APPLIED ELECTRONICS AND INSTRUMENTATION

M.Tech. Programme

Electronics and Communication – Applied Electronics and Instrumentation

Curriculum and scheme of Examinations

SEMESTER I

Code No.	Name of Subject	Credits	Hrs /week	Exam duration	Marks			Remarks
					Continuous Assessment	University Exam	Total	
TAM 1001	Mathematical Methods for Electronics	3	3	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End semester exam is conducted by the University
TMC 1001	Advanced Digital Signal Processing	3	3	3	40	60	100	Do
TAC 1001	Instrumentation System Design	3	3	3	40	60	100	Do
TAC 1002	Non Linear and Adaptive Control Systems	3	3	3	40	60	100	Do
TAC 1003	CMOS Circuit Design	3	3	3	40	60	100	Do
TAC 1004	Advanced Digital System Design	3	3	3	40	60	100	Do
TAC 1101	Instrumentation & Control System Lab	1	2	-	100	-	100	No End Semester Examination
TAC 1102	Seminar	2	2	-	100	-	100	Do
	TOTAL	21	22					7 Hours of Departmental Assistance work

SEMESTER II

Code No.	Name of Subject	Credits	Hrs / week	Exam duration	Marks			Remarks
					Continuous Assessment	University Exam	Total	
TAC 2001	Design of Embedded Systems	3	3	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End semester exam is conducted by the University
TAC 2002	Micro Electro Mechanical Systems	3	3	3	40	60	100	Do
**	Stream Elective I	3	3	3	40	60	100	Do
**	Stream Elective II	3	3	3	40	60	100	Do
**	Department Elective	3	3	3	40	60	100	Do
TCC 2000	Research Methodology	2	2	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End Semester Exam is conducted by the Individual Institutions
TAC 2101	VLSI & Embedded Systems Lab	1	2	-	100	-	100	No End Semester Examination
TAC 2102	Thesis – Preliminary-Part I	2	2	-	100	-	100	Do
TAC 2103	Seminar	2	2	-	100	-	100	Do
	TOTAL	22	23	-				6 hrs of departmental assistance work

** Students can select a subject from the subjects listed under stream/department electives for the second semester as advised by the course coordinator.

List of Stream Electives

Stream Elective I:

TAE 2001 Medical Instrumentation
TAE 2002 Optical Instrumentation
TAE 2003 Digital Image Processing

Stream Elective II:

TAE 2004	Nano Electronics
TAE 2005	Robot Dynamics and Control
TAE 2006	Mixed Signal Circuit Design

List of Department Electives (Common for all streams)

TCD 2001	Design of VLSI Systems
TCD 2002	Soft Computing
TCD 2003	Optimization Techniques
TCD 2004	Information Hiding & Data Encryption

SEMESTER III

Code No.	Name of Subject	Credits	Hrs / week	Exam duration	Marks			Remarks
					Continuous Assessment	End Semester Exam	Total	
**	Stream Elective III	3	3	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End Semester Exam is conducted by the Individual Institutions
**	Stream Elective IV	3	3	3	40	60	100	Do
*	Non- Dept. (Interdisciplinary) Elective	3	3	3	40	60	100	Do
TAC 3101	Thesis – Preliminary Part II	5	14	-	200	-	200	No End Semester Examination
	TOTAL	14	23					6 hrs of departmental assistance work

** Students can select a subject from the subjects listed under stream electives III and IV for the third semester as advised by the course coordinator.

*Students can select a subject from the subjects listed under non department (Interdisciplinary) electives for the second semester as advised by the course coordinator.

List of Stream Electives

Stream Elective III:

TAE 3001 RF MEMS Circuit Design
TAE 3002 Low Power VLSI Design
TAE 3003 Industrial Drives and Control
TAE 3007 Computer aided design of Control Systems

Stream Elective IV:

TAE 3004 PWM Schemes for Power Converters
TAE 3005 Wireless Sensors and Systems
TAE 3006 Algorithms for VLSI Design Automation
TAE 3008 System Modeling and Identification

SEMESTER IV

Code No	Subject Name	Credits	Hrs/week	Marks					Remarks
				Continuous Assessment		University Exam		Total	
				Guide	Evaluation Committee	Thesis Eva	Viva Voce		
TMC 4101	Thesis	12	21	150	150	200	100	600	5 % of the mark is earmarked for Publication in journal/conference
	Total	12	21						8 hrs of departmental assistance work

TAM 1001 MATHEMATICAL METHODS FOR ELECTRONICS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To provide a foundation of linear algebra, probability theory and random process.

Learning Outcomes

- On completion of the course the student will be capable of using the mathematical principles and methods learned for analyzing and solving engineering problems

Module I.

Algebraic structures:- Sets-relations-Groups-subgroups- cosets and Lagranges Theorem
Rings Integral domain and Fields- Definition and examples.
Linear Algebra:- Vector space-subspace-linear dependence-basis-dimension-Interpolation and wronskian-Linear Transformation-change of bases- diagonalization.
Eigen values and eigen vectors- diagonalization of matrices-exponential matrices-of linear recurrence relations

Module II.

Probability spaces:- Random variables-distributions and densities-statistical independence-expectations-moments and characteristic functions.
Sequence of random variables and it's convergence-Chebychev's inequality-law of large numbers-Central limit theorem.

Module III.

Random processes:- Definition and classification of random processes-stationarity(strict sense and wide sense)-Autocorrelation function and its properties.-Ergodicity- ergodic theorems. spectral density function and it's properties.
Special Random Processes:- Poisson process-properties-Markov process- Markov Chains-Transition probability matrix-Chapman-Kolmogorov theorem.-Birth death process-weiner process.

References:

1. C.L.Liu,*"Elements of Discrete Mathematics"*, Tata McGraw Hill
2. Fraleigh, *"A first course in abstract algebra"*, Narosa
3. Jin Ho Kwak and Sungpyo Hong, *"Linear Algebra*-, 2/e", Springer.
4. Strang and Gilbert, *Introduction to Linear Algebra*, 3/e, Cambridge.
5. J.Medhi, *"Stochastic processes"*, New Age International, India
6. Stark Henry,*"Probability and random process with application to signal processing"*,3/e,Pearson Education India.
7. Gray.R.M and Davisson.L.D, *"An introduction to statistical signal processing"*, Cambridge university press.
8. T. Veerarajan, *"Probability, Statistics and Random processes"*, Tata- McGraw Hill

Structure of the Question paper
There will be three questions from each module out of which two questions are to be answered by the students.

TMC 1001 ADVANCED DIGITAL SIGNAL PROCESSING

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To provide an overview of time frequency analysis and hence the significance of wavelet transform.
- To enable the students to use various wavelet transforms for applications like data compression.
- To familiarize the students with multirate sampling principles.
- To enable the students to appreciate various applications of multirate systems.
- To equip the students to work with various linear prediction algorithms.
- To familiarize the students with power spectrum estimation of signals using parametric and non-parametric methods.

