
ORDER

As per paper read as (1) above, an expert committee consisting of following members were constituted for framing the syllabus for the M.Tech Course in Instrumentation and Control Systems.

a) Dr. Thajudin Ahamed .V.I (Convenor)
   Professor & Head, Dept. of Electronics and Communication Engineering,
   Govt. Engineering College, Idukki, Painav.

b) Dr. C. Sathish Kumar, Professor, Dept. of Electronics & Communication Engineering

c) Dr. N. Vijayakumar, Associate Professor, Dept. of Electronics and Communication

Vide paper read as 2nd above, the meeting of Board of Studies in Engineering (P.G) held on 30.03.2012, vide item No. 1 unanimously resolved to approve the Scheme & Syllabus of the M.Tech course in Instrumentation and Control Systems.

Vide paper read as 3rd above, the Vice-Chancellor had ordered to seek the opinion of the Dean, Faculty of Engineering regarding the approval of the minutes of the meeting of the Board of Studies in Engineering (PG) held on 30.03.2012.

The Dean, Faculty of Engineering vide paper read as 4th above, recommended for the approval of the minutes of the meeting of the Board of Studies in Engineering (PG) held on 30.03.2012.

Considering the urgency of the matter, the Vice-Chancellor has accorded sanction to implement the Scheme & Syllabus of the M.Tech Course in Instrumentation and Control Systems, subject to ratification by the Academic Council, vide paper read as 5th above.

Sanction has therefore been accorded for implementing the Scheme & Syllabus of the M.Tech course in Instrumentation and Control Systems with effect from 2011 admission onwards.
Orders are issued accordingly.
(The Syllabus is available in the University website)

Sd/-
DEPUTY REGISTRAR (GA.IV)
For Registrar.

To

The Principals of all affiliated Engineering Colleges offering M.Tech Course.
Copy to :- P.S to V.C/PA. to PVC/ P.A. to Registrar/P.A to C.E/Enquiry Ex.Sn/EG Sn/DR,M.Tech M.Tech.Tabulation Section/Dean, Faculty of Engineering/ Chairman, BOS in Engg (PG)&(UG) System Administrator (with a request to upload in the university website)/ SF/FC

Forwarded/By Order

Sd/-
SECTION OFFICER
UNIVERSITY OF CALICUT

SCHEME AND SYLLABUS FOR
M.Tech
in
INSTRUMENTATION & CONTROL SYSTEMS
(2011 Admission onwards)

Scheme and Syllabus for M. Tech Programme in
Instrumentation & Control Systems
### SEMESTER 1

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course code</th>
<th>Subject</th>
<th>Hours/week</th>
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<td></td>
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<td>L  T  P</td>
<td>ICA  ESE</td>
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<td>3  1  0</td>
<td>100</td>
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<tr>
<td>2</td>
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<td>Modern Control Systems</td>
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<td>Advanced Instrumentation</td>
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<td>5</td>
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<td>Elective 1</td>
<td>3  1  0</td>
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</table>

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

**ELECTIVE I**

- EIC11 105 (A) Computer Controlled Systems
- EIC11 105 (B) Data Communications
- EIC11 105 (C) Optimization Techniques
- EIC11 105 (D) Biomedical Instrumentation

Note: 6 hours/week is meant for departmental assistance by students. Each student has to take up work assigned by the Head of the Department.

### SEMESTER 2

<table>
<thead>
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<td>L  T  P</td>
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<tr>
<td>1</td>
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<td>Process Control Instrumentation</td>
<td>3  1  0</td>
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<td>EIC11 202</td>
<td>Optimal &amp; Adaptive Control Theory</td>
<td>3  1  0</td>
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<td>3</td>
<td>EIC11 203</td>
<td>Non-linear Systems</td>
<td>3  1  0</td>
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<td>Elective II</td>
<td>3  1  0</td>
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*Industrial Training is for a minimum period of two weeks
ELECTIVE IV

EIC11 301 (A) Research Methodologies
EIC11 301 (B) Robust Control
EIC11 301 (C) Advanced topics in Control Systems
EIC11 301 (D) Bio-sensors

ELECTIVE V

EIC11 302 (A) VLSI Architecture & Design Methodologies
EIC11 302 (B) Soft Computing Techniques
EIC11 302 (C) Industrial Instrumentation
EIC11 302 (D) Optimal Estimation and Filtering

Note: 6 hours/week is meant for departmental assistance by students. Each student has to take up the work assigned by the Head of the Department.

SEMESTER 4

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<td>Guide Evaluation Committee</td>
<td>External Examineer</td>
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<td>Master Research Project Phase II</td>
<td>0 0 30</td>
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L-Lecture  T-Tutorial  P-Practical  ICA-Internal Continuous Assessment  ESE-End Semester Examination  EC-Evaluation Committee

Note: 6 hours/week is meant for departmental assistance by students. Each student has to take up the work assigned by the Head of the Department.

Total credits for all semesters: 75
Objective

 Objective: To enable the students to apply probability and reliability theory in various electrical engineering problems

 MODULE 1 (13 Hours)


 Sampling distributions: Sampling distributions of mean and variance – Estimation - Point animation - Interval Estimation - Test of hypothesis.

 MODULE 2 (14 Hours)

 Curve fitting: Method of least squares - Normal equations - Fitting of straight line - Fitting of second degree curve - Correlations and regressions - Curvilinear regression - Multiple regression & multiple correlation.

