KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*1*
Branch	**:**	*Electronics & Communication*
Stream	**:**	*Micro & Nano Electronics*
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	01MA6035	Mathematical Methods for Nanoelectronics	3-0-0	40	60	3	3
B	01EC6701	Analog CMOS Circuit Design	3-1-0	40	60	3	4
C	01EC6703	Nano Materials and Characterization	3-1-0	40	60	3	4
D	01EC6705	Nanoelectronic Devices and Circuits	3-0-0	40	60	3	3
E		Elective I	3-0-0	40	60	3	3
S	01EC6999	Research Methodology	0-2-0	100			2
T	01EC6791	Seminar I	0-0-2	100			2
U	01EC6793	Device Modeling and Process Simulation Lab	0-0-2	100			1
		TOTAL	**15-4-4**	**500**	**300**	**-**	**22**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 22

Elective I

01EC6711	Physics of Low Dimensional Materials
01EC6713	Process and Device Modeling
01EC6715	Carbon Nanoelectronics

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01EC6702	Digital CMOS Design	3-1-0	40	60	3	4
B	01EC6704	MEMS and NEMS	3-0-0	40	60	3	3
C	01EC6706	Lower Power VLSI Design	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
V	01EC6792	Mini Project	0-0-4	100			2
U	01EC6794	MEMS Lab	0-0-2	100			1
		TOTAL	**15-1-6**	**400**	**300**	**-**	**19**

TOTAL CONTACT HOURS : 22
TOTAL CREDITS : 19

Elective II

01EC6712	CAD for VLSI
01EC6714	Lithographic Techniques and Green Synthesis
01EC6716	Nanophotonics and Plasmonics

Elective III

01EC6122	Design of VLSI Systems
01EC6218	Soft Computing
01EC6322	Optimization Techniques
01EC6726	Societal Implications Of Nanotechnology

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
T	01EC7791	Seminar II	0-0-2	100			2
W	01EC7793	Project (Phase 1)	0-0-12	50			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective IV

01EC7711	RF Microelectronics
01EC7713	Nanomedicine
01EC7715	Nano Bio-Technology

Elective V

01EC7717	Nanosystems For Energy Applications
01EC7719	Instrumental Methods And Analysis
01EC7721	Algorithms For VLSI Design Automation

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credit
					Marks	Duration (hours)	
W	01EC7794	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: 67

SEMESTER – I

Syllabus and Course Plan

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

01MA6035
Mathematical Methods for Nanoelectronics
3-0-0
3
2016

Course Objectives

1. To provide a foundation of linear algebra, Partial Differential Equations and Numerical Methods.

Syllabus

Vector space, Linear Transformation, Inner Product space, Cauchy Problems for First Order Partial differential Equations, Classification of Second Order Partial Differential Equations, Canonical forms, interpolation, Numerical Solutions of System of linear equations and ODE, Numerical Integration, Numerical solutions of Partial Differential Equations.

Expected Outcome

1. On completion of the course the student will be capable of using the mathematical principles and methods learned for analyzing and solving problems related to micro and nanoelectronics

References

1. Richard Bronson , Costa; Linear Algebra, 2/e, Elsevier
2. Prem K Kythe,Puri, Schaferkotter; Partial Differential Equations and Boundary Value Problems with Mathematica, 2/e, Chapman & Hall/CRC
3. Sankara Rao, Introduction to PDE, 2/e, PHI
4. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, Wiley

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

Vector space(Rn, Mp*n, Pn), Subspaces, Linear independence, Basis, Dimension, Coordinates of a vector, Linear transformation, Matrix representation of Linear Transformation. (results without proof)

Text 1 : 2.1,2.2,2.3,2.4,3.2,3.3

7

15

II

Euclidean Inner Product, Orthogonality, Gram-Schmidt Orthonormalization, QR algorithm, Computing eigen values using QR Algorithm.(results without proof)

Text 1: 5.1, 5.2, 5.3.

7

15

FIRST INTERNAL EXAM

III

Cauchy's Problems for First order: linear PDE with constant coefficients and variable coefficients, Quasi-linear PDE, Nonlinear PDE.

Text 2: 2.1, 2.2, 2.3, 2.4

7

15

IV

Classification of Second Order Partial Differential Equations, Canonical forms, Solutions using canonical forms. (results without proof)

Text 3: 1.1, 1.2, 1.3

7

15

SECOND INTERNAL EXAM

V

Interpolation: Lagrange method, Numerical integration: Trapezoidal and Simpson's 1/3 rd rule, Numerical solution of Linear system of equations: Gauss Elimination, Gauss- Seidel, Numerical solution of Ist order ODE: Euler's Method, Classical Runga-Kutta Method of 4^{th} order.

(Relevant portions of sections

Text 4: 19.3, 19.5, 20.1, 20.3, 21.1)

7

20

VI

Numerical solution of : Laplace Equation by Liebman's Method, Heat Equation by Crank- Nicolson Method, Wave Equation.

(Relevent portions of sections

Text 4: 21.4, 21.6, 21.7

7

20

END SEMESTER EXAM

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

01EC6701
Analog CMOS Circuit Design
3-1-0
4
2015

Course Objectives

1. To provide an overview of frequency analysis
2. To enable the students to use small signal MOSFET model
3. To familiarize the students with To give ideas about the basic amplifiers, current Mirrors and Differential Amplifiers
4. To equip the students to work with frequency compensation methods.
5. To familiarize the students toAnalog CMOS circuits for Signal processing application.

Syllabus

Sub-micron MOS Transistor, Small signal parameters for MOSFET, Differential Amplifier, OPAMP Performance Metrics, Comparator, Sense Amplifier, DAC, ADC.

Expected Outcome

1. After the course the student will be capable to Design, analyze, and develop Analog circuits .

References

1. Phillip E. Allen, Douglas R. Holbery, ”CMOS Analog Circuit Design” , Oxford, 2004
2. Razavi B., ” Design of Analog CMOS Integrated Circuits”, Mc G Hill, 2001.
3. Baker, Li, Boyce, ”CMOS: Circuits Design, Layout and Simulation”, Prentice Hall India, 2000

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

The Sub-micron MOS Transistor for Analog Design, Small signal parameters for MOSFET Cut-off frequency, Concept of Poles and Zeros, Miller approximation

9

15

II

Small signal analysis of Amplifiers- Common source, Common gate, Source follower. Cascode Current Mirror-Cascode Current Mirror, Wilson Current Mirror, Regulated Cascode BandgapVoltage Reference

9

15

FIRST INTERNAL EXAM

III

Differential Amplifier, Gilbert Cell, Design of 2 stage CMOS OPAMP Differential to Single ended conversion, DC and AC response Frequency Compensation, Pole Splitting, Zero Cancellation

9

15

IV

OPAMP Performance Metrics-Slew rate, CMRR, Offset, Noise, output stage OTA and OPAMP circuits sample and hold, Switched Capacitor Circuits.

10

15

SECOND INTERNAL EXAM

V

Comparator, Sense Amplifier- Voltage SA, Current SA, Latch typeSA, Gain bandwidth analysis Impact of mismatch on Analog design Offset effects in Sense Amplifier

10

20

VI

DAC, ADC – High speed ADC, Over sampling ADC..

9

20

END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6703	Nano Materials and Characterization	**3-1-0**	**4**	**2016**

Course Objectives

1. Appreciate the methods of synthesis of various nanomaterials
2. Identify the various methods of material growth and deposition
3. Understand the equipment used in characterization of nanomaterials.