Learning Outcomes

- Design multirate systems for applications like sub-band coding.
- Account for the wavelet transform principles, taking into consideration, time frequency analysis and multi resolution analysis.
- Implement various wavelet transforms on 1D as well as 2D signals.
- Use wavelet transforms for applications like image compression.
- Design linear prediction systems using Levinson-Durbin algorithm.
- Have a better appreciation of the uses of parametric and non-parametric methods for power spectrum estimation of signals.

Module I

Review of fundamentals of the Discrete Time Systems: Design of FIR Digital filters-Window method, Park-McClellan′s method. Design of IIR Digital Filters ‑ Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters. Effect of finite register length in FIR filter design. Basics of Multirate systems and its application, up sampling and Down - Sampling, Fractional Sampling rate converter.

Module II

Polyphase decomposition. Efficient realisation of Multirate systems. Uniform filter banks and it's implementation using polyphase decomposition. Two channel Quadrature Mirror Filter Banks, Perfect Reconstruction. Time Frequency Analysis, Heisenberg's uncertinity principle. Short time fourier transform. Continous Wavelet Tranform and it's properties. Multi Resolution Analysis,

Module III

Discrete Wavelet Transform, Orthonormal Wavelet Analysis - Filterbank interpertation. Application of wavelet tranform for data compression. Linear Prediction -Forward and Backward Prediction - Levinson-Durbin Algorithm. Power spectrum estimation of signals: Wide Sense Stationary Random Processes. Power spectral density. Non parametric methods:

periodogram,Backman-Tuckey method. Parametric method: ARMA, AR processes, Yule-Walker method.

References:

1. P. P. Vaidyanathan, *"Multirate Systems and Filterbanks"*, Prentice Hall
2. *"Wavelet Transforms "*- Bopadikar and Rao, Pearson Education
3. *"Insight into wavelets"*, K. P. Soman, Prentice Hall India
4. *"Digital signal Processing"*, By John G. Proakis, Dimitris G. Manolakis Pearson Education
5. L. Cohen, *"Time Frequency Analysis"*, Prentice Hall.
6. *"Wavelets and Filterbank"*, G Strang & T Nguyen , Wellesly-Cambridge
7. *"Wavelets and subband coding"*, M Vetterli & J Kovacevic, Prentice Hall

Structure of the Question paper
There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% problems and 40% theory.

TAC 1001 INSTRUMENTATION SYSTEM DESIGN

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- Appreciate the operation of typical instrumentation systems
- Identify the various methods of signal transmission
- Understand the equipment used in
  a. Current loops (process meters, trip amplifiers, transmitters, current repeaters)
  b. Temperature measurement
  c. Pressure measurement (bourdon gauges, air and electrical d p cells)
  d. Level measurement (bubblers, pressure cells, ultrasonic, load cells)
  e. Flow measurement (orifice plates, mag-flow meters, mass-flow meters, etc)
  f. Output devices (flow control valves, valve positioners, I to P converters)

- To understand signal conditioning relevant to instrumentation

Learning Outcomes

- Be able to interpret and formulate design specifications for instrumentation systems that meet accuracy and sampling speed requirements.
- Understand the principles of operation of sensors including thermocouples, strain gages.
- Understand principles of analog and digital signal and data processing, including
- amplifiers, filters and A-D conversion techniques.
- Understand sources and measures of error in instrumentation systems, including noise; aliasing; common-mode rejection ratio of differential amplifiers; the sampling theorem and its application.

Module I

Introduction to instruments: Design of transducers, transducer testing. Design of RTD's Pressure gauges ,Bellows , Bourden tubes and Diaphragm based instruments. Design of flow measuring instruments.

Module II

Design of LVDT , Strain gauge and Piezoelectric crystal based instruments Design of different sensing elements: Resistive sensing element, Capacitive sensing elements, Induction sensing elements, Electromagnetic sensing element. Velocity Sensors, Level Instrumentation Design.

Module III

Design of Signal Conditioning elements: Deflection Bridges, Amplifiers, Current Transmitters, Oscillation and Resonation, Design aspects of signal processing elements Analog to Digital Conversion, Sampling, Quantization, Encoding Signal processing calculations, Steady State compensation, Dynamic Digital Compensation and filtering

References

1 . C. D. Johnson, *"Process Control Instrumentation Technology"*, Fourth Edition, PHI, 1996.

2. Andrew and Williams, *"Applied Instrumentation in Process Industries"*, Vol. I, II, III, IV, Gulf Publishing Company, 1979.

3. John P. Bentley, *"Principles of Measurement Systems"*, Addison-Wesley publication, 1999.

4. T. R. Padmanabhan, *" Industrial Instrumentation: Principles and Design"*, Springer-Verlag Publications, 1999.

5. B. C. Nakra and K. K. Choudhari, *" Instrumentation: Measurement and Analysis"*, Tata McGraw Hill Pub, 1985.

6. B. G. Liptak, *"Instrument Engineers Handbook"*, Vol. I and II, Third Edition, Chilton and Book Company, 1990.

7. D. M. Considine, *"Process/Industrial Instruments and Control Handbook"*, Fourth Edition, McGraw-Hill Inc., 1993.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 50% problems and 50% theory.

TAC 1002 NON LINEAR AND ADAPTIVE CONTROL SYSTEMS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To study the characteristics of a non-linear system and different types of non-linearities in a system.
- Should be able to analyze a Non-linear system.
- Should be able to analyze an adaptive control system with different configurations.

Learning Outcomes

- Understand more details about different nonlinearities present in a system.
- Understand different methods used for analysing a Nonlinear system.
- Understand more about an adaptive control system schemes

Non Linear systems and analysis

Module I

Features of linear and non-linear systems- Common non-linearities- Characteristics of Nonlinear systems - Limit cycles - stability, jump resonance - Describing function Analysis - Describing function of different non linearities - saturation, dead zone, relay, hysteresis. Phase plane analysis - Singular points – types - Construction of Phase portrits – Isocline, Delta methods.

Module II

Stability analysis of Nonlinear systems, Liapunov stability analysis- Construction of Liapunov function- variable gradient method, Popov's stability criterion, Circle criterion, Variable structure control systems-basic concepts- Sliding mode control.

Adaptive Control systems

Module III

Introduction- Development of adaptive control problem- The role of Index performance(IP) in adaptive systems- Gain scheduling- Model Reference Adaptive Systems- The MIT rule- Determination of Adaptation gain- Self tuning regulators- Adaptive predictive control. Back-stepping approach to Stabilization.

References

1. Jean-Jacques Slotine& Weiping Li, *"Applied Nonlinear Control"*, Prentice- Hall .
2. Shankar Sastry, *"Nonlinear System Analysis, Stability and Control"*, Springer.
3. Hassan K Khalil, *"Nonlinear systems"*, MACMILLAN Publishing company

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 80% problems and 20% theory.

