Department of Electronics and Communication Engineering
Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become a centre of excellence in teaching and research for creating technical manpower to meet the technological needs of the country in the field of Electronics and Communications Engineering.

Department Mission

- To facilitate state of the art Education and Research at Undergraduate, Post Graduate and Doctoral levels to enable to perform challenging engineering and managerial jobs in the field of Electronics and Communication Engineering.
- To build national capabilities in Technology, Education and Research in emerging areas in the field of Electronics and Communication Engineering.
- To create an environment to provide excellent Research and Development facilities to strengthen Ph.D. programmes and Research Projects.
- To provide excellent Technological Services to bridge the gap between Academics and Industry in order to fulfil the overall academic needs of the society.
- To provide high quality Course Structure in order to turn out qualified professionals to meet the engineering needs of the country.
- To develop effective Teaching Skills and the Research Potentials of the faculty members.
- To ensure All Round Development of the students and to create a platform for turning out engineering professionals who can assume leadership position in society.

M. Tech. in Instrumentation Engineering

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1	To enable students to acquire in-depth knowledge in the field of Instrumentation Engineering with an ability to integrate existing and new knowledge with the advancement of the technology.
PEO2	To develop students to critically analyze the problems in the field of Instrumentation Engineering and find optimal solution.
PEO3	To train students to conduct research and experiments by applying appropriate techniques and tools with an understanding of the limitations for sustainable development of society.
PEO4	To prepare students to act as a member and leader of the team to contribute positively to manage projects efficiently in the field of Instrumentation Engineering.
PEO5	To train students to effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards.
PEO6	To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

PROGRAM OUTCOMES (POs)

After completion of the programme, students will be able to

PO1	Independently carry out research /investigation and development work to solve practical problems.
PO2	Write and present a substantial technical report/document.
PO3	Demonstrate the degree of mastery in Instrumentation Engineering at a level higher than the requirements in the appropriate bachelor program.
PO4	Recognize the need for continuous learning and to prepare themselves to create, select and apply appropriate techniques and tools to undertake activities in the field of Instrumentation Engineering with an understanding of the limitations.
PO5	Demonstrate professional and intellectual integrity, professional code of conduct, and ethics of research with an understanding of responsibility to contribute in the field of Instrumentation Engineering for sustainable development of society.
PO6	Possess knowledge and understanding of engineering with management principles to apply the same as a member or leader in a team to carry out research work/projects efficiently in the field of Instrumentation and other multidisciplinary areas.

1st Semester

Programme Core

COURSE INFORMATION SHEET

Course code: EC518
Course title: Advanced Instrumentation System
Pre-requisite(s): B.E./B.Tech. in ECE/EEE/CS with basic courses on DSP
Co- requisite(s): Electronics Instrumentation
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Explain the concept of intelligent instrumentation and impart knowledge on automation.
2.	Develop an ability to model and analyze a real time system.
3.	Develop an ability to evaluate the performance of a Automation system.
4.	To select a particular controller based on the requirement of the system
5.	Develop an ability to design an intelligent system for industrial automation.

Course Outcomes:
After the completion of this course, students should be able to:

CO1	Demonstrate on the understanding of automation and functioning of various elements in a real time system.
CO2	Have an ability to identify and analyze various components of an automation system.
CO3	Have an ability to evaluate the performance of PLC.
CO4	Have an ability to develop a virtual instrumentation system.
CO5	Communicate the instrumentation signal using HART protocol

SYLLABUS

Module I:
Review of transducer, Introduction about Instrumentation system. Types of Instrumentation system. Data acquisition system and its uses in intelligent Instrumentation system. Detail study of each block involved in making of DAS, Signal conditioners as DA, IA, signal converters (ADC), Sample and hold. Designing application for Pressure, Temperature measurement system using DAS. Data logger.

(8L)

Module 2:
Introduction about Automation system. Concepts of Control Schemes, Types of Controllers.
Components involved in implementation of Automation system i.e., DAS, DOS, Converter (I to P) and Actuators: Pneumatic cylinder, Relay, solenoid (Final Control Element), Computer Supervisory Control System, Direct Digital Control's Structure and Software. SCADA-Remote terminal units, Master station, Communication architectures and Open SCADA

protocols. DCS- Evolution of Different architecture, Local unit, Operator Interface, Displays, Engineering interface, factors to be considered in selecting DCS, case studies in DCS.

