelets and Subband Coding*, Prentice Hall Inc., 1995.
7. N. Jayant and P. Noll, *Digital Coding of Waveforms: Principles and Applications to Speech and Video*, Prentice Hall, USA, 1984.
8. Z. Li and M.S. Drew, *Fundamentals of Multimedia*, Pearson Education (Asia) Pte. Ltd., 2004.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Review of Information Theory, Compression Techniques, Lossless and Lossy Compression, Huffman Coding, its variants, Optimality, Arithmetic Coding and its variants, Run Length Coding, Dictionary Techniques , Lempel-Ziv coding, Predictive Coding, Burrows Wheeler Transform, Dynamic Markov Compression. Golomb codes, Rice codes, Tunstall codes, Facsimile encoding	8	15
II	Quantization, Uniform & Non-uniform, optimal and adaptive quantization, vector quantization, structures for VQ, Optimality	6	15

	conditions for VQ, Predictive Coding , Differential Encoding		
First Internal Examination			
III	Image compression: Predictive techniques, DM, PCM, DPCM: Optimal Predictors and Optimal Quantization, Contour based compression, Transform Coding, JPEG Standard, Sub-band coding algorithms: Design of Filter banks, Wavelet based compression, EZW, SPIHT, JPEG 2000 standards, JBIG, JBIG2, JPEG-LS, CALIC.	10	15
IV	Audio compression techniques, Standards for audio compression in multimedia applications, MPEG audio encoding and decoding, Dolby AC-3 standard.	6	15
Second Internal Examination			
V	Speech compression techniques, Vocoders, Speech compression - quality measures, waveform coding, source coders, Speech compression standards for personal communication systems	8	20
VI	Video compression techniques and standards, Motion estimation and compensation techniques, H.261, Dolby AC-3.	4	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6119	**TRANSFORM THEORY**	**3 - 0 - 0 3**	**2015**

Course Prerequisites

(1) Basic knowledge in transforms at UG level.
(2) Basic knowledge in digital signal processing at UG level.

Course Objectives

(1) To attain a thorough knowledge in various transforms used in signal processing;
(2) To apply transforms in various fields like coding, compression, etc.

Syllabus

Introduction on the integral and discrete transforms and their applications, Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Relations between the transforms, Short Term Fourier Transform (STFT), Heisenbergs uncertainty principle, Continuous wavelet transform (CWT), Hilbert Transforms, Radon Transform, Abel Transform, Sine transform, Cosine Transform, The Mellin Transform, Hankel Transform, Hartley Transform, Discrete Transforms and Applictions, Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Discrete Wavelet Transform (DWT), lifting, Applications, image compression (JPEG 2000), Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).

Expected Outcomes

The students are expected to :

1. Attain a sound knowledge in various transforms like Lapalce transform, Z-transform, Fourier transforms, Wavelet transform, DCT, etc.
2. Apply these transforms in different areas line image compression, coding etc.
3. Understand new transforms like CTT and WBCT.

References

1. Alexander D. Poularikas, *The Transforms and Applications Handbook*, Second Edition, CRC Press.
2. Abdul Jerri, *Integral and Discrete transforms with applications and error analysis*, Marcel Dekker Inc.
3. Lokenath Debnath, Dambaru Bhatta, *Integral Transforms and Their Applications*, Taylor & Francis Inc.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility- basis – Requirements of transforms- (Linear algebraic approach) - Review of Laplace Transform, Z transform,	7	15
II	Review of Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms-Integral Transforms: Short Term Fourier Transform (STFT) – Limitations of STFT -Heisenbergs uncertainty principle - Continuous wavelet transform (CWT) - Hilbert Transforms	7	15
First Internal Examination			
III	Radon Transform, Abel Transform, Sine transform,,Cosine Transform, The Mellin Transform, Hankel Transform, Hartley	7	15

	Transform		
IV	Discrete Transforms and Applications : Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Application of DSTFT in audio signal processing, Discrete Wavelet Transform (DWT), lifting applied to DWT	7	15
Second Internal Examination			
V	Applications of DWT in audio signal processing, image compression (JPEG 2000), At least one application of each transform in one dimensional, Two-dimensional or Three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking, steganography, denoising, signal separation, signal classification), Limitations of DWT in image processing	6	20
VI	New Transforms and Applications : Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT such as wavelet Based Contourlet Transform (WBCT).	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To attain a perspective of the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.

17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles, laboratory experiment, experimental designs, ex post facto research, qualitative research.	5	15
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6209	SEMINAR - 1	0 - 0 – 2 2	2015

Course Prerequisites

1. The habit of reading technical magazines, conference proceedings and journals;
2. Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

1. To enhance the reading ability required for the literature review regarding the project work;
2. To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :

1. Be motivated in reading which enhances the literature review required for doing project work;
2. Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10EC6211	EMBEDDED SYSTEMS LAB	0 - 0 - 3 1	2015

Course Prerequisites

1. Basic knowledge in Digital System Design and Design with Embedded processors.

Course Objectives

1. To attain practical skills in digital/analog system design

Experiments

1. Design with Microcontrollers- PIC Microcontrollers- Assembly and C Programming: I/O Programming, Timers.
2. Interrupts, Serial port programming.
3. PWM Generation, Motor Control, ADC/DAC.
4. LCD and RTC Interfacing, Sensor Interfacing.
5. Design with ARM Processors: I/O programming, ADC/DAC, Timers, Interrupts
6. Study of one type of Real Time Operating Systems (RTOS)
7. Basic Processing – Transforms, Convolution and Correlation using MATLAB and DSP Processor.

Expected Outcomes

The students are expected to :

1. Attain a thorough understanding of design of digital circuits through software programming;
2. Develop skills for interfacing peripheral devices using kits like ARM LPC 2148.

References

1. VI ARM LPC 2148 Manual-VI Microsystems Pvt.Ltd.
2. PIC 16F877 Manual-VI Microsystems Pvt.Ltd.
3. John B Peatman, *Design with PIC Microcontroller*, Pearson Education Asia, 2002.
4. Steve Furber, *ARM System –On-chip Architecture*, Pearson Education, 2nd Edition, 2007.
5. William Hohl, *ARM Assembly Language Programming,*CRC Press, 2009.
6. Web based Resources.

Course plan

Item	Description	Time	
1	PIC 16F877 based Experiments	4 Weeks	
2	ARM LPC 2148 based Experiments	4 Weeks	
3	TMS 320CXXXX based experiments	1 Week	
4	Preparation of Laboratory Record	2 Weeks	
5	Internal Examination	2 Weeks	
6	Publishing Grades	1 Week	