TAC 1003 CMOS CIRCUIT DESIGN

Structure of the Course

Lecture : 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To get Fundamental idea of Analog Circuits
- To give ideas about the basic amplifiers, current Mirrors and Differential Amplifiers
- To get an idea of static and switching characteristics of the CMOS Inverter
- Operation of pass transistor logic and transmission gates
- Operational Amplifiers are discussed with its design and stability factors
- Different types of Memory and its decoder Circuits are discussed

This is prerequisite paper for Mixed Signal Circuit Design

Learning Outcomes

- Able to understand, design and analyse various analog and digital CMOS Circuits

Module I

Review of single stage MOS Amplifiers CS, CD, CG and cascode Amplifiers . Design of current Mirrors, Wilson current mirrors and Widlar current mirrors.Band gap voltage reference Differential Amplifiers: MOS Load Current Source, Current Mirror, Cascode Load.

Module II

CMOS Inverter-Static Characteristics, Derivation for V_{TH}, V_{IL} and V_{IH} Switching Characteristics and Calculation of delay times Sequential Logic Circuits- Different CMOS Flip flops Theory of operation and Circuits of Pass transistor Logic and transmission gate.

Module III

MOS Operational Amplifiers, Cascode and Folded Cascode opamps . Stability and frequency compensation in Op amps. Design of a two stage Op amp DRAM, SRAM, Sense Amplifiers, Design of Row and Column Decoders Flash Memory- NOR and NAND Flash Memory Cell

References

1. Razavi B., *"Design of Analog CMOS Integrated Circuits"*, Mc G Hill, 2001.
2. Sung-Mo Kang,Yusuf Leblebici , *"CMOS Digital Integrated Circuits: Analysis and Design "*,Third Edition, Tata McGraw-Hill 2003
3. Baker, Li, Boyce, *"CMOS: Circuits Design, Layout and Simulation"*, Prentice Hall India, 2000
4. Phillip E. Allen, Douglas R. Holbery, *"CMOS Analog Circuit Design "*, Oxford, 2004

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAC 1004 ADVANCED DIGITAL SYSTEM DESIGN

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- Starting from the basic XOR,EQV algebra, the course systematically teaches the hazard issues in digital design, and then the design and analysis methods for synchronous and asynchronous state machines.

Learning Outcomes

- Identify, formulate, and solve engineering problems in the area of digital logic circuit design
- An ability to optimize the design of different types of digital systems to meet specifications
- Able to identify potential hazards/ORGs in given FSM design and to provide solutions for the hazards / ORGs

Module I

XOR and EQV operators and their mixed circuit symbology. Laws of XOR algebra. Entered variable K map minimization.Introduction to Espresso Algorithms and cube representation Binary decision diagrams. Reed Muller transformation forms. CRMT minimization. Propagation Delay and Timing Defects in combinational Logic. Hazards – static and dynamic. Essential hazards. Static hazard free and dynamic hazard free combinational logic circuits design. Function hazards. The Basic Memory Cells : The Set-Dominant Basic Cell, The Reset-Dominant Basic ,Mixed-Rail Outputs of the Basic Cells Triggering Mechanisms , The D Flip-Flops: General , The D-Latch, The RET D Flip-Flop , The Master-Slave D Flip-Flop , Flip-Flop Conversion: The T, JK Flip-Flops and Miscellaneous Flip-Flops , 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 Simple Synchronous State Machines with Edge-Triggered Flip-Flops: Map Conversion ,Analysis of Simple State Machines

Module II

Synchronous State machine Design and analysis:Procedure for FSM design and Mapping Algorithm.Flip Flop conversions.Design of simple Synchronous State machine Design with edge-triggered flip-flop. Analysis of simple State machine. Detection and elimination of output race glitches. Detection and elimination of static hazards in the output logic. Asynchronous inputs: Rules and caveats. Clock skew. Clock sources and clock signal specifications. Initialization and reset of the FSM: Sanity circuits. Design of complex state machines. Algorithmic state machine charts and state tables. Array algebraic approach to logic design. State minimization. System-level design: controller, data path and functional partition.

Module III

Asynchronous state machine design and analysis**.** The one hot Design method. Lumped path delay models for asynchronous FSMs. Functional relationships and stability criteria. Excitation table for LPD model. State diagram, K-maps and state table for asynchronous FSMs. Design of the basic cells by using the LPD model. Design of the Rendezvous modules, , RET D flip-flop, RET JK flip-flop. Detection and elimination of timing defects in asynchronous FSMs. Single-transition-time machines and Array algebraic approach. Hazard-free design of fundamental mode FSMs. One-hot design of Asynchronous State Machines. Design and Analysis of fundamental mode FSMs.

References

1. Richard F. Tinder, *" Engineering Digital Design"*, Academic Press2001
2. Gray D Hatchel, *"Logic Synthesis and Verification Algorithms"*, Kluwer Academic Publishers.1996.
3. William I. Fletcher, *"An Engineering Approach to Digital Design"*, PHI,1996.
4. N.N. Biswas, *" Logic Design Theory"*, PHI, 1993.
5. James E. Palmer, David E. Perlman, *"Introduction to Digital Systems"*, TMH, 1996.
6. Richard F. Tinder, *"Asynchronous Sequential Circuit Design And Analysis: A Comprehensive Development of the Design and Analysis of Clock-independent State Machines and Systems"*

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAC 1101 INSTRUMENTATION AND CONTROL SYSTEM LAB

Structure of the Course

Lecture : 2 hrs/ Week Credits : 1

Internal Continuous Assessment : 100 Marks

Course Objectives

- Familiarising Various PLC software and Ladder Logic
- Familiarising GUI (Graphical user interface) software like SCADA and LabVIEW.
- Implementing various Control systems.

Learning Outcomes

- On completion of the LAB student will be capable doing PLC and SCADA programming in Industrial Level.
- On completion of the LAB student will get a sound understanding of Control system in industrial level.

1. Data Acquisition and control using Lab VIEW.
2. Controller tuning techniques
3. Determining the non-linearity of a system.
4. Distributed Control through PROFIBUS.
5. SCADA.
6. Control of Robotic arm.
7. PLC.
8. Cascade control.
9. Feed forward control.
10. Ratio Control
11. Inferential Control
12. Override Control

TAC 1102 **SEMINAR**

Structure of the Course

Duration : 2 hrs/ Week Credits : 2
Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in Applied Electronics and Instrumentation, with application of Signal Processing. 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.

Marks:

Seminar Report Evaluation : 50 Marks
Seminar Presentation : 50 Marks

TAC 2001 DESIGN OF EMBEDDED SYSTEMS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To explore the concepts of embedded system design
- To Study about embedded system design and its analysis
- To Study about software development tools

Learning Outcomes

- Understand the concepts of embedded system design
- Understand software development tools
- Understand , Analyze embedded system design and its applications

Module I

Introduction-characteristics of embedded computing applications-challenges in embedded computing design –design process: requirements-specification-architecture design-designing hardware and software components-system integration and testing-structural description-behavioral description.The Embedded Computing Platform CPU bus-memory devices-I/O devices-component interfacing-development and debugging-testing-design examples - alarm clock.

Module II

Program Design and Analysis Introduction-design patterns-data flow graph-control /data flow graphs-assembly and linking-basic compilation techniques-analysis and optimization of execution time, energy, power and program size program validation and testing-design examples :software modem.