Syllabus

Synthesis of Nanomaterials- synthesis of oxide nanoparticles: mechanical, physical and chemical methods, Deposition techniques of Nanomaterials: Lithographic process and its limitations. Non lithographic techniques, Etching of Nanostructures, Progressive etching techniques, Characterization tools of Nanomaterials: STM, AFM, TEM, SNOM. Structure of nanomaterials, X-Ray Diffraction (XRD), X-Ray absorption method, Raman Spectroscopy, X-Ray Photoelectron spectroscopy (XPS), NMR and EPR spectroscopy, SIMS, AES

Expected Outcome

1. Understand the synthesis methods of various nanomaterials
2. Understand the principles of fabrication and characterization of nanomaterials

References

1. W. R. Fahrner, Nanotechnology and Nanoelectronics, Springer International Edition, 2004.
2. V.S. Muralidharan, A.Subramania, Nanoscience &Technology, Ane Books Pvt Ltd., 2009
3. T. Pradeep, NANO: The Essentials,Tata McGraw Hill Education Private Limited, 2007
4. Hans H. Gatzen, Volker Saile, Micro & Nano Fabrication, Springer-Verlag, Heidelberg, 2015
5. D. K. Schroder, Semiconductor Material and Device Characterization, Wiley-Interscience, New York, 1990.
6. Sami. Fransilla, Introduction to Micro fabrication, John Wiley & Sons Limited,2004
7. Charles P. Poole Jr., Frank J. Owens, Introduction to Nanotechnology, John Wiley& Sons Pvt. Ltd., 2007

COURSE PLAN

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

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Nanoclusters, nanoclusters on polymers, nanocluster organization, Inorganic nanotubes and nanowires: properties and applications, Metallic nanorods, Nanostructured ordered/disordered materials, organic nano crystals, nanofibers :biomedical applications	8	15
II	Synthesis of metal colloids, Synthesis of nanoclusters : Laser induced evaporation,Laser methods,Polymer nanoparticle synthesis,Synthesis of nanotubes and nanowires: VLS growth of nanowires. Synthesis of nanorods. Template based synthesis, Solvo thermal synthesis, Synthesis of nanocrystalline materials: synthesis of silver nanocrystals and semiconductor nanaoparticles, synthesis of oxide nanoparticles: mechanical, physical and chemical methods.	12	15
FIRST INTERNAL EXAM			
III	Deposition techniques of Nanomaterials:Thermal PVD, Molecular Beam epitaxy (MBE), Pulsed Laser deposition (PLD), Plasma /Arc Physical Vapour deposition, Physics of Sputtering, Ion Beam Deposition (IBD), CVD, PECVD, Laser induced CVD, Activated Reactive evaporation, Sol-Gel Process, Electrophoretic Deposition	9	15
IV	CVD, LPCVD examples (SiO2, Si3N4, Poly-Si, Silicon epitaxy).; MOCVD, examples: dielectrics, epitaxy.; PECVD.; ALD Etching of Nanostructures, Progressive etching techniques, Lithographic procedures: Optical lithography- contact and non-contact exposure, XRL, Scanning probe based lithography: AFM lithography, Laser lithography, Ion beam lithography, Nanoimprint lithography (NIL),	9	15
SECOND INTERNAL EXAM			
V	Characterization tools of Nanomaterials: Scanning Probe Microscopy: Scanning Tunneling Microscope(STM), Atomic force microscopy(AFM), Electron spectroscopy: Scanning Electron Microscopy, Transmission Electron Microscopy(TEM), Optical Microscopy: Confocal Microscopy, SNOM	9	20
VI	Characterization of nanomaterials, structure of nanomaterials, X-Ray Diffraction (XRD): Powder method and Rotating crystal method, X-Ray absorption method, Infrared and Raman Spectroscopy, X-Ray Photoelectron spectroscopy (XPS), Ultraviolet Photoelectron Spectroscopy(UPS), NMR and EPR spectroscopy, Secondary Ion Mass Spectrometry (SIMS), Auger electron spectroscopy(AES)	9	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6705	Nanoelectronic Devices and Circuits	**3-0-0**	**3**	**2016**

Course Objectives

1. To introduce the basic semiconductor physics and working of the MOSFETs, band bending theory to follow scaling of device, carbon nanotubes, functionalized carbon nanotubes in field effect transistor, carbon nanotube device and single electron devices

Syllabus

MOS capacitors,Metal-Silicon Contacts, High-Field Effects, Small MOSFETs, Practical CMOS scaling, Resonant Tunneling Transistors, FinFETs, new storage, optoelectronic, and spintronics devices, Carbon nanotube electronics, Resonant Tunneling Transistors, FinFET, Hysteresis and device passivation, Single-Electron Memory, Single-Electron Transistor (SET).

Expected Outcome

1. To investigate the use of carbon nanotubes as active components .
2. To explore the working of SWNT and its characteristics .
3. Understand single electron devices

References

1. Fundamentals of VLSI devices, Taur and Ning., Cambridge University Pres
2. WaserRanier, Nanoelectronics and Information Technology (Advanced Electronic Materials and NovelDevices), Wiley-VCH (2003).
3. Silicon nano electronics Edited by ShunriOda, David Ferry Taylor & Francis Group, LLC
4. R. Saito and M. S. Drbselmus, Physical properties of Carbon Nanotubes, Imperial College Press.
5. Francois Leonard, The Physics of Carbon Nanotube Devices, William Andrew Inc.

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester Examination
I	MOS Capacitors -Surface Potential: Accumulation, Depletion, and Inversion Electrostatic Potential and Charge Distribution in Silicon Capacitances in a MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, Metal-Silicon Contacts-static Characteristics of a Schottky Barrier Diode, Current Transport in a Schottky Barrier DiodeCurrent-Voltage Characteristics of a Schottky Barrier Diode, Ohmic Contacts	8	15
II	High-Field Effects- Impact Ionization and Avalanche Breakdown, Band-to-Band Tunnelling, Tunnelling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown Short-Channel MOSFETs- Short-Channel Effect, Velocity Saturation and High-Field Transport, Channel Length Modulation, Source-Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields	7	15
FIRST INTERNAL EXAM			
III	Practical CMOS scaling : Constant-Field Scaling , Generalized Scaling Nonscaling Effects, direct source drain tunneling, Quantum effects and influences in nanodevices. Threshold Voltage-Threshold Voltage Requirement, Channel Profile Design, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage	8	15
IV	One-Dimensional Theory, Quantum Behaviour, quantum dot single electron devices, Resonant Tunneling Transistors, Carbon nanotube electronics- Schottky barrier heights of metal S/D contacts – High k-gate dielectric integration.	7	15
SECOND INTERNAL EXAM			
V	Quantum capacitance, Metal-contacted MOSFETs - SWNT MOSFETs - SWNT band-to-band tunneling FETs .Single-Electron Memory ,	6	20
VI	Single-Electron Devices, Operating Principle of Single-Electron Memory, Silicon Single-Electron Memory ,Single Electron Memory Array, Single Electron Transistor (SET), Logic Circuit Applications of SETs	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6711	Physics of Low Dimensional	**3-0-0**	**3**	**2015**

Cluster: *1* Branch: *Electronics & Communication* Stream: *Micro & Nano Electronics*

	Materials			

Course Objectives

1. To get Fundamental idea of Quantum mechanics Quantum wells and low dimensional device physics

Syllabus

Particles and waves, time-independent Schrödinger equation, spin two particle systems, bosons ,fermions, Quantum mechanics in crystalline material, , Bloch theorem, Quantum wells and low dimensional systems.

Expected Outcome

1. Able to understand, theory of working of nanodevices

References

1. 1.Griffiths, Introduction to Quantum Mechanics, Prentice Hall 1995.
2. David A. B. Miller Quantum Mechanics for Scientists and Engineers, Cambridge University Press
3. John H. Davies ,'The Physics of Low-Dimensional Semiconductors An Introduction, Glasgow University, Cambridge University Press

	COURSE PLAN		
Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Particles and waves, time-independent Schrödinger equation, states and operators, particle-in-a-box, density-of-states	7	15
II	Harmonic oscillator, Schrödinger equation in 3 dimensions hydrogen atom (derivation not required)	6	15
FIRST INTERNAL EXAM			
III	Angular momentum , spin two particle systems, bosons ,fermions, time independent perturbation theory ,WKB approximation ,tunneling, time dependent perturbation theory, two-level systems	7	15
IV	Quantum mechanics in crystalline material :one electron approximation, Bloch theorem (derivation not required) ,Density of states in k-space ,Band structure ,Effective mass theory ,Density of states in energy .	8	15
SECOND INTERNAL EXAM			
V	Densities of states in quantum wells ,Electrons and phonons in a crystal	6	20
VI	Quantum wells and low dimensional systems : square well, parabolic well, triangular well, two and three dimensional potential wells	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6713	Process and Device Modeling	**3-0-0**	**3**	**2016**

Course Objectives

1. Starting from the basic process design of CMOS to the device modelling are covered.

Syllabus

Diffusion in silicon, MOSFET device structure, MOSFET Scaling, MOSFET circuit models, MOSFET DC Model, Dynamic Model. Model Parameter Extraction, SPICE Diode and MOSFET Models, Statistical Modelling and Worst-Case Design Parameters

Expected outcome

1. The student will be capable of designing CMOS circuits at back end process

References

1. N. Arora, MOSFET Models for VLSI Circuit Simulation Theory and Practice,
2. Paolo Antognetti, Dimitri A. Ajroniadis :Process and Device Simulation for MOS-VLSICircuits
3. Mark S. Lundstrom: NanoscaleTransistors Device Physics, Modeling and Simulation