 Design of experiments: Analysis of variance - statistical principle of experimentation - Basic designs - Completely randomized design- Randomized block design.

 MODULE 3 (14 Hours)


 Markov chains: Definition and examples - Transition matrix - order of Markov chain - higher transition probabilities - Generalization of independent Bernoulli trails, Markov – Bernoulli chain - Correlated random walk - Classification of states and chains - Determination of higher transition probabilities - Stability of Markov system.

 MODULE 4 (13 Hours)

 Reliability: series configuration - Parallel configuration - An r-out of n configuration - Failure time distributions - Exponential model in reliability - Exponential model in life testing – Weibull model in life testing
REFERENCES:


2. Schupta and V.K.Kapoor Fundamentals of statistics(Sultan Chand)

3. J. Medhi- Stochastic Process- 2nd edition New age international publication-Chapter 2.1,2.2,2.3,3.1,3.2.3.3,3.4,3.5,3.6


Internal continuous assessment: 100 marks

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

End Semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.

<table>
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<tr>
<th>Module 1</th>
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<th>Module 3</th>
<th>Module 4</th>
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Objective

This course is intended to introduce design using state space model, basics of optimal control theory, robust control and predictive control.

MODULE 1 (14 Hours)

Review of State space modeling and analysis, controllability and observability concepts- State feedback and implementation- Arbitrary placement of poles using state feed back for continuous and discrete systems using controllable canonical form and any other state model - Design of full order and reduced order observers for implementing state feedback - Separation principle.

MODULE 2 (13 Hours)

Introduction to optimal control - Different types of performance measures - Linear quadratic regulator problem - Matrix Riccatti Equation - Linear Quadratic Gaussian (LQG) problem - Properties of Linear Quadratic Regulator (LQR) design - Optimal observers - LQG problem - Critique of LQG, Model-Reference control systems-design of controller, control system optimization by the second method of Liapunov.

MODULE 3 (14 Hours)

Feed forward control – Introduction - Ratio control - Feed forward controller design based on steady state models and dynamic models - Relationship between steady state and dynamic design methods - Configuration of feed forward control. Model predictive control – Overview - Prediction for Single Input Single Output (SISO) models - Multiple Input Multiple Output (MIMO) models - Model predictive control calculations - Set point calculations - Selection of design and tuning parameters - Implementation of model predictive control.

MODULE 4 (13 Hours)

Robust control system design-system sensitivities to parameter perturbation, sensitivity of a control system, system with uncertain parameters, stability of uncertain systems, design considerations for robust control system, design of robust PID controlled system.

Text Books

2. K.Ogata, Discrete time control systems, Prentice Hall Inc.
3. M.Gopal, Modern Control System Theory, New age International (P) Ltd.

REFERENCES


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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This course provides an exposure to the students on characteristics of instruments, sensors and transmitters. Also it gives an overview of data acquisition systems and virtual instrumentation.

**MODULE 1 (14 Hours)**

General concepts and terminology of measurement systems, static and dynamic characteristics, errors, standards and calibration. - Least square calibration curves - Calibration accuracy - installed accuracy - Effect of measurement error on quality control decision in manufacturing - static sensitivity - Computer aided calibration and measurement - Generalized Mathematical modeling of instruments - Classification of instruments based on their order - response of instruments to standard test input (Step ,Impulse, ramp) -frequency response studies.

**MODULE 2 (12 Hours)**

Sensors, Thermal sensors - Metal resistance versus temperature devices - Resistance temperature detectors - Characteristics of thermistor and thermocouple - Design considerations of thermal sensors - Introduction to transmitters - Two wire and four wire transmitters - Smart and intelligent transmitters - Design of transmitters.

**MODULE 3 (14 Hours)**

Cable transmission of analog voltage and current signals - Cable transmission of digital data – Fiber optic data transmission - Radio telemetry - Synchro position repeater systems - Slip rings and rotary transformers.

Engineered data acquisition and processing Systems - Versatile modular system emphasizing analog signal processing - Instrument inter connection systems - Sensor based computerized data system - Computer aided experimentation - Conditional description of the computer system.

**MODULE 4 (14 Hours)**

Historical perspective – Advantages - Block diagram and architecture of a virtual instrument – Data flow techniques - Graphical programming in data flow - Comparison with conventional programming - Development of virtual Instrument using Graphical User Interface (GUI).

Introduction to Lab VIEW - Software environment - Front panel - Block diagram – Palettes – Loops - Structures and Tunnels – Arrays – Clusters - Plotting data.
Text Books


REFERENCES


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Pattern for the Question paper

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<td>Question 4: 20 marks</td>
<td>Question 6: 20 marks</td>
<td>Question 8: 20 marks</td>
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</table>
Objective

To study the analysis and design of digital control systems-classical and advanced design methods for digital control system.

MODULE 1 (12 Hours)

Introduction to discrete time control system - Block diagram of a digital control system - Typical examples - Sampling process - Data reconstruction and hold circuits - Zero and first order hold - Review of z-transforms and inverse z-transforms - Solution of difference equations - Pulse transfer function - Pulse transfer function with dead time - System time response - Realization of pulse transfer functions (Digital Controllers) - Direct programming - Standard programming - Series programming - Parallel programming - Ladder programming.

