APPLIED ELECTRONICS
AND INSTRUMENTATION
# M.Tech. Programme

**Electronics and Communication – Applied Electronics and Instrumentation**

## Curriculum and scheme of Examinations

### SEMESTER I

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs/week</th>
<th>Exam duration</th>
<th>Marks</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>TAM 1001</td>
<td>Mathematical Methods for Electronics</td>
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<td>TAC 1002</td>
<td>Non Linear and Adaptive Control Systems</td>
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- **Remarks:**
  - Do
  - End Semester Examination
**SEMESTER II**

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<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>Exam duration</th>
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**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

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>Exam duration</th>
<th>Continuous Assessment</th>
<th>End Semester Exam</th>
<th>Total</th>
<th>Remarks</th>
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** 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
<table>
<thead>
<tr>
<th>Code No</th>
<th>Subject Name</th>
<th>Credits</th>
<th>Hrs/week</th>
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</table>
Structure of the Course
Lecture : 3 hrs/ Week
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:
2. Fraleigh, ”A first course in abstract algebra”, Narosa
5. J.Medhi, ”Stochastic processes”, New Age International, India
Cambridge university 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.
TMC 1001 ADVANCED DIGITAL SIGNAL PROCESSING

Structure of the Course
Lecture : 3 hrs/ Week
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits : 3

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

Module II

Module III

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
   Pearson Education

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
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits : 3

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

Module III
References

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
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits : 3

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

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
References
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
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

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

Module II
Module III

References

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.
Structure of the Course
Lecture : 2 hrs/ Week
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
Structure of the Course

Duration : 2 hrs/ Week
Continuous Assessment : 100 Marks

Credits : 2

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 EMBEDED SYSTEMS

Structure of the Course
Lecture : 3 hrs/ Week  
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

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

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<td>End Semester Examination</td>
<td>60 Marks</td>
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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

Module II
Microfabrication – Fabrication process for silicon MEMS - deposition techniques for thin films in MEMS – Bulk micromachining – surface micromachining- 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).

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/ 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 for research 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
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

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
Internal Continuous Assessment: 100 Marks
Credits: 1

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 EXPERIMENTS 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
Internal Continuous Assessment : 100 Marks

Credits : 2

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 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 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


Module II

Measurement of blood pressure – Cardiac output – Cardiac rate – Heart sound – Respiratory rate – Gas volume – Flow rate of CO₂, O₂ in exhaust air – PH of blood, ESR, GSR measurements – Plethysmography

Module III


References

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

<table>
<thead>
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<th>Study Component</th>
<th>Details</th>
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<tbody>
<tr>
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<td>40 Marks</td>
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<tr>
<td>End Semester Examination</td>
<td>60 Marks</td>
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</table>

Credits: 3

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

Module II

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


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
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits : 3

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
References

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*

<table>
<thead>
<tr>
<th></th>
<th>Lecture</th>
<th>Credits</th>
<th>Internal Continuous Assessment</th>
<th>End Semester Examination</th>
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<tbody>
<tr>
<td></td>
<td>3 hrs/ Week</td>
<td>3</td>
<td>40 Marks</td>
<td>60 Marks</td>
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</table>

*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
3. A N Al-Rabadi, "Reversible Logic synthesis from Fundamental to Quantum computing, Springer 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 50% problems and 50% theory.
TAE 2005 ROBOT DYNAMICS AND CONTROL

Structure of the Course

- Lecture: 3 hrs/ Week
- 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

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


Module II


Module III

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

References


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.
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

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
2. Kesshab K. Parhi, VLSI DIGITAL SIGNAL PROCESSING SYSTEMS, John Wiley & Sons 2002

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
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits: 3

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


Module II


Module III


References:


*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
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

Module II

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:

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 
Internal Continuous Assessment : 40 Marks 
End Semester Examination : 60 Marks

Credits: 3

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

Module II

Module III

References:

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
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits : 3

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

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

References

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
- Gary Yeap "Practical Low Power Digital VLSI Design", 1997
- 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  INDUSTRIAL 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 :

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
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Credits : 3

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

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

Reference


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

Module II

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

References

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

Module III
References

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.
Structure of the Course

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

Course Objective

- As a graduate level course on Computer Aided Design, this course assures 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


Module II


Module III


References:

2. Bernard Friedland, "Advanced Control System Design", PHI
5. Edward W Kamen, Bonnies S Heek, "Fundamentals of Signals and Systems using MATLAB”.

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 assures 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

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

to subspace methods for system identification.

References

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.
Structure of the Course

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

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 earmarked for publication in Journal/Conference) ] TOTAL – 300 Marks