COURSE PLAN			
Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Diffusion in silicon : self diffusion , impurity diffusion ,modeling Thermal oxidation : oxidation kinetics, oxide charges, Ion implantation ,Implantation profiles, annealing types, Modelling of poly Si crystal structures	7	15
II	MOSFET device structure, MOSFET Scaling , Hot-Carrier Effects VLSI Device Structures , MOSFET Parasitic Elements ,MOSFET circuit models, Threshold Voltage Variations with Device Length and Width , Temperature Dependence of the Threshold voltage	6	15
FIRST INTERNAL EXAM			
III	MOSFET DC Model: Pao-Sah Model, Charge-Sheet Model ,Piece-Wise Drain Current Model for Enhancement Devices, Drain Current Model for Depletion Devices, Short-Geometry Models	6	15
IV	Dynamic Model :Meyer Model Charge-Based Capacitance Model , Long-Channel Charge Model , Short-Channel Charge Model , Small-Signal Model Parameters, Modeling Hot-Carrier Effects	7	15
SECOND INTERNAL EXAM			
V	Model Parameter Extraction Using Optimization method- Model Parameter Extraction, Basics Definitions in Optimization, Optimization Methods, Constrained Optimization, Multiple Response Optimization, Parameter Extraction Using Optimizer, Drain Current Model Parameter Extraction, MOSFET AC Model Parameter Extraction	8	20
VI	SPICE Diode and MOSFET Models- Diode Model MOSFET Level 1 Model, DC Model Capacitance Model, MOSFET Level 4 Model, DC Model, Capacitance Model Statistical Modelling and Worst-Case Design Parameters -Methods of Generating Worst Case Parameters, Model Parameter Sensitivity, Principal Factor Method, Statistical Analysis with Parameter Correlation, Principal Component Analysis,	8	20
END SEMESTER EXAM			

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

01EC6715	Carbon Nanoelectronics	**3-0-0**	**3**	**2015**

Course Objectives

1. To provide the structural and electronic properties of carbon nanotubes, as well as the device structures and operation. It also deals with the incorporation of functionalized carbon nanotubes in field effect transistor, carbon nanotube device modeling and circuit simulation.

Syllabus

Carbon nanotube field-effect transistors- Chemical doping- Metal-contaced MOSFETs – SWNT MOSFETs- AC RESPONSE AND DEVICE SIMULATION OF SWNT FET- Assessing the AC response of Top gated SWNT FETs- Device simulation of SWNT FETs- carbon nanotube device modeling and circuit simulation- Applications of the SWNT- Carbon nanotube interconnects – Applications.

Expected outcome

1. To investigate the use of carbon nanotubes as active components in organic electronic devices

References

1. Ali Javey and Jing Kong, ―Carbon Nanotube Electronics‖ Springer Science media, (2009).
2. Michael J. O'Connell, ―Carbon nanotubes: Properties and Applications‖, CRC/Taylor & Francis, (2006).
3. Francois Leonard, ―The Physics of Carbon Nanotube Devices‖, William Andrew Inc., (2009).
4. R. Saito and M. S. Drbselmus, ―Physical properties of Carbon Nanotubes‖ Imperial College Press, (1998).

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester**
I	Carbon nanotube field-effect transistors-Schottky barrier heights of metal s/d contacts – high k-gate dielectric integration – quantum capacitance	7	15
II	Chemical doping – Hysteresis and device passivation – Near ideal, Metal-contact MOSFETs – SWNT MOSFETs – SWNT band-to-band tunneling FETs.	7	15
FIRST INTERNAL EXAM			
III	Ac response and device simulation of SWNT FETs Assessing the AC response of Top gated SWNT FETs – Power measurement using a spectrum analyzer – Homodyne detection using SWNT FETs – RF characterization using a two tone measurement – AC gain from a SWNT FET common source amplifier	6	15
IV	Device simulation of SWNT FETs – SWNT FET simulation using NEGF – Device characteristics at the Ballistic limit – Role of Phonon scattering – High frequency performance limits – Optoelectronic phenomena	8	15
SECOND INTERNAL EXAM			
V	Carbon nanotube device modeling and circuit simulation-Schottky barrier SWNT-FET modeling – Compact model for circuit simulation – Model of the intrinsic SWNT channel region – Full SWNT-FET model.	7	20
VI	Applications of the SWNT-FET compact model – Performance modeling for carbon nanotube interconnects – Circuit models for SWNTs – Circuit models for SWNT bundles – Circuit models for MWNTs – Carbon nanotube interconnects – Applications.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6999	Research Methodology	**0-2-0**	**2**	**2015**

Course Objectives

1. To prepare the student to do the M. Tech project work with a research bias.
2. To formulate a viable research question.
3. To develop skill in the critical analysis of research articles and reports.
4. To analyze the benefits and drawbacks of different methodologies.
5. To understand how to write a technical paper based on research findings.

Syllabus

Introduction to Research Methodology-Types of research- Ethical issues- Copy right-royalty-Intellectual property rights and patent law-Copyleft- Openacess-
Analysis of sample research papers to understand various aspects of research methodology:
Defining and formulating the research problem-Literature review-Development of working hypothesis-Research design and methods- Data Collection and analysis- Technical writing- Project work on a simple research problem

Approach

Course focuses on students' application of the course content to their unique research interests. The various topics will be addressed through hands on sessions.

Expected outcome

Upon successful completion of this course, students will be able to
1. Understand research concepts in terms of identifying the research problem
2. Propose possible solutions based on research
3. Write a technical paper based on the findings.
4. Get a good exposure to a domain of interest.
5. Get a good domain and experience to pursue future research activities.

References

1. C. R. Kothari, Research Methodology, New Age International, 2004
2. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
3. J. W. Bames, Statistical Analysis for Engineers and Scientists, Tata McGraw-Hill, New York.
4. Donald Cooper, Business Research Methods, Tata McGraw-Hill, New Delhi.
5. Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.
6. Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.
7. Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.
8. Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall ofIndia, New Delhi, 2012.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Introduction to Research Methodology: Motivation towards research - Types of research: Find examples from literature. Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law - Copyleft-Openacess-Reproduction of published material - Plagiarism - Citation and acknowledgement. Impact factor. Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.	4	15
II	Defining and formulating the research problem - Literature Survey-Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.	4	15
FIRST INTERNAL EXAM			
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how different it is from previous works.	4	15
IV	Data Collection and analysis. Analyze the chosen papers and study the methods of data collection used. - Data Processing and Analysis strategies used– Study the tools used for analyzing the data.	4	15
SECOND INTERNAL EXAM			
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes-use of tools like Latex.	6	20

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester**
VI	Identification of a simple research problem – Literature survey- Research design- Methodology –paper writing based on a hypothetical result.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6791	Seminar I	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6793	Device Modeling and Process Simulation Lab	**0-0-2**	**1**	**2015**

Course Objectives

1. Familiarising process and device simulation softwares
2. Familiarising device modelling.

List of Experiments

1. Simulation of process steps for PN junction diode and study of device performance.
2. Study process steps in CMOS .
3. Study the Effects of different process methods of Gate oxide formation and its effects in device
4. Study the Effects of annealing temperature variation process and its effects in device
5. Circuit simulation using device simulator.
6. Simulation of high K -MOSFET.
7. Device model generation using LUT method.
8. BSIM parameter extraction from simulated device.

Expected outcome

1. On completion of the LAB student will be capable doing CMOS device design
2. On completion of the LAB student will get a sound understanding device modeling

SEMESTER - II

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6702	Digital CMOS Design	**3-1-0**	**4**	**2015**

Course Objectives

1. To explore the concepts of digital system design

Syllabus

CMOS Inverter-Static Characteristics- Design of combinational circuits- Design of Flip-Flops in CMOS- Design of counters- Arithmetic System Design- Multiplexers, de-multiplexers, Multiplication circuits.