MODULE 2 (16 Hours)


MODULE 3 (14 Hours)

State Space analysis of digital control systems - State space representation of discrete time systems - Transfer function from state model - Diagonal/ Jordan Canonical forms from transfer function - Solution of linear time invariant discrete time state equations - Discretization of continuous time space equation- Representing state models in Combinatorial Canonical Form (CCF), Observable Canonical Form (OCF), Diagonal Canonical Form (DCF)/ Jordan Canonical Form (JCF) using transformation matrix.

MODULE 4 (12 Hours)

Concept of controllability and observability for a linear time invariant discrete time control system - Condition for controllability and observability - State feedback - Condition for arbitrary pole placement - Design via pole placement - State observers - Design of full order state observer.
Text Books
1. K. Ogata, Discrete time control systems, PHI.

REFERENCES

Internal continuous assessment: 100 marks
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End semester Examination: 100 marks

Pattern for the Question paper
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<table>
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ELECTIVE 1

<table>
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<tr>
<th>EIC11 105(A)</th>
<th>COMPUTER CONTROLLED SYSTEMS</th>
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<td>Hours/week: Lecture-3 and Tutorial-1</td>
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Objective

*Giving an exposure to the students on different types of controllers and their implementations. Computer based control techniques are also discussed.*

MODULE 1 (14 hours)

Multivariable control - Basic expressions for MIMO systems - Singular values - Stability norms - Calculation of gain analysis - Effects of interaction - Response to disturbances - Decoupling system norms – Robustness - Robust stability - $H^2$ / $H^\infty$ Theory - Interaction and decoupling - Relative.

MODULE 2 (13 hours)

Programmable logic controllers - Organization- Hardware details - I/O- Power supply - CPU Standards - Programming aspects - Ladder programming - Sequential function charts - Man- machine interface - Detailed study of one model.

MODULE 3 (15 hours)

SCADA: Introduction - SCADA architecture - Different communication protocols- Common system components - Supervision and control - Human Machine Interface (HMI) - Remote Terminal Unit (RTU) and Supervisory Stations - Trends in SCADA - Security Issues.


MODULE 4 (12 hours)

Real time systems - Real time specifications and design techniques- Real time kernels - Inter task communication and synchronization - Real time memory management - Supervisory control - Direct digital control - Distributed control - PC based automation.
Text Books


REFERENCES


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.
Objective

Giving an exposure to the students on characteristics of communication network and to develop an idea about the industrial networks.

MODULE 1 (12 Hours)

Traffic characterization and services - Circuit switched and packet switched networks- Virtual circuit switched networks - OSI Model - Protocol layers and services - The physical layer -Theoretical basis for data communication - Signaling and modulation – Multiplexing - Transmission media - Physical interface and protocols.

MODULE 2 (14 hours)

The transport layer - Connectionless transport - UDP – TCP - Congestion control - Network layer series and routing - Internet protocol (IP) - Network layer addressing - Hierarchical addresses -Address resolution – Services – Datagram - Virtual circuits - Routing algorithm (Bellman Ford, Dijkstra)

MODULE 3 (14 hours)

Direct link Networks: Framing - Error detection - Reliable transmission - Multiple access protocols - Concept of LAN - Ethernet LAN – Ethernet frame structure - Ethernet (IEEE 802.3) - Token rings (IEEE 802.5 & FDDI) - Address resolution protocol - IEEE 802.11 LAN’s - Architecture and media access protocols – Hubs – Bridges – Switches – PPP – ATM - Wireless LAN.

MODULE 4 (14 hours)

Introduction to industrial networks – SCADA networks - Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED) - Communication Network - SCADA Server - SCADA/HMI Systems - Single unified standard architecture -IEC 61850 - SCADA Communication: various industrial communication technologies - Wired and wireless methods and fiber optics - Open standard communication protocols.
**Text Books**


**REFERENCES**

1. Keshav. An engineering approach to computer networking, Addison-Wesley, 1999


**Internal continuous assessment: 100 marks**

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**End semester Examination: 100 marks**

**Pattern for the Question paper**

Any five questions to be answered by choosing at least one question from each module.
Objective

To apply different optimization techniques to both linear and non-linear systems.

MODULE 1 (13 Hours)


MODULE 2 (14 Hours)

Unconstrained dimensional optimization techniques: Necessary and sufficient conditions - Search methods(unrestricted Fibonacci and golden) - Interpolation methods(Quadratic, Cubic and direct root method) - Direct search methods - Random search - Pattern search and Rosen Brock’s hill climbing method - Descent methods - Steepest descent - Conjugate gradient - Quasi Newton and DFE method.

MODULE 3 (14 Hours)

Constrained optimization techniques & dynamic programming: Necessary and sufficient conditions - Equality and inequality constraints - Kuhn-Tacker conditions - Gradient projection method - Cutting plane method - Penalty function method(Interior and exterior) - Principle of optimality - Recurrence relation - Computation procedure - Continuous dynamic programming.

MODULE 4 (13 Hours)

Recent developments in optimization techniques: Rosen brocks Rotating Coordinate Method - Tabu search-Simulated Annealing - Genetic Algorithm - Particle Swarm Optimization – Ant colony Optimization - Bees Algorithm.

REFERENCES:

Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Pattern for the Question paper

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Objective
This course imparts knowledge about origin of bioelectric signals and deals with different systems in human body. Also the course highlights the computerized analysis of bio signals, different imaging technology and gives an idea about bioinformatics.