Module III

System Design Techniques Introduction-design methodologies-requirement analysis-specifications-system analysis and architecture design-quality assurance- Software Development and Tools Introduction to assembler, compiler, cross-compiler, linker and integrated development environment debugging strategies-simulators-emulators-logic analysers - :introduction to JTAG.

References

1. Wayne Wolf, *"Computers as Components-Principles of Embedded Computing System Design"*, Morgan Kaufman Publishers, 2008.
2. David E. Simon, *" An Embedded Software Primer"*, Pearson Education, 2004.
3. Frank Vahid and Tony Givargi, *"Embedded System Design: A Unified Hardware/Software Introduction"*, John Wiley & Sons, 2001.
4. Steve Heath, *"Embedded System Design"*, Elsevier science, 2003.

5. Arnold S. Berger, *"Embedded System Design: An Introduction to Processors, Tools and Techniques"*, CMP Books, 2005.
6.Rechard Zurawski, *"Embedded System Hand Book"*, CRC Press, 2006

Structure of the Question paper
There will be three questions from each module out of which two questions are to be answered by the students. It shall have 50% design problems and 50% theory.

TAC 2002 MICRO ELECTRO MECHANICAL SYSTEMS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course objectives

- Introduction to the concepts of micro electro mechanical systems
- To enable students to learn the principles MEMS fabrication
- To impart design principles of micro electro mechanical systems

Learning Outcomes

- By the end of the course students will be able to understand, analyze ,design and optimize micro electro mechanical systems

Module I

MEMS based system design principles- Sensors and Actuators in MEMS – Conductometric sensors – Capacitive sensors – Piezoelectric sensors – magentostrictive sensors – semicondutor based sensors – Bio sensors – carbon nano tube sensors – electrostatic actuators – electromagnetic actuators – electrothermal actuators .

Module II

Microfabrication – Fabrication process for silicon MEMS - deposition tehniques for thin films in MEMS – Bulk micromachining – surface michromachining- processing by both bulk and surface machining –wet and dry etching - LIGA processes- microstereolithography .

Module III

System Case studies : Pressure Sensor – MEMS micro phone – Gyros- Accelerometer (In these case studies the principle, design consideration and one typical commercial device has to be studied)

Fabrication case studies : PVDF based transducer for structural health monitoring – SAW based accelerometers – cantilever based piezoelectric sensor.

References

1. V.K.Varadan,K.J.Vinoy,S.Gopalakrishnan, "*Smart material systems and MEMS*" Wiley India, 2011(Reprint).
2. Chang Liu, "*Foundations of MEMS*" Pearson , 2012.
3. Stephen D. Senturia, "*Microsystem Design*" , Kluwer Academic Publishers, 2001.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students.

TCC 2000 RESEARCH METHODOLOGY

Structure of the Course

Lecture	: 2 hrs/ Week	Credits : 2
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objective

- To formulate a viable research question
- To distinguish probabilistic from deterministic explanations
- To analyze the benefits and drawbacks of different methodologies
- To understand how to prepare and execute a feasible research project

Learning Outcomes

Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

Module I

Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods *vs.*Methodology. Type of research: Descriptive *vs.*Analytical, Applied *vs.* Fundamental, Quantitative *vs.* Qualitative, and Conceptual*vs.* Empirical. Research Formulation - Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem. Literature review: Primary and secondary sources - reviews, treatise, monographs, patents.Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis. (15 Hours)

Module II

Research design and methods: Research design - Basic Principles- Need forresearch design — Features of a good design. Important concepts relating to research design: Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction. Development of Models and research plans: Exploration, Description, Diagnosis, Experimentation and sample designs.Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection - Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-Testing -Generalization and Interpretation. (15 Hours)

Module III

Reporting and thesis writing - Structure and components of scientific reports -Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes. Presentation; Oral presentation - Planning - Preparation -Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.

Application of results of research outcome: Environmental impacts –Professional ethics - Ethical issues -ethical committees.Commercialization of the work - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction

of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability. (15 Hours)

References:

1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi,1990
2. Panneerselvam, “Research Methodology”, Prentice Hall of India, New Delhi, 2012.
3. J.W Bames,” Statistical Analysis for Engineers and Scientists”, McGraw Hill, New York.
4. Donald Cooper, “Business Research Methods”, Tata McGraw Hill, New Delhi.
5. Leedy P D, "Practical Research: Planning and Design", MacMillan 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 of India, New Delhi, 2012.

Structure of the question paper:

There will be three questions from each module out of which two questions are to be answered by the students.

TAC 2101 VLSI AND EMBEDDED SYSTEMS LAB

Structure of the Course

Lecture : 2 hrs/ Week Credits : 1
Internal Continuous Assessment : 100 Marks

Course Objectives

- Familiarising Various ARM kit and its programming.
- Familiarising CMOS analog and digital.
- Application of C and C++ programming.

Learning Outcomes

- On completion of the LAB student will be capable doing programming in ARM kit.
- On completion of the LAB student will get a sound understanding of CMOS and C programming.

VLSI EXPERIMENNTS USING TANNER TOOLS:

CMOS analog circuits
CMOS digital circuits
CMOS implementation of Neural Networks
Reference voltage sources
Experiments using available kits, packages and tools.

EMBEDDED SYSTEMS EXPERIMENTS

1. Embedded Applications using C Programming and C++ programming
2. Assembler level programming for ARM
3. C programming to illustrate ARM/Thumb Networking

TAC 2102 THESIS PRELIMINARY: PART-I

Structure of the Course

Thesis : 2 hrs/week Credits : 2

Internal Continuous Assessment : 100 Marks

For the Thesis-Preliminary part-I the student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/she should broadly identify the area of the Thesis work, familiarize with the design and analysis tools required for the Thesis work and plan the experimental platform, if any, required for Thesis work. The student will submit a detailed report of these activities at the end of the semester.

Distribution of marks

Internal assessment of work by the Guide : 50 marks

Internal evaluation by the Committee : 50 Marks

TAC 2103 **SEMINAR**

Structure of the Course

Duration	: 2 hrs/ Week	Credits : 2
Internal Continuous Assessment	: 100 Marks	

The student is expected to present a seminar in one of the current topics in Electronics, Communication, Instrumentation, Computers, Information Technology, Control systems and related areas with application of Signal Processing. 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.

Marks:

Seminar Report Evaluation	: 50 Marks
Seminar Presentation	: 50 Marks

TAE 2001 MEDICAL INSTRUMEMTATION

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course objectives

- Introduction to the concepts of biomedical structures ,transducers and equipments.
- To enable students to appreciate various biomedical measurements .
- To impart design principles of biomedical measurement systems.

Learning Outcomes:

- By the end of the course students will be able to understand analyze, design and optimize biomedical measurement systems

Module I

Cell and its structure – Action and resting – Potential propagation of action potential – Sodium pump – Nervous system – CNS – PNS – Nerve cell – Synapse – Cardio pulmonary system – Physiology of heart and lungs – Circulation and respiration – Transducers – Different types – Piezo-electric, ultrasonic, resistive, capacitive, inductive transducers – Selection criteria.