Expected outcome

1. Understand the concepts of digital circuit design using CMOS at transistor level

References

1. Richard F. Tinder, " Engineering Digital Design", Academic Press2001.
2. William I. Fletcher, "An Engineering Approach to Digital Design", PHI,1996.
3. James E. Palmer, David E. Perlman, "Introduction to Digital Systems", TMH, 1996.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	CMOS Inverter-Static Characteristics, Derivation for V_{TH}, V_{IL} and V_{IH} Switching Characteristics and Calculation of delay times Sequential Logic Circuits.	8	15
II	Different CMOS Flip flops Theory of operation and Circuits of Pass transistor Logic and transmission gate, Design of combinational circuits.	10	15
FIRST INTERNAL EXAM			
III	Design of Flip-Flops in CMOS - D Flip-Flops: General , The D-Latch, The RET D Flip-Flop , The Master-Slave D Flip-Flop , T, JK Flip-Flops.	9	15
IV	The T Flip-Flops and Their Design from D Flip-Flops , The JK Flip-Flops and Their Design from D Flip-Flops , Design of T and D Flip-Flops from JK Flip-Flops , Design of counters.	10	15
SECOND INTERNAL EXAM			
V	Arithmetic System Design – Half-Adder, Full- adder, Carry look-adders, Carry Propagate adders, sub tractors	10	20
VI	Multiplexers, de-multiplexers, Multiplication circuits.	9	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6704	MEMS and NEMS	**3-0-0**	**3**	**2015**

Course Objectives

1. Introduction to the concepts of micro electro mechanical systems.
2. To enable students to learn the principles MEMS fabrication.
3. To impart design principles of micro and nano electro mechanical systems.

Syllabus

Historical Background- Microfabrication and Micromachining- Physical Microsensors-Microactuators- Microactuator systems-Surface Micromachining- Surface Micromachined Systems-Optical MEMS- Advances in NEMS

Expected outcome

1. By the end of the course students will be able to understand, analyze ,design and optimize micro electro mechanical system

References

1. Stephen D. Senturia, "Microsystem Design" by, Kluwer Academic Publishers, 2001 .
2. Marc Madou, “Fundamentals of Microfabrication” by, CRC Press, 1997.Gregory.
3. Kovacs, “Micromachined Transducers Sourcebook” WCB McGraw-Hill, Boston.
4. M.-H. Bao, “Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes” by Elsevier, New York, 2000.
5. Gabriel M. Rebeiz, RF MEMS, Theory, Design, and Technology, Wiley Interscience,2003.

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester
I	Historical Background: Silicon Pressure sensors, Micromachining, MicroElectroMechanical Systems. Microfabrication and Micromachining : Integrated Circuit Processes, Bulk Micromachining : Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA).	7	15
II	Physical Microsensors : Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples : Thermal sensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors	8	15
FIRST INTERNAL EXAM			
III	Microactuators : Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples, microvalves, micropumps, micromotors-Microactuator systems : Success Stories, Ink-Jet printer heads, Micro-mirror TV Projector.	7	15
IV	Surface Micromachining: One or two sacrificial layer processes, Surface micromachining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface MicromachinedSystems : Success Stories, Micromotors, Gear trains, Mechanisms.	6	15
SECOND INTERNAL EXAM			
V	Optical MEMS: Micro opto electro mechanical sensors and systems, fiber optic sensors, Fiberbragg grating, miniature sensors for temperature, pressure, fluid flow applications.	7	20
VI	MEMS for automotive, communication and other applications, sensors, small structure. Introduction to BioMEMS-materiels,sensors,fabrication,application. Advances in NEMS.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6706	Lower Power VLSI Design	**3-0-0**	**3**	**2015**

Course Objectives

1. Introduction to the concepts of low power CMOS design.

Syllabus

Basics of CMOS circuits- Power estimation at different design levels- Approaches for low power design- Low power design at different design levels-Circuit techniques for reducing power in adders and multiplier- Low power interconnect and layout design- Advanced techniques Adiabatic Switching Circuits.

Expected outcome

1. By the end of the course students will be able to understand analyze, design and optimize low power CMOS systems.

References

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgraw Hill.
2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint).
3. A. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995.
4. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.
5. Gary Yeap "Practical Low Power Digital VLSI Design", 1997.
6. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Basics of CMOS circuits ,Sources of Power dissipation Dynamic and Static Power Dissipation, Need for low power VLSI chips Introduction to simulation based power analysis	8	15
II	Power estimation at different design levels ,Probabilistic power analysis Approaches for low power design-Supply Voltage Scaling Approaches Switched Capacitance Minimization Approaches Leakage Power minimization Approaches.	8	15
FIRST INTERNAL EXAM			
III	Low power design at different design levels – Circuit level, logic level, system and architecture level, Low power memory circuits Power optimization for combinational and sequential circuits.	7	15
IV	Software design for low power, Co-design. Circuit techniques for reducing power in adders and multipliers, Case studies.	6	15
SECOND INTERNAL EXAM			
V	Low power interconnect and layout design, Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew.	6	20
VI	Chip and package co-design of clock network Advanced techniques Adiabatic Switching Circuits Battery-aware Synthesis Variation tolerant design, CAD tools for low power synthesis.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6712	CAD for VLSI	**3-0-0**	**3**	**2015**

Course Objectives

1. Understand new theoretical or practical developments and techniques in VLSI design and CAD algorithms.

Syllabus

VLSI physical design automation and Fabrication VLSI Design cycle- layout of basic devices VLSI automation Algorithms Partitioning- Pin assignment- recent trends in placement- Detailed routing problem formulation- Over the cell routing & via minimization.

Expected outcome

1. Familiarity with computer assisted VLSI design process.

References

1. NaveedShervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, Second edition.
2. ChristophnMeinel& Thorsten Theobold, "Algorithm and Data Structures for VLSIDesign", KAP, 2002.
3. Rolf Drechsheler : "Evolutionary Algorithm for VLSI", Second edition.

COURSE PLAN

Module	Contents	otted Hours	% of Marks in End-Semester
I	VLSI physical design automation and Fabrication VLSI Design cycle- New trends in VLSI design- Physical design cycle- Design style- Introduction to fabrication process, design rules- layout of basic devices VLSI automation.	8	15
II	Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing- Floor planning: Problem formulation, classification of floor planning algorithms, constraint based floor planning, floor planning algorithms for mixed block & cell design, chip planning	8	15
FIRST INTERNAL EXAM			
III	Pin assignment, problem formulation, classification of pin assignment algorithms, General & channel pin assignment Placement Problem formulation, classification of placement algorithms, simulation base placement algorithms.	7	15
IV	Recent trends in placement- Global Routing and Detailed routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, performance driven routing.	6	15
SECOND INTERNAL EXAM			
V	Detailed routing problem formulation, classification of routing algorithms, introduction to single layer routing algorithms, two layer channel routing algorithms, greedy channel routing, switchbox routing algorithms.	6	20
VI	Over the cell routing & via minimization: Two layers over the cell routers, constrained & unconstrained via minimization- Compaction: Problem formulation, classification of compaction algorithms, one dimensional compaction, two dimension based compaction, hierarchical compaction.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6714	Lithographic Techniques And Green Synthesis	**3-0-0**	**3**	**2015**

Course Objectives

1. The ultimate aim is to study about lithographical methods of nanostructures fabrication and processing in detail green synthesis.

Syllabus

Material Wave Nanotechnology- Nanometer Lithography Using Organic Positive/Negative Resists-State-Of-The-Art (including principles, capabilities, limits, applications) EUV lithography- Soft Lithography- sustainable green manufacturing- International green manufacturing standards and compliance- Sustainable green manufacturing system design

Expected outcome

1. Understand the key concepts of lithographic and microscopic resolution and apply this knowledge to estimate the intrinsic resolution limits for manipulation and imaging/inspection tools; Redefining the concepts of contrast and a transfer function for all systems and explain their role in both microscopy and lithography.

References

1. Guozhong Cao, Nanostructures &Nanomaterials Synthesis, Properties G; Z: Applications, World Scientific Publishing Private, Ltd., Singapore (2004).
2. W.R.Fahrner, Nanotechnology and Nanoelectronics – Materials, Devices, Measurement Techniques, Springer-Verlag Berlin, Germany (2006).
3. R. H. J. Hannink and A. J. Hill, Nanostructure control of materials, Woodhead Publishing Limited and CRC Press LLC, Cambridge, England (2006).
4. Zheng Cui, Nanofabrication, Principles, Capabilities and Limits, Springer Science + business media, New York (2008)
5. David Dornfeld, Green manufacturing fundamental and applications, Prentice hall.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Material Wave Nanotechnology: Nanofabrication Using a de Broglie Wave-Electron Beam Holography – Atomic Beam Holography- Nanometer Lithography Using Organic Positive/Negative Resists	8	15
II	Sub-10 nm Lithography Using Inorganic Resist – 40 nm-Gate-Length Metal-Oxide-Semiconductor Field-Emitter-Transistors-14 nm Gate-Length.	6	15
FIRST INTERNAL EXAM			
III	State-Of-The-Art (including principles, capabilities, limits, applications) EUV lithography – Phase-shifting photolithography – X-ray lithography – Electron Beam Direct Writing System – Focused ion beam (FIB) lithography	7	15
IV	Neutral atomic beam lithography – Plasma-Aided Nanofabrication – Soft Lithography – Nanosphere Lithography – Nanoimprint – Dip-pen nanolithography – key consequences of adopted techniques	7	15
SECOND INTERNAL EXAM			
V	Introduction - sustainable green manufacturing -green manufacturing sustainability processes, requirements, and risk - The sustainable lean and green audit process. International green manufacturing standards and compliance.	7	20
VI	Green rapid prototyping and rapid manufacturing. Green flexible automation. Green collaboration processes . Alternative energy resources. Globally green manufacturing supply chains and logistic networks. Sustainable green manufacturing system design.	7	20
END SEMESTER EXAM			

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

01EC6716	Nanophotonics And Plasmonics	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce to the students the basic principles of Nanophotonics.