MODULE 1 (14 Hours)

MODULE 2 (14 Hours)
General Considerations for signal conditioners- Biomedical signal analysis techniques-FFT – Signal Processing techniques-Effects of artifacts on ECG recordings-Computerized analysis of EEG—Frequency/Amplitude analysis-Display format-Compressed Spectral Array(CSA)- Frequency Response and Damping Adjustment of systolic and diastolic blood pressure- Cardiac Arrhythmias – Arrhythmia Monitor.

ECG QRS Detection and analysis – Power spectrum of ECG, QRS detection algorithm, ST-segment analyzer-ST Arrhythmia Algorithm-Data Compression and Processing of the ECG signal by AZTEC (Amplitude-Zone-Time-Epoch-Coding).

MODULE 3 (13 Hours)

MODULE 4 (13 Hours)
Concepts of Bio informatics- Genetic material-nucleotides-orientation-Central dogma-Gene structure and information content-Promotor sequences-genetic code-open reading frames-Introns and Exons – Protein Structure and functions-primary and secondary- Data searches and Pairwise Alignments-Dynamic Programming-Needle Man and Wunsch
Algorithm—Global and Local Alignment—The Smith—Waterman algorithm—Data Base Searches—BLAST and FASTA—Multiple Sequence Alignments.

Text Books
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India, New Delhi.
3. Dan .E. Krane, Michael L. Raymer ,Fundamental Concepts of Bioinformatics

REFERENCES

Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

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Objective

Familiarizing the students about measuring, processing, monitoring and analysing the data using special software such as MATLAB, LABVIEW etc.

- Experiments based on LabVIEW
  - Virtual Instrumentation
  - Data Acquisition Systems
- Experiments based on signal processing
  - Design and response of lowpass filters
  - Development and Implementation of FFT
  - Spectral analysis
  - Zero crossing detection – Simulation
- Data analysis experiments
  - Develop database of different measured parameters
  - Data sorting obtained from measurements
  - Load line analysis of electrical circuits
  - Prediction of traffic flow rate from a measured data base
  - Find unknown data using Least squares method
  - Analysis of measured temperature data
  - Temperature dynamics
  - Experiments based on curve fitting – for analysis of measured data
• Biomedical Instrumentation experiments
  - Design of instrumentation to measure aortic pressure and also to plot the aortic pressure response
  - Modeling of bacteria growth
  - Response of a biomedical instrument
• Level / Flow processing experiments
  - Distance travelled by a piston in an internal combustion engine
  - Optimization of an irrigation channel
  - Hydraulic resistance curve / flow rate Vs volume curve
  - Hydraulic cylinder simulation
  - Dynamics of liquid in a tank – animation
• Data monitoring experiments
  - Earthquake resistant building design – measuring natural frequencies of oscillation
  - To monitor the flight of an instrumented rocket
  - Computation of time to reach a specified height
• Measurements and Instrumentation
  - Modeling of non-linear pendulum and to plot its response
  - Measurements of force and deflection in a cantilever beam
• Robotics experiments
  - Computation of arm angle resolution for three knot points – path of a robot’s hand
  - Positioning a robot arm.

**Essential Software required – LabVIEW / MATLAB - SIMULINK**

**Internal continuous assessment: 100 marks**
- **Regularity** – 10%
- **Lab Practical & Record** – 40%
- Test – 50%  

<table>
<thead>
<tr>
<th>EIC11 107(P)</th>
<th>SEMINAR</th>
<th>Credits: 2</th>
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<td>Hours/week: 2</td>
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**Objective**

*This course is intended to assess the technical presentation capability of the students. Also to augment the skill of technical report writing.*

Individual students are required to choose a topic of their interest related to Instrumentation and Control systems preferably from outside the M.Tech course syllabus and give a seminar on that topic for about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Instrumentation and Control Systems) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and interaction by other students.

**Internal continuous assessment: 100 marks**
SEMESTER 2

EIC11 201
PROCESS CONTROL
INSRUMENTATION

Hours/week: Lecture-3 and Tutorial-1
Credits: 4

Objective

After this course the students are expected to get an idea about modeling of measuring systems, different types of processes, controllers. Advanced process control techniques are also discussed.

MODULE 1 (14 Hours)


MODULE 2 (13 Hours)

Introduction to Nonlinear process control - Model Reference Nonlinear Controller (MRNC) - MRNC incorporating integral and derivative actions - MRNC for systems with relative order two or higher, Series cascade control of nonlinear systems, parallel cascade control of nonlinear systems, Control of nonlinear, non minimum phase systems with input multiplicities. Parallel cascade control of non-minimum phase systems with input multiplicities - control of nonlinear systems with significant actuator dynamics, Control of nonlinear systems with actuator delay, nonlinear control of multi variable systems with input or output constraints, problems.

MODULE 3 (13 Hours)

Introduction to controller characteristics-process characteristics, process equation, process load, process lag, self-regulation, control system parameters, error, variable range, control parameter range, control lag, dead time, cycling, controller modes, discontinuous controller modes, two-position modes, multiposition mode, floating control mode, continuous controller modes, composite controller modes.

MODULE 4 (14 Hours)

Advanced process control - Multi-loop and multivariable control – Process Interactions -
Singular value analysis-Tuning of multi loop PID control systems-Decoupling control.