Module II

Basic components of a biomedical system – Electrodes – Micro, needle and surface electrodes – Amplifiers – Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier. ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms

Measurement of blood pressure – Cardiac output – Cardiac rate – Heart sound – Respiratory rate – Gas volume – Flow rate of Co_2, o_2 in exhaust air - PH of blood, ESR, GSR measurements – Plethysmography

Module III

X-ray machine - Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Electrical safety ,Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dializers.

References

1. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, '*Bio-Medical Instrumentation and Measurements*', II Edition, Pearson Education, 2002 / PHI.
2. 2. R.S.Khandpur, '*Handbook of Bio-Medical instrumentation*', Tata McGraw Hill Publishing Co Ltd., 2003.
3. L.A. Geddes and L.E.Baker, '*Principles of Applied Bio-Medical Instrumentation'*, John Wiley & Sons, 1975.
4. J.Webster, '*Medical Instrumentation'*, John Wiley & Sons, 1995.
5. C.Rajarao and S.K. Guha, '*Principles of Medical Electronics and Bio-medical Instrumentation*', Universities press (India) Ltd, Orient Longman ltd, 2000.

Structure of the Question paper
There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 2002 OPTICAL INSTRUMENTATION

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course objectives

- Introduction to the concepts of optical instruments and transducers .
- To impart knowledge about lasers and their applications .
- To impart design principles laser based measurement systems.

Learning Outcomes:

- By the end of the course students will be able to understand analyze, design and optimize Laser based measurement systems.

Module I

Lasers for instrumentation:-Condition for laser oscillations-Coherence, He-Ne laser -frequency stabilization, semiconductor lasers, line width and frequency stability. Triangulation, types of laser telemeters - Pulsed and sine wave telemeters -accuracy and ambiguity problem. LIDAR and applications.

Module II

Laser for interferometry:- Basic optical interferometers -Performance parameters and limits of performance. Laser vibrometry- white light interferometry. Speckle- pattern instruments-Speckle properties-Speckle in single point interferometers-electronic speckle pattern inteferometry

Module III

Laser Doppler Velocimetry-Principle of operation and performance parameters. Doppler signal processing.

Gyroscopes-The Sagnac effect-Basic Gyro configurations –Fiber optic Gyroscopes (FOG)-Open loop FOG-components and technology to implement FOGs.

References

1. Silvano Donati, *"Electro-Optical Instrumentation-Sensing and Measuring with Lasers"*, Pearson Education, 2005 Edn.
2. Vardeyen, Joseph, *"T-Laser Electronics"*, 2nd Edn 1993, Prentice Hall of India Private Limited

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 2003 **DIGITAL IMAGE PROCESSING**

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- Understand the various steps in digital image processing.
- Get a thorough understanding of digital image representation and processing techniques.
- Ability to process the image in spatial and transform domain for better enhancement.

Learning Outcomes

- Understand various techniques for image representation.
- Understand various low level image processing techniques including reconstruction from Projections.
- Understand the fundamentals of high level image processing.

Module I

Image representation - Gray scale and colour Images, image sampling and quantization. Two dimensional orthogonal transforms - DFT, FFT, WHT, Haar transform, KLT, DCT. Image enhancement - filters in spatial and frequency domains, histogram-based processing, homomorphic filtering.

Module II

Edge detection - non parametric and model based approaches, LOG filters, localization problem.
Image Restoration - PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.
Mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition.

Module III

Image and Video Compression Standards: Lossy and lossless compression schemes: Transform Based, Sub-band Decomposition, Entropy Encoding, JPEG, JPEG2000, MPEG
Computer tomography - parallel beam projection, Radon transform, and its inverse, Back-projection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection.
Image texture analysis - co-occurence matrix, measures of textures, statistical models for textures.Hough Transform, boundary detection, chain coding, segmentation and thresholding methods.

References

1. Gonzalez and Woods, *"Digital image processing"* , Prentice Hall, 2002.
2. A. K. Jain, *"Fundamentals of digital image processing"*, Prentice Hall of India,1989.
3. M. Haralick, and L.G. Shapiro, *"Computer and Robot Vision"*, Vol-1, Addison Wesley, Reading, MA, 1992.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% problems and 40% theory.

TAE 2004 NANO ELECTRONICS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

- Introduction to electronics at nano scale.
- Get a thorough understanding of laws governing atomic structure, reversible computation and quantum logic

Learning Outcomes

- After the course the student will be capable to Design, analyze, and develop quantum computing systems

Module I

An atomistic view of electronic conduction, Schrodinger equation, Self-consistent field -Basis functions, Band structure, Sub-bands - Capacitance, Level broadening Coherent transport - Atom to transistor and new paradigms in nano electronics - Modeling and Analysis of single electron transistor (SET).

Module II

Reversible Computation - Reversible Turing machine- Entropy of Logic gates - Energy and Information Loss - Reversible Logic Gates- requirements - NOT, k-CONT, TOFFOLI gates

Module III

Reversible Logic synthesis - Elimination of Garbage - Reversible Lattice structures - Modified Reconstructability Analysis (MRA), Reversible Decision Diagrams, Quantum computation and Quantum Logic gates

References

1. S. Data, *"Quantum Transport: Atom to Transistor"*, Cambridge University Press, 2005
2. David K. Ferry, Shunt Oda, *"Silicon Nanoelectronics"*, CRC Press, 2005
3. A N Al-Rabadi, *"Reversible Logic synthesis from Fundamental to Quantum computing*, Springer 2004
4. CH Bennet, *"Logical Reversibility of Computation"*, IBM Jl. of Res. Develp., 17:525-532, 1973
5. CH Bennet, *"The thermodynamics of computation - a review"*, Int. J. Of theoret. Phys., 21(1982) 905-940
6. R Lanunder, *"Irreversibility and heat generation in the computing process"*, IBM Jl. of Res. Develp., 5:183-191, 1961

7. Vivek V Shende, Aditya K Prasad etc, *"Synthesis of Reversible Logic circuits"*, IEEE Tran. on Comp. aided Design of Integrated Circuits and Systems, Vol 22, No 6, 710-722, June 2003

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 50% problems and 50% theory.

TAE 2005 ROBOT DYNAMICS AND CONTROL

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- Analyze the kinematics of robot arms and force propagation through linkages
- Develop dynamic models for robot arms and robot control strategies
- Perform path and motion planning
- Develop simulations of robotic systems

Learning Outcomes

- Design, model, analyze, simulate and develop robotic systems

Module I

Introduction – Historical information, Elements of robots – links, joints, actuators, and sensors, robot characteristics, robot anatomy, basic structure of robots, resolution, accuracy and repeatability. Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Module II

Robot Kinematics: Position Analysis forward and inverse kinematics of robots, including frame representations, transformations, position and orientation analysis, and the Denavit-Hartenberg representation of robot kinematics, the manipulators, the wrist motion and grippers. Examples- Kinematics analysis and inverse kinematics analysis of four axis, five axis and six axis robot.
Differential motions, Inverse Manipulator Kinematics: differential motions and velocity analysis of robots and frames. Dynamic Analysis and Forces analysis of robot dynamics and forces. Lagrangian mechanics

Module III

Motion planning and control- Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Nonlinear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators. **Modeling and control of flexible robots -** Models of flexible links and joints, Kinematic modeling of multilink flexible robots, Dynamics and control of flexible link manipulators. **Modeling and analysis of wheeled mobile robots -**

Introduction and some well known wheeled mobile robots (WMR), two and three-wheeled WMR on flat surfaces, Slip and its modeling, WMR on uneven terrain, Design of slip-free motion on uneven terrain, Kinematics, dynamics and static stability of a three-wheeled WMR's on uneven terrain.