Syllabus

Photons and electrons-.Nanoscale optical interactions- Quantun confinement effects- Internal reflection and evanescent waves- Important features of photonic crystals- Photonic crystal sensing.- Near Field Optics- SNOM based visualization of waveguide structures.

Expected outcome

1. To make the students acquainted with the concepts of Nanophotonics.
2. To describe the effects of quantization on the optical properties of semiconductors and metals.
3. To determine the areas of opportunity in nanophotonic research.

References

1. H. Masuhara, S. Kawata and F. Tokunga, ―NanoBiophotoics", Elsevier Science, (2007).
2. B. E. A. Saleh and A. C. Teich, "Fundamentals of Photonics", John Wiley and Sons, NewYork, (1993).
3. P. N. Prasad, ―Introduction to Biophotonics", John Wiley and Sons, (2003).
4. M. Ohtsu, K. Kobayashi, T. Kawazoe and T. Yatsui, ―Principals of Nanophotonics (Optics and Optoelectronics)" University of Tokyo, Japan,.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Photons and electrons: similarities and differences, freespace propagation. Band gap. Cooperative effects for photons and electrons. Nanoscale optical interactions, axial and lateral nanoscopiclocalization.	7	15
II	Nanoscale confinement of electronic interactions: Quantun confinement effects,nanoscale interaction dynamics, nanoscale electronic energy transfer. Cooperative emissions.	8	15
FIRST INTERNAL EXAM			
III	Internal reflection and evanescent waves –plasmons and surface plasmon resonance –Attenuated Total reflection –Grating SPR coupling –Optical waveguide SPR coupling-SPR dependencies and materials –plasmonics and nanoparticles	8	15
IV	Important features of photonic crystals-Presence of photonic bandgap-anomalous group velocity dispersion-Microcavity-effects in Photonic Crystals-fabrication of photonic Crystals-Dielectric mirrors and interference filters-photonic crystal laser-PBC based LEDs-Photonic crystal fibers (PCFs)-Photonic crystal sensing.	7	15
SECOND INTERNAL EXAM			
V	Near Field Optics-Apertureless near field optics-near field scanning optical microscopy (NSOM or SNOM)-SNOM based detection of plasmonic energy transport-SNOM based visualization of waveguide structures	6	20
VI	SNOM in nanolithography-SNOM based optical data storage and recovery-generation of optical forces-optical trapping and manipulation of single molecules and cells in optical confinement-laser trapping and dissection for biological systems	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6122	Design of VLSI Systems	**3-0-0**	**3**	**2015**

Course Objectives

1. Understand the basics of CMOS Inverter and other Logic Design Techniques
2. Get a feel of current design technology
3. In-depth knowledge about various memory elements

Syllabus

CMOS Inverter - Behavior and Performance, CMOS Circuit and Logic Design, Advanced techniques in CMOS Logic Circuits, Arithmetic Circuits in CMOS VLSI- Adders, High speed adders, Multipliers, Low power design, Designing Memory and Array Structures, Addressable or Associative Memories, Sense Amplifier

Expected outcome

1. Understand the basics of VLSI Design
2. Understand the working of high speed adders and multipliers
3. Understand , various methods in the design of memory elements

References

1. John P. Uyemura, “Introduction to VLSI Circuits and Systems”, John Wiley & Sons 2002
2. Keshab K. Parthi,” VLSI Digital Signal Processing Systems”, John Wiley & Sons 2002
3. Neil H. E. Weste, Kamran Eshranghian, “Principles of CMOS Design”, Pearson Education Asia 2000
4. Jan M. Rabaey and et al, “Digital Integrated Circuits”, Pearson Edn. Inc. 2003

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	CMOS Inverter - Static Behaviour, Performance of CMOS Inverter - Dynamic Behaviour, Power Energy and Energy Delay, CMOS Circuit and Logic Design-CMOS Logic structures.	7	15
II	Advanced techniques in CMOS Logic Circuits-Mirror circuits, Pseudo nMOS, Tri-state circuits, Clocked CMOS, Dynamic CMOS Logic circuits, Dual Rail Logic Networks.	7	15
FIRST INTERNAL EXAM			
III	Arithmetic Circuits in CMOS VLSI-Bit Adder Circuits, Ripple Carry Adder, Carry Look Ahead Adders, Other High speed adders-Multiplexer based fast binary adders, Multipliers-Parallel multiplier, Wallace Tree and Dadda multiplier,	7	15
IV	Low power design- Scaling Versus Power consumption, Power reduction techniques	7	15
SECOND INTERNAL EXAM			
V	Designing Memory and Array Structures - Memory classification, Memory Core - Read Only Memories, Non-volatile Read Write Memories	7	20
VI	Content - Addressable or Associative Memories, Memory Peripheral Circuits - Address Decoders, Sense Amplifiers.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6218	Soft Computing	**3-0-0**	**3**	**2015**

Course Objectives

1. To familiarize various components of soft computing.
2. To give an overview of fuzzy Logic
3. To give a description on artificial neural networks with its advantages and application.

Syllabus

Basics of Fuzzy Sets, Fuzzy relations, Concepts of Artificial Neural Networks, Integration of Fuzzy and Neural Systems, Types of Neural Fuzzy Controllers, Survival of the Fittest, Predicate calculus, Semantic networks, Applications

Expected outcome

1. Identify and describe soft computing techniques and their roles in building intelligent machines
2. Recognize the feasibility of applying a soft computing methodology for a particular problem
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems

References

1. JyhShing Roger Jang, Chuen-Tsai Sun, EijiMizutani, (1997), Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine, Prentice Hall,.
2. Chin –Teng Lin and C.S. George Lee,(1996) “Neural Fuzzy Systems” – A neuro fuzzy synergism to intelligent systems, Prentice Hall International
3. Yanqing Zhang and Abraham Kandel (1998), Compensatory Genetic Fuzzy Neural Network and Their Applications, World Scientific.
4. T. J. Ross (1995)- Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc.
5. NihJ.Nelsson, "Artificial Intelligence - A New Synthesis", Harcourt Asia Ltd., 1998.
6. D.E . Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley,N.Y, 1989.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Basics of Fuzzy Sets: Fuzzy Relations – Fuzzy logic and approximate reasoning – Design. Methodology of Fuzzy Control Systems – Basic structure and operation of fuzzy logic control systems.	7	15
II	Concepts of Artificial Neural Networks: Basic Models and Learning rules of ANN's. Single layer perception networks – Feedback networks – Supervised and unsupervised learning approaches – Neural Networks in Control Systems.	7	15
FIRST INTERNAL EXAM			
III	Integration of Fuzzy and Neural Systems: Neural Realization of Basic fuzzy logic operations – Neural Network based fuzzy logic inference – Neural Network based Fuzzy Modeling	7	15
IV	Types of Neural Fuzzy Controllers. Data clustering algorithms - Rule based structure identification - Neuro-Fuzzy controls - Simulated annealing.	7	15
SECOND INTERNAL EXAM			
V	Survival of the Fittest - Fitness Computations - Cross over - Mutation -Reproduction - Rank method–Rank space method AI search algorithm	7	20
VI	Predicate calculus - Rules of interference – Semantic networks - Frames - Objects - Hybrid models - Applications.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6322	Optimization Techniques	**3-0-0**	**3**	**2015**

Course Objectives

1. To familiarize the students with the need of optimization in engineering.
2. To introduce the students with the different types of optimization algorithms
3. To enable the students to select the suitable optimization technique for the particular problem.

Syllabus

One dimensional- necessary and sufficient conditions, Search methods, Gradient methods, Multivariable- Search methods, Gradient based methods, Linear programming, Theory of Simplex method, Two phase method, Non Linear Programming, search method, Meta-heuristic optimization Techniques, Differential Evolution, Harmony Search Algorithm, Artificial Bee Colony Algorithm

Expected outcome

1. Understand the role of optimization in engineering design.
2. Understand the working principle of optimization algorithms.
3. Understand the formulation of the problem and usage of optimization algorithms.