**Text Books**

1. Chidambaram M, Nonlinear Process Control, New Age International (P) limited publishers New Delhi

**REFERENCES**


**Internal continuous assessment: 100 marks**

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

**End semester Examination: 100 marks**

**Pattern for the Question paper**

Any five questions to be answered by choosing at least one question from each module.

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</table>
Objective

*The course aims to give an overview of the optimal control problem, adaptive control problem and different solution methods.*

**MODULE 1 (14 Hours)**


**MODULE 2 (14 Hours)**


**MODULE 3 (13 Hours)**


**MODULE 4 (13 Hours)**

Model Reference Adaptive systems (MRAS) - The need for MRAS - An over view of adaptive control systems - Mathematical description of MRAS - Design hypothesis - Equivalent representation of MRAS.
Text Books


REFERENCES

3. HSU and Meyer, Modern Control, Principles and Applications, Mc Graw Hill.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.
Objective:

*Giving an exposure to the students on characteristics, stability of nonlinear systems and addresses the analysis of feedback systems.*

**MODULE 1 (12 Hours)**


**MODULE 2 (15 Hours)**


**MODULE 3 (15 Hours)**


**MODULE 4 (12 Hours)**

Feedback Control and Feedback Stabilization - Analysis of feedback systems - Circle criterion - Popov criterion - Simultaneous Lyapunov functions - Feedback linearization - Stabilization - Regulation via integral control - Gain scheduling - Input state linearization - Input output linearization - State feedback control - Stabilization - Integral control.
Text Books


REFERENCES


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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ELECTIVE II

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<tr>
<th>EIC11 204(A)</th>
<th>SYSTEM IDENTIFICATION AND PARAMETER ESTIMATION</th>
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<td>Hours/week: Lecture-3 and Tutorial-1</td>
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Objective

Understanding and analysis of systems and models-model estimation methods-parameter estimation- experiment design.

MODULE 1 (13 Hours)

Models of linear time invariant systems- Linear models and sets of linear models- State space models – Distributed parameter models – Model sets structures and identifiability – Identifiability of some model structures – Models of time varying and nonlinear systems- Linear time varying models- Nonlinear state space models- Nonlinear black box models.

MODULE 2 (13 Hours)


MODULE 3 (15 hours)


MODULE 4 (13 Hours)

General Considerations – Informative experiments – Input design and open loop experiments – Closed loop identification – Approaches – Optimal experiment design – Choice of sampling interval – Preprocessing of data – Drifts de-trending – Outliers and missing data – Selecting segments of data and merging experiments.
Text Books


REFERENCES


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.

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Objective

Impart students with the fundamental of Robotics-mechanics of robot motion-dynamics of robots- sensing and vision system of robots.

MODULE 1 (13 Hours)

Robot definition - Robot classification - Robotic system components – Notations - Position definitions - Coordinate frames - Different orientation descriptions - Free vectors-Translations- Rotations and relative motion - Homogeneous transformations.

MODULE 2 (13 Hours)

Link coordinate frames- Denavit-Hartenberg convention - Joint and end-effector Cartesian space-Forward kinematics transformations of position- Inverse kinematics of position-Translational and rotational velocities -Velocity transformations-Manipulator jacobian -Forward and inverse kinematics of velocity-Singularities of robot motion-Static forces-Transformations of velocities and static forces -Joint and end effect or force/torque transformations

MODULE 3 (15 Hours)

Manipulator Dynamics- Transformations of acceleration- Trajectory planning- Control-Lagrangian formulation- Model properties - Newton-Euler equations of motion-Derivation for two link planar robot arm as example- Joint space-based motion planning - Cartesian space-based path planning-Independent joint control - Feed-forward control - Inverse dynamics control.

MODULE 4 (13 Hours)

Text Books


REFERENCES


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.
Objective

Providing knowledge on the fundamentals of mechatronics, numerical control machine tools, part programming and robotics.

MODULE 1 (14 Hours)


Fundamentals of numerical control-advantages of NC systems- Classification of NC systems- Point to point and contouring systems- NC and CNC – Incremental and absolute systems-Open loop and closed loop systems-features of NC machine tools- Fundamentals of machining-Design consideration of NC machine tools-Methods of improving machine accuracy and productivity- Special tool holders.

MODULE 2 (13 Hours)


MODULE 3 (13 Hours)


MODULE 4 (14 Hours)

Industrial Robotics: Basic concepts- Robotics and automation- Specification of Robots-Resolution, Repeatability and accuracy of manipulator- Classification of Robots- Industrial application- Robot drives- Characteristics of end of arm tooling- Sensors-Tactile, proximity
and range sensors- contact and non-contact sensors- velocity sensors- touch and slip sensors-
Force and torque sensors- Programming- Lead through programming- Textual programming-
Programming languages - On line and offline programming- Intelligent Robots.

**Text Books**

1. Introduction to Mechatronics and measurement systems, David Alciatore, Michael


**REFERENCES**

   Hill.


   2009.

**Internal continuous assessment: 100 marks**

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

**End semester Examination: 100 marks**

**Pattern for the Question paper**

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Objective

To acquaint the students with working, analysis and modelling of different types of converters.