References

1. Gonzalez, R. C., Fu, K. S. and Lee, C.S.G. *" Robotics Control Sensing, Vision and Intelligence"*, McGraw Hill (1987).
2. Ghosal, A., *"Robotics: Fundamental Concepts and Analysis"*, Oxford University Press, 2nd reprint, 2008.
3. Murray, R.M., Li, Z., and Sastry, S.S., *"A Mathematical Introduction to Robotic Manipulator"*, CRC Press, 1994.
4. Merlet, J.-P., *"Parallel Robots"*, Kluwer Academic, Dordrecht, 2001.
5. Featherstone, R.S., *"Robot Dynamics Algorithms"*, Kluwer Academic Publishers, 1987.
6. Haug, E.J., *"Computer-Aided Kinematics and Dynamics of Mechanical Systems: Basic Methods"*, Vol. 1, Allyn and Bacon, 1989.
7. Siciliano, B., and Khatib, O. (Editors), *"Handbook of Robotics"*, Springer, 2008.
8. Craig, J. J., *"Introduction to Robotics: Mechanics and Control"*, 2nd Edition, Addison-Wesley, 1989.
9. Koren,Y., *" Robotics for Engineers"*, McGraw Hill (1985).
10. Niku, S.B.,*"Introduction to Robotics, Analysis, Systems, Applications"*, Dorling Kingsley

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 50% design problems and 50% theory.

TAE 2006 MIXED SIGNAL CIRCUIT DESIGN

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- Introduction to mixed signal circuits.
- Get a thorough understanding of the design of CMOS op amps and circuits.

Learning Outcomes

- After the course the student will be capable to Design, analyze, and develop mixed signal circuits

Module I

Standard CMOS device models – BSIM 3, BSIM 4. Differential Amplifiers, Cascode differential amplifier, Wide Swing Differential Amplifier.

Module II

Design of CMOS Op Amps, Compensation, Low Noise Op Amps, Low voltage Op Amps. Design of two stage open loop comparator, High speed comparators.

Module III

Switched capacitor circuits – First order switched capacitor circuits, capacitor filters. PLL, Sense amplifiers, DAC, ADC – High speed ADC, Over sampling ADC.

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

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TCD 2001 DESIGN OF VLSI SYSTEMS

Structure of the Course

Lecture	: 3 hrs/ Week	Credits: 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

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

Learning Outcomes

- Understand the basics of VLSI Design
- Understand the working of high speed adders and multipliers
- Understand , various methods in the design of memory elements

Module I

CMOS Inverter - Static Behaviour, Performance of CMOS Inverter - Dynamic Behaviour, Power Energy and Energy Delay, CMOS Circuit and Logic Design-CMOS Logic structures. Advanced techniques in CMOS Logic Circuits-Mirror circuits, Pseudo NMOS, Tri-state circuits, Clocked CMOS, Dynamic CMOS Logic circuits, Dual Rail Logic Networks.

Module II

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, Low power design- Scaling Versus Power consumption, Power reduction techniques .

Module III

Designing Memory and Array Structures - Memory classification, Memory Core - Read Only Memories, Non-volatile Read Write Memories, Read Write Memories, Content - Addressable or Associative Memories, Memory Peripheral Circuits - Address Decoders, Sense Amplifiers.

References

1. John P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons 2002
2. Kesshab K. Parhi, 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

Structure of the Question Paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% problems and 40% theory.

TCD 2002 SOFT COMPUTING

Structure of the Course

Lecture	: 3 hrs/ Week	Credits: 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

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

Learning Outcomes

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

Module 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. Concepts of Artificial Neural Networks: Basic Models and Learning rules of ANN's. Single layer perceptron networks – Feedback networks – Supervised and unsupervised learning approaches – Neural Networks in Control Systems.

Module II

Integration of Fuzzy and Neural Systems: Neural Realization of Basic fuzzy logic operations – Neural Network based fuzzy logic inference – Neural Network based Fuzzy Modelling – Types of Neural Fuzzy Controllers. Data clustering algorithms - Rule based structure identification- Neuro-Fuzzy controls - Simulated annealing.

Module III

Survival of the Fittest - Fitness Computations - Cross over - Mutation -Reproduction - Rank method–Rank space method AI search algorithm - Predicate calculus - Rules of interference – Semantic networks - Frames - Objects - Hybrid models - Applications.

References:

1. Jyh Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, (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. Nih J.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

Structure of the Question Paper
There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% problems and 40% theory.

TCD 2003 OPTIMIZATION TECHNIQUES

Structure of the Course

Lecture	: 3 hrs/ Week	Credits: 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

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

Learning Outcomes

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

Module I

One dimensional – necessary and sufficient conditions, Search methods- Fibonacci search, golden section search, Gradient methods- Newton- Raphson method, cubic search. Multivariable- necessary and sufficient conditions, Search methods- Evolutionary method, Hook-Jeevs pattern search, Gradient based methods- steepest descent, Newton's method, conjugate gradient method.

Module II

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. 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.

Module III

Meta-heuristic optimization Techniques- (Principle and implementation steps for examples related to engineering (signal processing, communication, control system) optimization of the following) Differential Evolution (DE), Harmony Search Algorithm (HSA), Artificial Bee Colony Algorithm (ABC).

References:

1. Optimization for Engineering Design, Algorithms and Examples. -PHI, ISBN -978-81-203-0943-2, Kalyanmoy Deb, IIT Kanpur.
2. Unit - 4 Corresponding publications.

Structure of the Question Paper
There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% problems and 40% theory.

TCD 2004 INFORMATION HIDING & DATA ENCRYPTION

Structure of the Course

Lecture	: 3 hrs/ Week	Credits: 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- The ability to do Cryptography, watermarking and Steganalysis
- Should be able to use various Data Hiding techniques
- Ability to apply encryption techniques in dataforvarious applications

Learning Outcomes

- Understand Cryptography, watermarking and Steg analysis
- Understand capabilities of encryption techniques in data for various applications
- Understand, Analyse various Data Hiding techniques

Module I

Introduction to Complexity theory, Elementary Number theory, Algebraic Structures- Groups, Rings and Finite Fields, Polynomials over Finite Fields (Fq). Classical Cryptography, Stream Ciphers, Public Key Cryptography: based on Knapsack problem, AES. Digital Signature, Zero Knowledge Proofs.