References

1. Kalyanmoy Deb, "Optimization for Engineering Design, Algorithms and Examples. -PHI, ISBN -978-81-203-0943-2", IIT Kanpur.
2. S.S Rao ,"Optimization theory and Applications", New Age International

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	One Dimensional Optimization Algorithms– necessary and sufficient conditions, Search methods- Fibonacci search, golden section search, Gradient methods- Newton- Raphson method, cubic search.	8	15
II	Multivariable Optimization Algorithms- necessary and sufficient conditions, Search methods- Evolutionary method, Hook-Jeevs pattern search, Gradient based methods- steepest descent, Newton's method, conjugate gradient method.	7	15
FIRST INTERNAL EXAM			
III	Linear Programming - Systems of linear equations & inequalities, Formulation of linear programming problems, Theory of Simplex method, Simplex Algorithm, Two phase method-Duality, Dual Simplex method.	6	15
IV	Non-Linear Programming- Kuhn-Tucker conditions- Necessary and Sufficiency theorem – transformation method – penalty function method search method –random search method, linearized search - Frank-Wolf method.	7	15
SECOND INTERNAL EXAM			
V	Meta-heuristic optimization Techniques- (Principle and implementation steps for examples related to engineering (signal processing, communication, control system) optimization of the following)	7	20
VI	Differential Evolution (DE), Harmony Search Algorithm (HSA), Artificial Bee Colony Algorithm (ABC).	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6726	Societal Implications Of Nanotechnology	**3-0-0**	**3**	**2015**

Course Objectives

1. To provide an adequate basic knowledge on social impact of nanoscience and nanotechnology.

Syllabus

Managing the Nanotechnology Revolution, Semiconductor Scaling as a Model for Nanotechnology Commercialization

Expected outcome

1. To provide awareness to the engineering students about socio economic impact of nanotechnology and to handle the techniques effectively.
2. To enhance the nanotechnology research by taking ethics and public opinion into consideration, professional and ethical responsibility

References

1. Mihail C. Roco and William Sims Bainbridge —Nanotechnology: Societal Implications II-Individual Perspectives‖, Springer (2007).
2. Geoffrey Hunt and Michael D. Mehta —Nanotechnology: Risk, Ethics and Law‖, Earthscan/James & James publication (2006).
3. Jurgen Schulte —Nanotechnology: Global Strategies, Industry Trends and Applications‖, John Wiley & Sons Ltd (2005).
4. Mark. R. Weisner and Jean-Yves Bottero —Environmental Nanotechnology applications and impact of nanomaterial‖, The McGraw-Hill Companies (2007).

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester
I	Socio-Economic Impact of Nanoscale Science - Managing the Nanotechnology Revolution: Consider the Malcolm Baldrige National Quality Criteria - The Emerging Nano Economy: Key Drivers, Challenges, and Opportunities	6	15
II	Transcending Moore's Law with Molecular Electronics and Nanotechnology -Semiconductor Scaling as a Model for Nanotechnology Commercialization - Sustaining the Impact of Nanotechnology on Productivity, Sustainability, and Equity.	7	15
FIRST INTERNAL EXAM			
III	Navigating Nanotechnology Through Society - Nanotechnology, Surveillance, and Society: Methodological Issues and Innovations for Social Research - Nanotechnology: Societal Implications: Individual Perspectives - Nanotechnology and Social Trends - Five Nanotech Social Scenarios-Technological Revolutions and the Limits of Ethics in an Age of Commercialization - Vision, Innovation, and Policy.	8	15
IV	Nanotechnology's Implications for the Quality of Life - Management of Innovation for Convergent Technologies - The "Integration/Penetration Model:" - The Use of Analogies for Interdisciplinary Research in the Convergence of Nano-, Bio-, and Information Technology - Converging Technologies: Innovation, Legal Risks, and Society .Governance-Problems of Governance of Nanotechnology -Institutional Impacts of Government Science Initiatives - Nanotechnology for National Security	8	15
SECOND INTERNAL EXAM			
V	Ethics and Law - Ethical Issues in Nanoscience and Nanotechnology: Reflections and Suggestions - Ethics and Nano: A Survey - Law in a New Frontier - An Exploration of Patent Matters Associated with Nanotechnology - The Ethics of Ethics - Negotiations over Quality of Life in the Nanotechnology	6	20
VI	Public Interaction Research - Communicating Nanotechnological Risks - A Proposal to Advance Understanding of Nanotechnology's Social Impacts - Nanotechnology in the Media: A Preliminary Analysis - Public Engagement with Nanoscale Science and Engineering - Nanotechnology: Moving Beyond Risk - Communication Streams and Nanotechnology: The (Re)Interpretationof a New Technology - Nanotechnology:Societal	7	20

COURSE PLAN			
Module	Contents	Allotted Hours	% of Marks in End-Semester
	Implications — Individual Perspectives.		
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6792	Mini Project	**0-0-4**	**2**	**2015**

Course Objectives

To make students

Design and develop a system or application in the area of their specialization.

Approach

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work / hardware implementation.

Expected Outcome

Upon successful completion of the miniproject, the student should be able to

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6794	MEMS Lab	0-0-2	1	2015

Course Objectives

1. Familiarising Various MEMS software.
2. Simulation of MEMS structure.

MEMS Experiments :

1. Simulation of cantilever.
2. Simulation of micro machined structures.
3. Simulation of accelerometers.
4. Simulation of micromirror.
5. Simulation MEMS structures using sacrificial layer method.
6. Simulation of MEMS sensors.
7. Simulation study of integration of circuits and MEMS.

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Expected outcome

1. On completion of the LAB design MEMS.

SEMESTER - III

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7711	RF Microelectronics	**3-0-0**	**3**	**2016**

Course Objectives

1. Introduction to RF circuits and design concepts.
2. Get a thorough understanding of the Physical and practical aspects of RF circuit design.

Syllabus

RF circuit design, Basic RF modules, RF amplifiers, RF oscillators, RF filter design

Expected outcome

1. After the course the student will be capable to Design, analyze, and develop RF circuits

References

1. Thomas H. Lee ―Design of CMOS Radio Frequency Integrated Circuits, Cambridge University press, 2003
2. Behzad Razavi―RF Microelectronics‖, Prentice Hall 1998
3. W. Alan Davis, Krishna K. Agarwal, Radio Frequency Circuit Design, John Wiley & Sons Inc.2001

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Introduction to RF design: Transmission lines, reflection coefficient, wave equation, lossy transmission lines, impedance matching, insertion loss,. Scattering Parameters - Chain Scattering Matrix, Signal Flow analysis using S Parameters.	7	15
II	Basic RF modules: Review of basic blocks like amplifier, modulator /demodulator, mixer, filter, isolator, RF oscillators, coupler, phase shifters, tuner etc.	6	15
FIRST INTERNAL EXAM			
III	RF behaviour of passive components, High Frequency Resistors, High Frequency Capacitors, High frequency inductors, chip components, surface mount inductors	7	15
IV	Active RF components-RF diodes, BJT and RF Field Effect Transistors, diode models transistor models, BJT and MOSFET behaviour at RF frequencies, measurement of active devices scattering parameter device characterization	7	15
SECOND INTERNAL EXAM			
V	RF transistor amplifier design: characteristics of amplifiers, classes of operation and biasing networks, amplifier power relations, stability considerations, constant gain, unilateral and bilateral design, broad band, high power, and multi stage amplifiers, low noise amplifiers(LNA) impedance matching using discrete components, microstrip line matching networks.	8	20
VI	RF Filter Design-LP, HP, BP and BS filters	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7713	Nanomedicine	**3-0-0**	**3**	**2015**

Course Objectives

1. Awareness regarding the Nanomedicine development and application of materials and devices to study biological processes and to treat disease at the level of single molecules and atoms

Syllabus

Development of nano medicines, Nanotechnology in diagnostic application, Biomedical nanoparticles, Nanobiotechnology in Drug Delivery, Introduction and Rationale for Nanotechnologyin Cancer Therapy

Expected outcome

1. Understand the principles behind nanomedicine and understand the applications of Nanomaterials in medicine.
2. Impart the knowledge to apply the Nanomaterials in different medical applications

References

1. Kewal K. Jain ,‖ The Handbook of Nanomedicine‖Humana Press, (2008).
2. Zhang, ‖Nanomedicine: A Systems Engineering Approach” 1st Ed., Pan Stanford Publishing, (2005).
3. Robert A. Freitas Jr., ―Nanomedicine Volume IIA: Biocompatibility‖, Landes Bioscience Publishers, (2003).