MODULE 1 (14 Hours)

Review of Buck, Boost, Buck-Boost topologies - Basic operation – Waveforms - Modes of operation - Voltage mode control principles.
Push-pull and forward converter - Basic operation – Waveforms - Modes of operation - Transformer design - Voltage mode control principles.
Half and full Bridge Converters - Basic operation – Waveforms - Modes of operation - Voltage mode control principles.
Fly back converter - Basic operation – Waveforms - Modes of operation - Voltage mode control principles.

MODULE 2 (14 Hours)

Voltage Mode Control of SMPS - Loop gain and stability considerations - Shaping the error amplifier gain versus frequency characteristics - Error amplifier transfer function – Transconductance error amplifiers.

Current mode control of SMPS – Current mode control advantages - Current mode versus voltage mode control of SMPS – Current mode deficiencies - Slope compensation.

MODULE 3 (13 Hours)


MODULE 4 (13 Hours)

Introduction to resonant converters – Classification of resonant converters – Basic resonant circuit concepts – Load resonant converters – Resonant switch converters – Zero voltage switching - Clamped voltage topologies – Resonant DC Link inverters with zero voltage switching – High frequency link integral half cycle converter.
REFERENCES

1  Ned Mohan, Power Electronics: Converters, Applications And Design, John Wiley & Sons
3  R. W. Erickson, Fundamental of Power Electronics, Chapman & Hall Publishers
4  William Shepherd, Li Zhang, Power Converter Circuits, CRC Taylor Francis

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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</table>
Objective

This course introduces embedded controllers, its architecture, applications and real time systems.

MODULE 1 (14 Hours)


MODULE 2 (13 Hours)


MODULE 3 (14 Hours)


MODULE 4 (13 Hours)

REFERENCES

1. Mazidi & Mazidi, Embedded System Design using 8051 Microcontroller, Pearson
2. Ajay V Deshmukh, Microcontrollers -Theory and Applications, TMH
3. Phillip A Laplante, Real Time Systems Design and Analysis, PHI
6. H A Toliyat, S Campbell, DSP Based Electro Mechanical Motion Control, CRC Press,

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.
Objective:

To study the various methods for the analysis of digital systems, to design a digital filter for the given specifications and to study the architecture and applications of digital signal processors.

MODULE 1 (13 Hours)

MODULE 2 (15 Hours)
Linear prediction and optimum linear filters-forward and backward linear prediction-optimum reflection coefficients-solutions of the normal equations- Levinson-Durbin Algorithm-schur Algorithm-properties- Auto Regressive(AR) and Auto Regressive Moving Average(ARMA) lattice-ladder filters-Wiener Filters for filtering and prediction-FIR and IIR Wiener filters-Noncausal Wiener Filters-ARMA Model for power spectrum analysis.

MODULE 3 (15 Hours)

MODULE 4 (11 Hours)
Execution of simple programs using digital signal processor – Solution of specific problems in digital signal processing using MATLAB programs.
REFERENCES
1. Oppenheim A. V. & Schafer R. W., Discrete- time Signal Processing, Pearson Education

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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| EIC11 205(C) | VARIABLE STRUCTURE CONTROL SYSTEMS  
| Hours/week: Lecture-3 and Tutorial-1 | Credits: 4 |

**Objective**

*This course enable the students to learn, the analysis and design of variable structure control systems based on sliding mode control.*

**MODULE 1 (12 Hours)**


**MODULE 2 (14 Hours)**

Variable structure systems with sliding mode- Sliding mode motion- Existence condition- Equivalent control for sliding mode motion- Sliding mode motion on switching line- Invariance conditions- Design of sliding mode controllers using feedback linearization for non-linear systems.

**MODULE 3 (14 Hours)**

Sliding mode motion on switching surface- Design of stable switching surfaces- Design of sliding mode controller for higher order systems- Sliding mode controller design for a robotic manipulator- Chattering- Chattering reduction techniques.

**MODULE 4 (14 Hours)**

Variable Structure Model Following Control (VSMFC) Systems- Conditions for perfect model following- Sliding mode equivalent control- Sliding mode discontinuous control- Design of VSMFC for second order system.

**Text Books**

REFERENCES


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

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EIC11 205(D) 
DATA ACQUISITION AND SIGNAL CONDITIONING
Hours/week: Lecture-3 and Tutorial-1
Credits: 4

Objective
After completing this course students have an idea about different types of transducers and signal conditioning-filtering and sampling-signal conversion and transmission-digital signal transmission and interfacing.

MODULE 1 (14 Hours)

Data Acquisition Systems (DAS)- Introduction- Objectives of DAS- Block diagram description of DAS- General configurations - Single and multichannel DAS-Transducers for the measurement of motion, force, pressure, flow, level, dc and ac voltages and currents (CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors, Optosensors, Rogowski Coil, Ampflex Sensors etc.)- Signal Conditioning- Requirements - Instrumentation amplifiers- Basic characteristics- Chopped and Modulated DC Amplifiers- Isolation amplifiers.

MODULE 2 (14 Hours)

Review of Nyquist Sampling Theorem-Aliasing - Need for Prefiltering-First and second order filters - Classification and types of filters - Low -pass, High-pass, Band-pass and Band-rejection and All Pass- Butterworth- Bessel- Chebyshev and Elliptic filters - Opamp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS, Sample and Hold Amplifiers.

MODULE 3 (14 Hours)


MODULE 4 (12 Hours)

Acquisition Applications-Ultrasonic Measurement System-Electrocardiogram Measurement System.