Module II

Information Hiding: Watermarking, Steganography. Objectives, difference, requirements, types (Fragile and robust).Parameters and metrics (BER, PSNR, WPSNR, Correlation coefficient, MSE, Bit per pixel). LSB, additive, spread spectrum methods. Applications: Authentication, annotation, tamper detection and Digital rights management. Hiding text and image data, mathematical formulations.

Module III

Hiding in 1D signals: Time and transform techniques-hiding in Audio, biomedical signals, HAS Adaptive techniques. Hiding in 2D signals: Spatial and transform techniques-hiding in images, ROI images, HVS Adaptive techniques. Hiding in video: Temporal and transform domain techniques, Bandwidth requirements. Steganalysis: Statistical Methods, HVS based methods, SVM method, Detection theoretic approach.

References:

1. Neal Koblitz, *A Course in Number Theory and Cryptography*, 2nd Edition, Springer
2. Stefan Katzenbeisser, Fabien A. P. Petitcolas, *Information Hiding Techniques for Steganography and Digital Watermarking,* Artech House Publishers, 2000.
3. Neil F Johnson et al Kluwer, *Information hiding: steganography and watermarking attacks and countermeasures* Academic Publishers London.
4. Ingmar J Cox eta al *Digital Watermarking,* Morgan Kaufman Series, Multimedia information and system.
5. Ira S Markowitz, Proceedings, *4th international workshop,* IH 2001, Pittsburg, USA April 2001 Eds: 2. AVISPA package homepage, http:/ www.avispaproject.org/

6. Handbook of Applied Cryptography, AJ Menezesetc al, CRC Press

Structure of the Question Paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% problems and 40% theory.

TAE 3001 RF MEMS CIRCUIT DESIGN

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

- Introduction to RF MEMS .
- Get a thorough understanding of the Physical and practical aspects of RF circuit design.

Learning Outcomes

- After the course the student will be capable to Design, analyze, and develop RF MEMS

Module I

Physical and practical aspects of RF circuit design. Impedance mismatch effects in RF MEMS. RF/Microwave substrate properties. Micro machined- enhanced elements. MEM switches. Resonators. MEMS modeling.

Module II

Reconfigurable circuit elements. Resonator MEMS switch Tunable CPW resonator. MEMS microswitch arrays. Reconfigurable antenna. MEMS phase shifters. Types of phase shifters. Switched delay line phase shifters. Distributed MEMS phase shifters.

Module III

RF MEMS filters. Modeling of mechanical filters and resonators. SAW filters. Micromachined filters for millimeter wave applications.

References

1. H.J.D.Santos, *"RF MEMS Circuit Design for Wireless Communications"*, Artech House , 2002.
2. G.M.Rebeiz , *"RF MEMS Theory , Design and Technology"*, wiley , 2003.
3. V.K.Varadan etal, *"RF MEMS and their Applications"*, Wiley,2003

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 3002 LOW POWER VLSI DESIGN

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- Awareness regarding the importance of low power design and the possibilities.
- Aware students design optimizations with special focus on circuit level .
- Aware students the class of art techniques in VLSI design with power and delay tradeoffs.

Learning Outcomes

- Understand various power optimization techniques.
- Understand importance of delay power tradeoffs.
- Understand the ultra low power design concepts.

Module I

Need for low power design, Nanometer transistor behavior and models Sub-threshold currents and leakage Power and Energy Basics: Metrics, Dynamic power, Static power Energy– delay trade-offs.

Module II

Circuit level power optimization : Dynamic-power optimization, Static-power optimization System and architecture level Power optimization Interconnect optimization and clock distribution.

Module III

Power optimization in memory circuits, Power optimization techniques in standby mode, Runtime optimization techniques. Ultra low power design concepts.

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. 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.
7. Jan Rabaey Low *"Power Design Essentials"*, Springer

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 3003 INDUSTIAL DRIVES AND CONTROL

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- To understand the basic concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives

Learning Outcomes

- By the end of the course students will be able to understand ,analyze ,design and optimize industrial drives and associated circuits .

Module I

Basic Elements – Types of Electric Drives –factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.

Module II

Types of D.C Motor starters –Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors. Speed control of DC series and shunt motors – Armature and field control, Ward- Leonard control system - Using controlled rectifiers and DC choppers –applications.

Module III

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

References :

1. Vedam Subrahmaniam, *"Electric Drives (concepts and applications)"*, Tata McGraw-Hill, 2001
2. Nagrath .I.J. & Kothari .D.P, *"Electrical Machines"*, Tata McGraw-Hill, 1998
3. Pillai.S.K *"A first course on Electric drives"*, Wiley Eastern Limited, 1998
4. M.D.Singh, K.B.Khanchandani, *"Power Electronics"*, Tata McGraw-Hill, 1998
5. H.Partab, *"Art and Science and Utilisation of electrical energy"*, Dhanpat Rai and Sons, 1994

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 50% design problems and 50% theory.

TAE 3004 PWM SCHEMES FOR POWER CONVERTERS

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objectives

- To understand the basic concepts of different types of PWM schemes and their performance.
- Study of multi level inverters, modulation schemes, optimum switching and DSP based implementation

Learning Outcomes

- By the end of the course students will be able to understand , analyze ,design and optimize Multi level inverters, modulation schemes and associated systems .

Module I

Three phase Voltage Source Inverters (VSI) - Fundamental Concepts of PWM schemes, Sine-Triangle PWM, - Space Vector PWM - Comparison of Sine-Triangle PWM and Space Vector PWM - Zero vectors and importance of their placement in PWM -Harmonic Distortion-Harmonic Distortion factors for 3 phase inverters, Harmonic loses in PWM.

Module II

Multilevel Inverters- Fundamental Concepts, Modulation schemes- Sine triangle PWM and Space vector PWM 3-level inverters, Extension of the schemes to higher level inverters. Optimum switching in space vector PWM- Over modulation of a Voltage Source Inverter- Space Vector approach to Over modulation - Implementation of PWM controllers- Overview, DSP based implementation.

Module III

Current hysterisis control of a Voltage Source Inverter - Introduction to Random PWM strategy .

Reference

1. G.Holmes & T.A. Lipo, *"Pulse width Modulation for Power Converters, Principle and practice"*, IEEE Press, 2003
2. M.P.Kazmierkowski , *"Control of Power Converters : Selected Problems"*, Academic Press, 2003

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 3005 WIRELESS SENSORS AND SYSTEMS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course objectives

- Introduction to the concepts of wireless sensors and associated circuits and networking
- To enable students to appreciate various applications of wireless sensor networks
- To impart design principles of wireless networks

Learning Outcomes

- By the end of the course students will be able to understand analyze ,design and optimize wireless sensors and networks.