(8L)

Module 3:

PLC: PLC architecture, PLC operation, addressing modes of PLC, Languages used in PLC Programming, Instructions used in Ladder programming, Programming examples of different processes.

(8L)

Module 4:

Virtual Instrumentation- Introduction to LabVIEW, Block diagram and architecture of a virtual instrumentation, Graphical programming in data flow, comparison with conventional programming, Vis and sub-Vis, loops and charts, arrays, clusters and graph, case and sequence structures, formula nodes, local and global variables, string and file I/O.

(8L)

Module 5: Introduction about Intelligent controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Control system. Case study. Introduction to telemetry, Instrument interfacing, Current loop, RS232/485, Field bus, Modbus, GPIB, USB Protocol, HART communication Protocol- Communication modes and networks.

(8L)

Books recommended:

Textbooks:

1. Computer Based Industrial Control – By Krishna Kant, PHI
2. Process Control Instrumentation – By Curtis D. Johnson, Pearson Education

Reference books:

1. "Principle of Industrial Instrumentation" By D. Patranabis, TMH publications
2. National Instruments LabVIEW manual.
3. High performance Instrumentation and Automation, CRC Press, Taylor & Francis Group, 2005

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**

Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment
1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	2	1	3	2	1
CO4	2	3	2	3	2	2
CO5	3	3	3	2	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC520
Course title: Advanced Sensing Techniques
Pre-requisite(s): B.E./B.Tech. in ECE/EEE/CS with basic courses on DSP
Co- requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Describe the operation of various smart sensors and their application
2.	Select an appropriate sensor for a given application
3.	Compare analogue and digital transducer.
4.	Mathematically model a smart sensor

5.	Discuss the latest technology in sensor development

Course Outcomes:
After the completion of this course, students will be:

CO1	Understand the principle of operation of different sensors and their applications
CO2	Be updated on the recent trends in sensor technologies.
CO3	Design a wireless sensor network
CO4	Apply the concept of wireless sensor for weather monitoring
CO5	Solve design and modelling issue using complex engineering mathematics

SYLLABUS

Module I:
Introduction to smart sensors, Principles of operation, design approach, interface design, configuration supports.

(8L)

Module 2:
Introduction, Electro-chemical Cell, Cell potential, Sd. Hydrogen Electrode (SHE), Liquid Junction and Other potentials, Polarization, Reference Electrodes, Sensor Electrodes, Electro-Ceramics in Gas Media. Analyzers for different gas and laboratory testing of chemicals.

(8L)

Module 3:
MEMS sensor, Comparison between MEMS and Macro sensor, Fabrication and packaging issue in sensor design Thick film and thin film technique Physical sensors. Bio sensor, Silicon sensor, RF Sensor, sensors for robotics.

(8L)

Module 4:
Wireless Sensor, principle and working, wireless sensing network, protocols used, Application of wireless sensor for weather monitoring.

(8L)

Module 5:
Design and modelling issue in advanced sensing technique. Introduction of different mathematical tools used in sensor design. Optimization techniques used in sensor design. The role of PCA, LDA, Neural network in designing sensor array.

(8L)

Books recommended:

Textbooks:

1. Sensors and Transducers, by D. Patranabis. 2nd Edition
2. Electrical & Electronics Measurements and Instrumentation by A.K Sawhney, Dhanpat Rai & Sons.
3. Transducers and Instrumentation, by Murthy D. V. S., Prentice Hall, 2nd Edt., 2011

Reference books:

1. Sensor and signal conditioning by John G. Webster, Wiley Inter Science,2nd edition, 2008

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	2	1
CO2	3	3	3	2	2	1
CO3	3	3	2	3	2	1
CO4	2	3	2	2	2	2
CO5	3	2	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC522
Course title: Advanced Digital Signal Processing
Pre-requisite(s): B.E. /B. Tech. in ECE/EEE with basic courses on Digital Signal Processing
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03

Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	To understand the concept of signals and systems and filters.
2.	To impart knowledge on various transformation techniques.
3.	To impart knowledge on multirate signal processing and its applications.
4.	An understanding on optimum linear filters and power spectral estimation.
5.	Enhance skills to apply the filter design and spectral estimation in various applications.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Develop an understanding to concept of signals and systems and to design filters.
CO2	Have an ability to analyze and apply various single and multi-domain transformation techniques.
CO3	Have an ability to apply multirate signal processing on various engineering applications.
CO4	Develop an ability to apply use optimum linear filters and power spectral estimation.
CO5	Aspire for pursuing a carrier in signal processing, robotics and IOT, recognize the need to learn and adapt to the change in technology and play role of team leader or supporter of team.