Text Books


REFERENCES


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.
Objective

The course helps to familiarize modeling, control and simulation experiments on control systems.

- Experiments based on soft computing
  - Fuzzy Logic – Neural Networks
- Stability analysis of Linear systems
  - Time domain and Frequency domain analysis
- Pole placement using state feedback
- State space representation and analysis
- Numerical methods for system modeling and simulation
- Closed loop response of different (types/ order) control systems for different types of input signals with variable parameters.
- Adaptive step size numerical algorithm for system modeling and simulation.
- Design of PI, PD and PID controllers
  - Tuning of PID controller
  - Control System design using compensators (Lag, Lead & Lag – Lead)
- Controller design using SISO tool and state space design
- Experiments based on PLC
- Experiments based on embedded programming
  - Open loop / closed loop simulation
  - Controller design ,sampling period and performance specification
- Design and simulation of regulator systems
  - With observers – quadratic optimal regulator problems
  - Solution of Riccati equation
- Design of observers
- Design of controllers
- Servo systems with transportations lag – Modeling & simulation
• Design and stability analysis of inverted pendulum

**Essential Software required – MATLAB- SIMULINK & TOOL BOXES**

**Internal continuous assessment: 100 marks**

- Regularity – 10%
- Lab Practical & Record – 40%
- Test – 50%
Objective

*This course is intended to assess the technical presentation capability of the students. Also to augment the skill of technical report writing.*

Individual students are required to choose a topic of their interest from instrumentation and control related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 45 minutes. A committee consisting of at least three faculty members (preferably specialized in Instrumentation and Control) shall assess the presentation of the seminar and award marks to the students based on merits of topic of presentation. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

**Internal continuous assessment: 100 marks**
Objective

To impart knowledge about various methodologies followed in engineering research, formulation of research problems and to apply the same in project work. To make students aware of the problems faced by Indian researchers.

MODULE 1 (13Hours)


MODULE 2 (13Hours)

Formulation of research task – Literature review – Importance & methods – Sources – Quantification of cause effect relations – Discussions – Field study – Critical analysis of generated facts – Hypothetical proposals for future development and testing- selection of research task.

MODULE 3 (14Hours)


MODULE 4 (14Hours)

REFERENCES
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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Objective

At the end of the course the students will have a clear idea about robust control.

MODULE 1 (13 Hours)

Introduction- Definition of robust control-Classification of robust control-Elements of robust control theory-Modeling-Design objectives and specifications-Additive and multiplicative perturbations-Plant-controller configuration-Shaping the loop gain.

MODULE 2 (13 Hours)


MODULE 3 (14 Hours)


MODULE 4 (14 Hours)

Robust stabilizing controllers-Stabilizing P controllers-Stabilizing PI controllers- Stabilizing PID controllers $H_2$ and H optimization -LQG methodology-Separation principle-Algebraic Riccati Equation-Solution of LQG problem-Robustness properties of the LQG solution- H optimization techniques-State space formulation H control-H filter-Generalized H regulator. Basic concepts of $H_{\infty}$ and $\mu$ – Synthesis controllers.
Text Books

1. Richard.C.Dorf and R.T Bishop, Modern Control System, P.H.I.

REFERENCES

1. Michael Green, David J N Limebeer, Linear Robust Control, Prentice-Hall, 1995

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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Objective

Provide a strong foundation to understand neuro-fuzzy systems and non-linear systems and give an overview of variable structure systems.

MODULE 1 (15 Hours)


MODULE 2 (14 Hours)

Representations of MIMO systems- Equivalent transformations- Canonical forms- Solution of state equations- System response- Controllability and pole allocation- Observability and state estimator- System characterization by transfer matrix- Non interactive and model matching control design.

MODULE 3 (14 Hours)


Introduction - Trajectory aspects-Inertial and optical sensors-Inertial guidance for cruise vehicles- Guidance and control of rocket vehicles- Guidance and control of mobile-Launched ballistic missiles.

MODULE 4 (11 Hours)

Text Books


REFERENCES


5. S. Neil Rasband, Chaotic Dynamics of Nonlinear systems, John Wiley and Sons.


Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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Objective

At the end of the course the students will be able to define the fundamental components of any biosensors and its application in bio-instrumentation.

MODULE 1 (12 Hours)

Introduction – Microbial sensors for process control – Acetic acid sensor – Alcohol sensor – Glutamic acid sensor – Carbon dioxide sensor – Microbial sensors for environmental control – Ammonia sensor – Nitrogen dioxide sensor – BOD sensor.


MODULE 2 (14 Hours)


MODULE 3 (14 Hours)


MODULE 4 (14 Hours)


Text Books

3. Donald L. Wise, Bioinstrumentation and Biosensors, CRC Press.

REFERENCES

2. Willner, Itamar & Eugenii, Bioelectronic: From Theory to Applications, Wiley.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.

<table>
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<tr>
<th>Module 1</th>
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Objective

Providing an overview of VLSI System Design and fabrication

MODULE 1 (14 Hours)

Overview of VLSI Design Methodology: VLSI design process - Architectural design - Logical design - Physical design - Layout styles - Full custom - Semi custom approaches.