Module I

Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks. Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

Module II

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing,

Module III

Topology Control , Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control Sensor Node Hardware – Berkeley Motes, Programming Challenges

References

1. Holger Karl & Andreas Willig, *" Protocols And Architectures for Wireless Sensor Networks"* , John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, *"Wireless Sensor Networks- An Information Processing Approach"*, Elsevier, 2007
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, *"Wireless Sensor Networks- Technology, Protocols, And Applications"*, John Wiley, 2007.
4. Anna Hac, *"Wireless Sensor Network Designs"*, John Wiley, 2003.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 3006 ALGORITHMS FOR VLSI DESIGN AUTOMATION

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objective

- 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.

Learning Outcome

- Learn the physical problems and their mathematical formulation in VLSI Physical design.
- Learn efficient algorithms to solve the physical design automation problems
- Adapts the students, to inherits the methods learned, to address the emerging physical design
- Automation problems.

Syllabus:

Introduction to problems and algorithms in VLSI design flow and automation tools - structural, logical, transistor, physical and layout level design and extraction.

Module 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.

Graph algorithms for physical design classes problems. Algorithm for interval, permutation and circle graphs (MIS, Cliques).

Module II

Physical design automation algorithms: Clustering: Rajaraman and Wong algorithm, Flowmap algorithm, Multi-level coarsening algorithm. Partitioning: Kernighan and Ling Algorithm, EIG Algorithm, FBB algorithm. Floorplanning: Stockmayer algorithm, Normalized polish expression, ILP Floorplanning. Routing: Steiner routing.: L-shaped Steiner routing, 1-steiner routing, bounded radius and A-tree routing algorithms. Stainer min-max Tree multinet algorithm.

Module III

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. Layout compaction- problem formulation, 1-Dimensional compaction- constraint-graph and virtual graph based compactions. 2-dimensional and hierarchical compaction algorithms. Layout extraction.

References

1. Naveed A. Sherwaniz , *"Algorithms for VLSI Physical Design Automation"*, Kluwer Academic Press,3e.
2. Sung Kyu Lim,*"Practical Problems in VLSI Physical Design Automation"*, Springer, 2008.
3. Sung Kyu Lim,*"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 Sapatnekar etc, *"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.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 50% design problems and 50% theory.

TAE 3007 COMPUTER AIDED DESIGN OF CONTROL SYSTEMS

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objective

- As a graduate level course on Computer Aided Design, this course assure to deliver the students, a thorough understanding of the mathematical principles of computer aided design of control systems and practical tools like MATLAB and SIMULINK used for computer aided design of control systems.

Learning Outcome

- Learn the mathematical principles of computer aided design of control systems .
- Learn the use of MATLAB and SIMULINK used for computer aided design of control systems.

Module I

Introduction – The design process – Quantitative behavior and stability theory – Liapunov stability theorems – Root locus analysis – construction – design concepts . Case study: A light source tracking system, control of a flexible space craft – Root locus design – cascade P plus I compensator – cascade lead compensator – cascade lag lead compensator.

Module II

Case study control of a flexible space craft – State space analysis – state space representation – state transformation and diagonalisation – stability – controllability – observability – state space design – State feedback and pole placement – case study: A magnetic levitation system.

Module III

Control system design using MATLAB & SIMULINK Part-I. Introduction – the design process – simulating simple systems with SIMULINK – mathematical modes of systems – state variable models – feedback control system characteristics – performance of feedback control systems.

Control system design using MATLAB & SIMULINK Part-II. Stability of linear feedback systems – Root locus method – Design of feedback control systems – Design of state variable feedback systems – Robust control systems.

References :

1. Raymond T Stefani etal, *"Design of feedback control system"*, 3rd edn., Saunder's College Publishing
2. Bernard Friedland, *"Advanced Control System Design"*, PHI
3. John J D'Azoo, Constantine H Houpis, *"Linear Control System Analysis & Design"*, 4th Edn., Mc. Graw Hill

4. John J D'Azoo, Constantine H Houpis, *"Linear Control System Analysis & Design"*, 4th Edn., Mc. Graw Hill
5. Edward W Kamen, Bonnies S Heek, *"Fundamentals of Signals and Systems using MATLAB"*.
6. Robert H Bishop, *"Modern Control Systems Analysis & Design using MATLAB & SIMULINK"*, Addison Wesley.

Structure of the Question paper
There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAE 3008 SYSTEM MODELING AND IDENTIFICATION

Structure of the Course

Lecture	: 3 hrs/ Week	Credits : 3
Internal Continuous Assessment	: 40 Marks	
End Semester Examination	: 60 Marks	

Course Objective

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

Learning Outcome

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

Module 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.

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.

Module II

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.

Parameter estimation in closed loop: process identification without and without additional signals. methods for identification in closed loops.

Module III

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.

Parameter estimation in nonlinear systems. Dynamic systems with continuously differentiable non linearities- Volterra: series, Hammaerstein series, Weinier model, Latchmann models and parameter estimation.

References

1. Rolf Isermann, Marco Munchhof,*"Identification of Dynamic Systems: An Introduction with Applications"*, Springer, 2011.
2. Oliwer Nelles,*"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. Tohru Katayama,*"Subspace Methods for System Identification"*, Springer, 2005.
5. Tokunbo Ogunfunmi,*"Adaptive Nonlinear System Identification"*, Springer, 2007.
6. Rolain Yves, Pintelon Rik, Schoukens Johan,*"Mastering System Identification in 100 Exercises"*, John Wiley and Sons, 2012.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students. It shall have 60% design problems and 40% theory.

TAC 3101 **THESIS PRELIMINARY: PART II**

Structure of the Course

Thesis	: 14 hrs/week	Credits: 5
Internal Continuous Assessment	: 200 Marks	

The Thesis Preliminary Part - II is an extension of Thesis Preliminary Part - I. Thesis Preliminary Part II comprises preliminary thesis work, two seminars and submission of Thesis - Preliminary report. The first seminar would highlight the topic, objectives and methodology and the second seminar will be a presentation of the work they have completed till the third semester and the scope of the work which is to be accomplished in the fourth semester, mentioning the expected results.

Distribution of marks

Internal assessment of work by the Guide	: 100 Marks
Internal evaluation by the Committee	: 100 marks

TMC 4101 **THESIS**

Structure of the Course

Thesis	: 21 hrs/week	Credits: 12
Internal Continuous Assessment	: 300 Marks	
End Semester Examination	: 300 Marks	

The student has to continue the thesis work done in second and third semesters. There would be an interim presentation at the first half of the semester to evaluate the progress of the work and at the end of the semester there would be a pre-Submission seminar before the Evaluation committee for assessing the quality and quantum of work. This would be the qualifying exercise for the students for getting approval from the Department Committee for the submission of Thesis. At least once technical paper is to be prepared for possible publication in Journals/Conferences. The final evaluation of the Thesis would be conducted by the board of examiners constituted by the University including the guide and the external examiner.

Distribution of marks

Internal evaluation of the Thesis work by the Guide : 150 Marks

Internal evaluation of the Thesis by the Evaluation Committee : 150 Marks

Final evaluation of the Thesis Work by the Internal and External Examiners:

[Evaluation of Thesis: 200 marks *+ Viva Voce: 100 marks (**5% of the marks is ear marked for publication in Journal/Conference*)] TOTAL – 300 Marks