SYLLABUS

Module I:
Review of Signals and Systems, Sampling and data reconstruction processes, Z transforms. Chirp Z Algorithm, Goertzel's Algorithm, Discrete linear systems, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters,IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures.

(8L)

Module 2:
DSP Transforms: Fourier transform, Discrete sine and cosine transform, Discrete Hartely transform, short time Fourier transform, wavelet transform, Hilbert transform, Hilbert-Huang transform, Stockwell transform

(8L)

Module 3:
Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Multi resolution signal analysis, wavelet decomposition, Applications in subband coding

(8L)

Module 4:
Linear prediction and Optimum Linear Filters: Random signals and power spectra, Forward and backward Linear prediction, solutions of the normal equations, AR lattice and ARMA lattice-ladder filters, Wiener filters

(8L)

Module 5:

Power spectrum estimation: Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigenanalysis Algorithms for Spectrum Estimation

(8L)

Books recommended:

Textbooks:

1. J.G.Proakis and D.G.Manolakis"Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007. (T1)
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
3. S. Haykin and T. Kailath, Adaptive Filter Theory, Pearson Education, 4th Edition, 2005.

Reference books:

1. Digital Signal Processing 3/E by S.K.Mitra TMH Edition.
2. Fundamentals of adaptive filtering, A. H. Sayed, Wiley, 2003.
3. Monson H. Hayes, Statistical Digital Signal Processing and Modelling, Wiley, 2002

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets

CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	1	1
CO2	2	2	2	2	1	1
CO3	2	2	2	2	1	1
CO4	2	2	2	2	1	1
CO5	1	1	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

Programme Elective – I

COURSE INFORMATION SHEET

Course code: EC524
Course title: Measurements and Statistics
Pre-requisite(s): Electronic Measurements
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables students to

1.	Understand basic statistics, and develop proficiency in the application of statistical tools and digital data acquisition and spectral analysis of data
2.	Understand basic electronics and circuit analysis for filters, amplifiers, and other signal conditioning circuits and be able to build such circuits
3.	Understand how various kinds of analog and digital sensors and instruments work,
4.	Understand how analog and digital sensors are calibrated – both statically and dynamically, and how they are applied in engineering
5.	Advance proficiency in professional communications and interactions

Course Outcomes

On the completion of this course, the students will be able to:

CO1	Apply statistical analysis to data samples to calculate mean, standard deviation, etc. and to determine the accuracy, precision, and sensitivity of sensors and instruments and statistical and error analyses to measured data to identify and remove outliers and predict uncertainties.

CO2	Apply linear and nonlinear regression analysis to perform curve fits to data and to determine correlation of variables and trends and also Create histograms and probability density functions (PDFs) of data samples,
CO3	demonstrate the ability to compare the results to standard PDFs such as the Gaussian and student's t PDFs, and demonstrate the ability to predict probabilities based on the PDFs
CO4	Apply differential equation analysis of first- and second-order dynamic systems to predict the behaviour of sensors and instruments
CO5	Predict, analyze, and test the performance of sensors of various kinds, including strain gages, thermocouples, tachometers, displacement transducers, dynamometers, pressure gages and transducers, laser and Doppler velocimeters, pressure probes, and flow-meters

SYLLABUS

Module I:

Introduction to mechanical engineering measurements – purpose, dimensions and units, significant digits; Dimensional analysis - primary dimensions, method of repeating variables; Review of basic electronics and circuits; Errors and uncertainties - bias and precision error, accuracy, calibration; Basic statistics – mean, standard deviation, variance, median, mode, etc., Histograms; Probability density functions; The normal (Gaussian) distribution, Central limit theorem; Other PDF distributions - lognormal, student's t, chi-squared; Correlation and regression analysis (least-squares curve fits).