MODULE 2 (13 Hours)

Basic Electrical Properties Of MOS And CMOS Circuits: nMOS enhancement transistor - PMOS enhancement transistor - Threshold voltage - Threshold voltage equations - MOS device equations - Basic DC equations - Second order effects - MOS Modules - Small signal AC characteristics - nMOS inverter - Steered input to an nMOS inverter - Depletion mode and enhancement mode pull ups - CMOS inverter - DC characteristics - Inverter delay - Pass transistor - Transmission gate.

MODULE 3 (13 Hours)

Layout Design Rules: Need for design rules - Mead Conway design rules for the silicon gate nMOS process - CMOS nwell-Pwell1 design rules - Simple layout examples - Sheet resistance - Area capacitance - Wiring capacitance - Drive large capacitive loads.

MODULE 4 (14 Hours)

Logic Design: Switch logic - Pass transistor and transmission gate - Gate logic - Inverter - Two input NAND gate - NOR gate - Other forms of CMOS logic - Dynamic CMOS logic - Clocked CMOS logic - Precharged domino CMOS logic - Structured design - Simple combinational logic design examples - Parity generator - Multiplexers - Clocks sequential circuits - Two phase clocking - Charge storage - Dynamic register element - nMOS and CMOS - Dynamic shift register - Semi static register - JK flip flop circuit.
REFERENCES
1. Doglas A. PuckJ1ell and Kamran Eshranghian, Basic VLSI design, Prentice Hall of India, New Delhi
3. Amar Mukherjee, Introduction to nMos and CMOS VLSI System Design, Prentice Hall, USA.,
4. Caver Mead and LyTUI Conway, Introduction to VLSI Systems, Addison- Wesley, USA.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

Any five questions to be answered by choosing at least one question from each module.
Objective

To acquaint the students with soft computing methodologies such as neural networks, fuzzy logic, genetic algorithms and hybrid algorithms and enable the students to implement real-time intelligent and adaptive systems.

MODULE 1 (13 Hours)

Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value assignments- Fuzzy rule base- Defuzzification- different methods- Fuzzy logic controller(Block Diagram)

MODULE 2 (14 Hours)


MODULE 3 (13 Hours)


MODULE 4 (14 Hours)

REFERENCES
1. S. Rajasekharan, G. A. Vijayalakshmi Pai, Neural Network, Fuzzy Logic and Genetic
4. S. Haykins, Neural Networks a Comprehensive foundation, Pearson Education.
6. Recent Literature.

**Internal continuous assessment: 100 marks**

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

**End semester Examination: 100 marks**

**Pattern for the Question paper**

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Objective

To create an awareness of the different transducers used in industry and signal conditioning and to familiarize the process control elements and their control characteristics.

MODULE 1 (13 Hours)


MODULE 2 (14 Hours)


MODULE 3 (14 Hours)


MODULE 4 (13 Hours)

Control Loop Characteristics: Control system configurations- Cascade control- Multivariable control- Feed forward control- Split range control- Inferential control- Adaptive control- Control system quality – Loop disturbance- Optimum control- Measure of quality- Stability- Process loop tuning
REFERENCES
2. Curtis D. Johnson, Microprocessors in Process Control, PHI
3. George Stephanopoulis, Chemical Process Control
4. Caughner, Process Analysis and Control
5. Deshpande and Ash, Elements of computer process control of Industrial processes, ISA
7. S. K. Singh, Computer Aided Process Control, PHI
8. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mekkichamp, Process Dynamics and Control, Wiley India

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Pattern for the Question paper

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Objective

Understanding and studying of random process and stochastic systems-linear optimal filters and predictors-implementation methods of optimal smoothers-nonlinear filtering and practical considerations.

MODULE 1 (12 Hours)

MODULE 2 (12 Hours)

MODULE 3 (14 Hours)
Fixed Interval, fixed lag and fixed point smoothers – Algorithms- Computer round off – Effect of round off errors on Kalman filters- Factorization methods for square root filtering – Square root UD filters – Other implementation methods

MODULE 4 (16 Hours)
Text Books

REFERENCES

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Pattern for the Question paper
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Objective

Upon completion of industrial training, the student gains awareness of issues related to designing and maintaining sophisticated equipments, their management and he/she learns to correlate theory with industrial practice.

The students have to arrange and undergo an industrial training of minimum two weeks in an industry preferably dealing with instrumentation/control system equipments during the semester break between semester 2 and semester 3, and complete within 15 calendar days from the start of semester 3. The students are requested to submit a report of the training undergone and present the contents of the report before the evaluation committee. Evaluation committee will award the marks of end semester based on training quality, contents of the report and presentation.

Internal Continuous Assessment: 50 Marks
Objective

This course aims to improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research. Also, continued and self learning skill of the student is enhanced.

The project work can be a design project/experimental project and/or computer simulation project on any of the topics in instrumentation/control systems related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute, subject to the conditions in clause 10 of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

The student is required to undertake the master research project phase 1 during the third semester and the same is continued in the fourth semester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

Internal Continuous assessment:

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SEMESTER 4

EIC11 401  MASTERS RESEARCH PROJECT
PHASE 2
Hours/week: 30
Credits: 12

Objective

This course aims to improve the professional competency and research aptitude by touching the areas which are otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research. Also, continued and self learning skill of the student is enhanced.

Master Research project phase 2 is a continuation of project phase 1 started in the third semester. There would be two reviews in the fourth semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external.

Internal Continuous assessment:

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End Semester Examination: - Project Evaluation by external examiner: 150 Marks, Viva Voce by external / internal: 150 Marks