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester
I	Introduction - Development of nano medicines – Nano Shells – Nano pores – Tectodendrimers – Nanoparticle drug system for oral administration – Drug system for nasal administration – Drug system for ocular administration – Nanotechnology in diagnostic application. Preformulation Studies: on various dosage forms such as tablets, capsules, suspension, creams, emulsion, injectables, ophthalmic and aerosols etc	7	15
II	Biomedical nanoparticles – Liposome's – Dentrimers – Different types of drug loading – Drug release – Biodegradable polymers – Applications Nanobiotechnologies for Single-Molecule Detection -Protease-Activated QuantumDot Probes -Nanotechnology for Point-of-Care Diagnostics -Nanodiagnostics for the Battle Field -Nanodiagnostics for Integrating Diagnostics with Therapeutics.	7	15
FIRST INTERNAL EXAM			
III	Introduction -Nanobiotechnology for Drug Discovery -Gold Nanoparticles for Drug Discovery -Use of Quantum Dots for Drug Discovery -Nanolasers for Drug Discovery -Cells Targeting by Nanoparticles with Attached Small Molecules -Role of AFM for Study of Biomolecular Interactions for Drug Discovery Nanoscale Devices for Drug Discovery -Nanotechnology Enables Drug Design at Cellular Level Nanobiotechnology-Based Drug Development -DendrimersasDrugs- Fullerenes as Drug Candidates -Nanobodies. Nanobiotechnology in Drug Delivery -NanoscaleDelivery of Therapeutics	8	15
IV	Nanosuspension Formulations Viruses as Nanomaterials for Drug Delivery -Nanoparticle-Based Drug Delivery -Trojan Nanoparticles -Self-Assembling Nanoparticles for Intracellular Drug Delivery -Nanoparticle Combinations for Drug Delivery Liposomes -Liposome–Nanoparticle Hybrids-Nanospheres-Nanotubes -Nanocochleates.-Nanomolecular Valves for Controlled Drug Release -NanomotorsforDrugDelivery	7	15
SECOND INTERNAL EXAM			
V	Introduction and Rationale for Nanotechnologyin Cancer Therapy -- Passive Targeting of Solid Tumors: Pathophysiological Principles and Physicochemical Aspects of Delivery Systems -Active Targeting Strategies in Cancer with a Focus on\Potential Nanotechnology Applications -Pharmacokinetics of Nanocarrier-Mediated Drug and Gene Delivery -Multifunctional Nanoparticles for Cancer Therapy	7	20

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester
VI	Neutron Capture Therapy of Cancer: Nanoparticlesand High Molecular Weight Boron Delivery Agents. Nano-Oncology- Nanoneurology- Nanocardiology- Nano-Orthopedics- Nano-Ophthalmology	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7715	Nano Bio-Technology	**3-0-0**	**3**	**2015**

Course Objectives

1. To understand the basic concepts of theory and practice of bio-nanotechnology

Syllabus

Overview of natural Bio-nanomachines, Molecular modeling tools, Bimolecular motors, Magnetosomes, DNA based nanostructures

Expected outcome

1. Students have the basic knowledge of Nano biotechnology and DNA structures.
2. Students understand about the functional principles of bio-nanotechnology

References

1. C. M. Niemeyer, C. A. Mirkin, ―Nanobiotechnology: Concepts, Applications and Perspectives‖, Wiley – VCH, (2004).
2. T. Pradeep, ―Nano: The Essentials‖, McGraw – Hill education, (2007).
3. Challa, S.S.R. Kumar, Josef Hormes, CarolaLeuschaer, ‖Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact‖, Wiley – VCH, (2005).
4. Nicholas A. Kotov, ―Nanoparticle Assemblies and Superstructures‖, CRC, (2006).
5. David S Goodsell, "Bionanotechnology‖, John Wiley & Sons, (2004).

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester
I	Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bio-nanomachines. The role of proteins- amino acids- nucleic acids- lipids and polysaccharides in modern biomaterials. Overview of natural Bionanomachines: Thymidylate Sythetase , ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen. Recombinant Technology, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures and their integration with biological structures.	7	15
II	Molecular modeling tools: Graphic visualization, structure and functional prediction, Protein folding prediction and the homology modeling, Docking simulation and Computer assisted molecular design	6	15
FIRST INTERNAL EXAM			
III	Information driven nanoassembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, Structure and functional properties of Biomaterials	7	15
IV	Bimolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Potassium channels,ABC Transporters and Bactreriorhodapsin, Bimolecular sensing, Self replication, Machine-Phase Bionanotechnology Protein folding; Self assembly, Self-organization, Molecular recognition and Flexibility of biomaterials.	8	15
SECOND INTERNAL EXAM			
V	Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers – Microbial production of inorganic nanoparticles	7	20
VI	Magnetosomes .DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nano mechanics and Computing	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7717	Nanosystems For Energy	**3-0-0**	**3**	**2015**

	Applications			

Course Objectives

1. The purpose of this course is an introduction to various forms of energy used in industries and methods of converting from one form to another by using Nanotechnology.
2. Students should be provided with the opportunity to explore these various forms of energy, particularly in terms of Nanotechnology and how they are converted and how their use impact on the environment.

Syllabus

Nanotechnology for sustainable energy, . Energy challenges, development and implementation of renewable energy technologies, Micro-fuel cell technologies, Nano-electromechanical systems, Hydrogen storage methods, Hydriding/dehydriding kinetics.

Expected outcome

1. Students have aware of Renewable Energy technology, Micro Fuel Cell Technology and Micro Fluid System.
2. To appreciate the role of Nano technology in energy and its efforts to improve lifestyle.

References

1. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, (1986).
2. Martin A Green, Solar cells: Operating principles, technology and system applications, Prentice Hall Inc, Englewood Cliffs, NJ, USA, (1981).
3. H J Moller, Semiconductor for solar cells, Artech House Inc, MA, USA, (1993).
4. M.A. Kettani , Direct energy conversion, Addision Wesley Reading, (1970).
5. Linden , Hand book of Batteries and fuel cells, McGraw Hill, (1984).
6. Hoogers , Fuel cell technology handbook. CRC Press, (2003).

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Nanotechnology for sustainable energy- Energy conversion process, indirect and direct energy conversion-Materials for light emitting diodes-batteries-advanced turbines-catalytic reactors-capacitors-fuel cells. Energy challenges, development and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies	7	15
II	Energy transport, conversion and storage- Nano, micro, and poly crystalline and amorphous Si for solar cells, Nano-micro Si-composite structure, various techniques of Si deposition	7	15
FIRST INTERNAL EXAM			
III	Micro-fuel cell technologies, integration and performance for micro-fuel cell systems -thin film and microfabrication methods - design methodologies - micro-fuel cell power sources	7	15
IV	Nano-electromechanical systems and novel microfluidic devices - nano engines - drivingmechanisms - power generation - microchannel battery - micro heat engine (MHE) fabrication - thermocapillary forces -Thermocapillary pumping (TCP) - piezoelectric membrane.	7	15
SECOND INTERNAL EXAM			
V	Hydrogen storage methods - metal hydrides - size effects - hydrogen storage capacity -hydrogen reaction kinetics - carbon-free cycle-gravimetric and volumetric storage capacities	7	20
VI	Hydriding/dehydriding kinetics -high enthalpy of formation - and thermal management during the hydriding reaction.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7719	Instrumental Methods And Analysis	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce the basic principles of spectroscopy and to lay emphasis on advanced Spectroscopic techniques for Nanomaterials and the fundamentals

Syllabus

Simplified model for vibrational interactions, Reflection-absorption IR spectroscopy (RAIRS), The Raman Effect, Identification and Phase Transitions in Nanoparticles, Absorption saturation and harmonic generation, Luminescence up conversion, Optical properties of assembled nanostructures, , Spectral Analysis, Basic Principles of AES

Expected outcome

1. Students understand the principles underlying various spectroscopies and instrumentations specific to nanomaterials .

References

1. William W. Parson**,** Modern Optical Spectroscopy, Springer, (2007).
2. Collin Banwell, Mc Cash, Fundamentals of Molecular Spectroscopy, McGraw Hill (1994).
3. Harvey Elliot White, Introduction to Atomic Spectra, McGraw Hill, (1934).
4. Francis Rouessac and AnnickRouessac**,** Chemical Analysis**-**Modern Instrumentation Methods and Techniques,2007.
   Joseph. R. Lakowicz Principles of fluorescence spectroscopy, Springer, (2010)