(8L)

Module 2:

Outliers single variables and data pairs; Experimental uncertainty analysis - RSS uncertainty; Experimental design - full vs. fractional factorial tests, Taguchi design arrays, RSM - Response surface methodology - an efficient way to hunt for an optimum result; Hypothesis testing - how to use statistics to make decisions, Digital data acquisition - introduction to digital data, A/D conversion, discrete sampling, clipping, aliasing; Signal reconstruction - the Cardinal series; Spectral analysis - introduction to Fourier series, harmonic amplitude plots; Fourier transforms - introduction to Fourier transforms, DFTs and FFTs,

(8L)

Module 3:

FFTs (continued) - Windowing - a technique to reduce leakage in FFTs; How to analyze the frequency content of a signal, Filters - first-order low-pass filter, first-order high-pass filter, other filters, Operational amplifiers (Op-Amps) - introduction and some circuits in which op-amps are used; Clipping circuits and examples, common-mode rejection ratio, gain-bandwidth product

(8L)

Module 4:

Stress, strain, and strain gages - review of stress and strain, Hooke's law; Description of strain gages and how to use them; Wheatstone bridge circuits, and how they are used to measure strain, dynamic system response - dynamic measuring systems, zero-, first-, and second-order systems, Temperature measurement - types of temperature measurement including mechanical, thermoresistive, thermojunctive, and radiative methods,

(8L)

Module 5:

Mechanical measurements - mechanical measuring devices, such as potentiometers, linear variable displacement transducers, ultrasonic transducers, capacitance diplacement sensors, accelerometers, tachometers, and dynamometers, Fluid flow measurements - pressure, velocity, and volume flow rate measurements, Fluid flow measurements

(8L)

Books recommended:

Textbook: http://www.mne.psu.edu/cimbala/me345/

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	3	2	1
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7

CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC525
Course title: High Frequency Measurements
Pre-requisite(s): Electromagnetic Filed Theory
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Understand various oscilloscope probes, current probes, Probe ground lead effects, wiggly scope patterns, ground loading,
2.	Understand probe compensation, compensation and waveform distortion, Differential measurements and probe correction techniques
3.	Understand Magnetic Pickup loops and related parameters, related theories, effect and application.
4.	Study current probes theory and uses for current probes limitations, Magnetic core saturation
5.	Study the measurement of pulsed EMI effects on Electronic circuits

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Gain the knowledge of various oscilloscope probes, current probes, Probe ground lead effects, wiggly scope patterns, ground loading
CO2	Explain probe compensation, waveform distortion, Differential measurements,
CO3	Explain Magnetic Pickup loops and related parameters, related theories, effect and practical applications
CO4	Gain the knowledge of current probes theory and uses for current probes limitations, Magnetic core saturation
CO5	Measure the pulsed EMI effects on Electronic circuits

SYLLABUS

Module I:
Oscilloscope probes: types, Passive and Active oscilloscope probes, current probes, current probe specification, current probe electric field response, simple signal generator,
Probe ground lead effects, lead inductance, lead inductance and probe response, probe type with improved response, tell-tale signs of probe resonance, Wiggly scope patterns, Ground lead common impedance induced error, The null experiment, ground loading, use of ferrite on probes, More wiggly scope patterns

(8L)

Module 2:
High Frequency passive probe compensation, Probe compensation, compensation and measurement frequency response, compensation and waveform distortion, compensation adjustment, compensation adjustment location, when to compensate, probe compensation effects

Differential measurements, need of differential measurements, advantages of differential measurements, available options for differential measurements, FET differential probes, two hi-Z 10X passive probe using A-B, balance coaxial probe, probe correction techniques

(8L)

Module 3:

Magnetic loop and other noncontact measurements, Square magnetic pickup loop- theory of operation, factors affecting size and shape of pickup loop, orientation of loop, current response of the pickup loop, pickup loop null experiments, effect of the pickup loop on circuit operation, Pickup loop technique of locating noise sources, other non-contact measurements

(8L)

Module 4:

Current probes theory and uses, DC coupled, AC Coupled, Theory of operation, uses for current probes, limitations and Magnetic core saturation.

(8L)

Module 5:

Measurement of pulsed EMI effects on Electronic circuits: introduction, Technical background, inductive and capacitive coupling, the skin effect, and Measurement pitfalts, realistic options for system level pulsed.