COURSE PLAN			
Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Simplified model for vibrational interactions-Characteristic bands for organic compounds - Attenuated-total reflection (ATR) and grazing incidence angle techniques-Reflection-absorption IR spectroscopy (RAIRS)	6	15
II	The Raman Effect- Lateral and in-depth Resolution of Conventional μRS- Resonant Raman Spectroscopy (RRS) - Nano-specific Modes- Surface-Enhanced Raman Spectroscopy (SERS)- Nano-Raman- Phase Identification and Phase Transitions in Nanoparticles- Characterizing Carbon Materials with Raman Spectroscopy.	8	15
FIRST INTERNAL EXAM			
III	Absorption saturation and harmonic generation,Second-harmonic generation (SHG) and sum frequency spectroscopy (SFG)- Luminescence up conversion-The use of nonlinear optical methods to obtain infrared spectra of ultra-thin assemblies confined to surfaces.	7	15
IV	Optical properties of assembled nanostructures-interaction between nanoparticles-Direct and indirect gap transitions-, -Single molecule and single nanoparticles spectroscopy-Dynamic light scattering spectroscopy Fluorimetry and chemiluminescence - X-ray fluorescence spectrometry-Atomic emission spectroscopy.	8	15
SECOND INTERNAL EXAM			
V	X-Ray Beam Effects, Spectral Analysis -Core Level Splitting Linewidths-Elemental Analysis: Qualitative and Quantitative -Secondary Structure ,XPS Imaging -Angle-Resolved	6	20
VI	Basic Principles of AES-Instrumentation- Experimental Procedures Including Sample Preparation - AES Modifications and Combinations with other Techniques -Auger Spectra: Direct and Derivative Forms and Applications-Electron energy loss spectroscopy of nanomaterials.	7	20
END SEMESTER EXAM			

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

01EC7721	Algorithms For VLSI Design Automation	**3-0-0**	**3**	**2015**

Course Objectives

1. As a graduate level course on VLSI Design Automation area, this course assure to deliver the students, a thorough understanding of the algorithms used in VLSI Physical Design Automation problems

Syllabus

Graph theory and algorithms, Physical design automation algorithms, Floor planning, Routing, Clock routing schemes and lay out compassion

Expected outcome

1. Learn the physical problems and their mathematical formulation in VLSI Physical design.
2. Learn efficient algorithms to solve the physical design automation problems
3. Adapts the students, to inherit the methods learned, to address the emerging physical
4. design
5. Automation problems

References

1. Naveed A. Sherwaniz , "Algorithms for VLSI Physical Design Automation", Kluwer Academic Press,3e.
2. Sung KyuLim,"Practical Problems in VLSI Physical Design Automation", Springer, 2008.
3. Sung KyuLim,"Algorithms for VLSI Design Automation", Wiley, 1e, 1998.
4. M Sarafzadeh, CK Wong,"An Introduction to VLSI Physical Desig", McGrawHill, 1996.
5. Charles J Alpert, Dinesh P Mehta, Sachin S Sapatnekaretc, "Handbook of Algorithms for Physical Design Automation", CRC Press, 2009
6. Luis Scheffer, Luciano Lavango, Grant Martin,"EDA for IC Implementation, Circuit Design and Process Technology", CRC Taylor and Francis, 2006.

COURSE PLAN

Module	Contents	Allotted Hours	% of Marks in End-Semester Examination
I	Introduction to graph theory-data structures for graphs. Backtracking, branch and bound algorithms. Graph algorithms- depth first search, breadth first search, shortest path, critical path, strongly connected components, minimum spanning tree, min-cut max-cut algorithm, Steiner tree algorithm. Integer linear programming and simulated annealing.	8	15
II	Graph algorithms for physical design classes' problems. Algorithm for interval, permutation and circle graphs (MIS, Cliques).	6	15
FIRST INTERNAL EXAM			
III	Physical design automation algorithms: Clustering: Rajaraman and Wong algorithm, Flow map algorithm, Multi-level coarsening algorithm. Partitioning: Kernighan and Ling Algorithm, EIG Algorithm, FBB algorithm.	7	15
IV	Floor planning: Stockmayer algorithm, Normalized polish expression, ILP Floor planning. Routing: Steiner routing.: L-shaped Steiner routing, 1-steiner routing,bounded radius and A-tree routing algorithms. Stainer min-max Tree multinet algorithm.	7	15
SECOND INTERNAL EXAM			
V	Clock routing schemes - design considerations and problem formulation. H-tree based, MMM, Geometric Matching based, Weighted center, Exact Zero Skew, DME Algorithms, Multiple clock routing. Power and Ground routing.	7	20
VI	Layout compaction- problem formulation, 1-Dimensional Compaction - constraint - graph and virtual graph based compactions. 2-dimensional and hierarchical compaction algorithms. Layout extraction.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7723	System Modelling and Identification	**3-0-0**	**3**	**2015**

Course Objectives

1. As a graduate level course on system modeling and identification, this course assures to deliver the students, a sound understanding of the mathematical methods used on dynamic system modeling and identification.

Syllabus

Theoretical and experimental modelling, Identification and Modelling of Dynamic systems, Identification of Non Parametric Models, Identification with Parametric models, Parameter estimation.

Expected outcome

1. Learn parametric, non parametric static and dynamic system models.
2. Learn identification methods and their merits for dynamic and static linear and non linear systems.
3. Helps the student to address and solve the system modeling issues on their thesis problems.

References

1. Rolf Isermann, Marco Munchhof,"Identification of Dynamic Systems: An Introduction with Applications", Springer, 2011.
2. OliwerNelles,"Nonlinear System Identification: From Classical Approaches to Neural Networks and Fuzzy models", Springer, 2000.
3. JR Raol, G, Girja, J Singh,"Modeling and Parameter Estimation of Dynamic Systems", IET, 2004
4. TohruKatayama,"Subspace Methods for System Identification", Springer, 2005.
5. TokunboOgunfunmi,"Adaptive Nonlinear System Identification", Springer, 2007.
   Rolain Yves, PintelonRik, SchoukensJohan,"Mastering System Identification in 100 Exercises", John Wiley and Sons, 2012.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Introduction to theoretical and experimental modeling: Identification of Dynamic systems- identification methods and applications. Mathematical models for dynamic system for continuous, discrete time, discrete time stochastic signals. Characteristic parameter determination. System integral and derivative actions.	7	15
II	Identification of non parametric models in frequency domain: Spectral analysis methods using Fourier and Wavelet transform for periodic, non periodic signals and test signals. Identification of non parametric models with correlation analysis - continuous and discrete estimations of correlation functions, correlation analysis of binary stochastic and linear dynamic systems	8	15
FIRST INTERNAL EXAM			
III	Identifications with parametric models : Least square estimation of static and dynamic processes. non recursive and recursive least square method. spectral analysis with periodic parametric signals. recursive and weighted least square method. Bayes maximum likelihood methods.	7	15
IV	Parameter estimation in closed loop: process identification without and without additional signals. methods for identification in closed loops.	6	15
SECOND INTERNAL EXAM			
V	Parameter estimation for frequency response: least square frequency response approximation. Parameter estimations for differential equations and cont nous time processes- methods of least square and determination of derivatives, consistent parameter estimation methods. Introduction to subspace methods for system identification.	8	20
VI	Parameter estimation in nonlinear systems. Dynamic systems with continuously differentiable non linearities- Volterra: series, Hammaerstein series, Weinier model, Latchmann models and parameter estimation.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7791	Seminar II	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7793	Project (Phase I)	**0-0-12**	**6**	**2015**

Course Objectives

To make students

1. Do an original and independent study on the area of specialization.
2. Explore in depth a subject of his/her own choice.
3. Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4. Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5. Plan the experimental platform, if any, required for project work.

Approach

The student has to present two seminars and submit an interim Project report. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is the presentation of the interim project report of the work completed and scope of the work which has to be accomplished in the fourth semester.

Expected Outcome

Upon successful completion of the project phase 1, the student should be able to

1. Identify the topic, objectives and methodology to carry out the project.
2. Finalize the project plan for their course project.

SEMESTER - IV

Syllabus and Course Plan

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

01EC7794	Project (Phase II)	**0-0-23**	**12**	**2015**

Course Objectives

To continue and complete the project work identified in project phase 1.

Approach

There shall be two seminars (a midterm evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work.

Expected Outcome

Upon successful completion of the project phase II, the student should be able to

1. Get a good exposure to a domain of interest.
2. Get a good domain and experience to pursue future research activities