(8L)

Books recommended:

Textbooks:

1. High Frequency Measurements and Noise in Electronic Circuit. Douglas C. Smith, Kluwer Academic Publishers, 1992
2. Noise in High-Frequency Circuits and Oscillators, Burkhard Schiek, Heinz-Jürgen Siweris
3. Ilona Rolfes, Wiley-Interscience, A john Wiley & sons inc. pub., 2006

Reference books:

1. High-Frequency Circuit Design and Measurements, Peter C. L. Yip, Chapman & Hall, Delhi

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	2	2	1
CO4	3	3	3	3	2	2
CO5	3	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 515
Course title: Control system Design
Pre-requisite(s): Fundamentals of Mathematics and Physics, Introduction to System Theory, Control Theory
Co- requisite(s): Linear Algebra
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 3
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	To state the performance characteristics of control systems with specific design requirements and design objectives;
2.	To understand the concepts of PD, PI, PID, lead, lag and lag lead controller design in time domain and frequency domain and apply it to specific real time numerical problems;
3.	To apply the state feedback controller and observer design techniques to

	modern control problems and analyse the effects on transient and frequency domain response;
4.	To realize and then design digital and analog compensators;
5.	Design controller for any type of linear plants

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Identify the design objectives and requirements of control systems;
CO2	Interpret the concepts of PD, PI, PID, lead, lag, lag lead, and discrete data controller design and apply it to solve some design problems;
CO3	Apply the state feedback controller design and techniques and outline its effects on system's performance which includes transient response and robustness;
CO4	To develop methodologies to design real time digital and analog compensators and reproduce the results and write effective reports suitable for quality journal and conference publications;
CO5	Aspire for pursuing a carrier in control, recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

SYLLABUS

Module 1:
Performance characteristics of feedback control system & design specification of control loop. Different types of control system applications and their functional requirement. Derivation of load-locus (toque/ speed characteristics of load). Selection of motors, sensors, drives. Choice of design domain & general guidelines for choice of domain. Controller configuration and choice of controller configuration for specific design requirement. Fundamental principles of control system design. Experimental evaluation of system dynamics in time domain and frequency domain

(8L)

Module 2:
Design with PD Controller: Time domain interpretation of PD controller, frequency domain interpretation of PD controller, summary of the effects of PD controller. Design with PI controller: Time domain interpretation of PI controller frequency domain interpretation of PI controller, summary of the effects of PI controller, design with PID controller, Ziegler Nichols tuning & other methods

(8L)

Module 3:
Design with lag/lead/lag-lead compensator, time domain interpretation of lag/lead/lag-lead compensator, frequency domain interpretation of lag/lead/lag-lead compensator, summary of the effects of lag/lead/lag-lead compensator. Forward & feed-forward controller, minor loop feedback control, concept of robust design for control system, pole-zero cancellation design.

(8L)

Module 4:
Sate feedback control, pole placement design through state feedback, state feedback with integral control, design full order and reduced order state observer.

(8L)

Module 5:
Design of Discrete Data Control System: Digital implementation of analog controller (PID) and lag-lead controllers, Design of discrete data control systems in frequency domain and Z plane

(8L)

Books recommended:

Textbooks:

1. B.C. Kuo, "Automatic Control System", 7th Edition PHI.
2. M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH.
3. J.G. Truxal, "Automatic Feedback Control System", McGraw Hill, New York.
4. K. Ogata, "Discrete Time Control Systems", 2nd Edition, Pearson Education.

Reference books:

1. Norman Nise, "Control System Engineering", 4th Edition.
2. M. Gopal, "Digital Control & State Variable Method", TMH.
3. B.C. Kuo, "Digital Control System", 2nd Edition, Oxford.
4. Stephanie, "Design of Feedback Control Systems", 4th Edition, Oxford.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	2		
CO2	3	2	1	3		1
CO3	3	1	2	3		1
CO4	3	3	2	3	2	2

CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1,CD2,CD6
CO3	CD1,CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1, CD5

COURSE INFORMATION SHEET

Course code: EC526
Course title: Digital Image Processing Techniques
Pre-requisite(s): B.E./B.Tech. in ECE/EEE/CS with basic courses on DSP
Co- requisite(s): Linear Algebra, Probability Theory
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Gain an understanding on digital image formation, characteristics and its processing steps.
2	Demonstrate the use of different spatial and frequency domain processing techniques to improve the image quality.
3	Apply various segmentation techniques of an image.
4	Analyse various image description and representation methods for computer vision applications.
5	Demonstrate various techniques and its applications in object recognition and classification.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Develop an understanding on the image formation, pixel characteristics and processing step.
CO2	Have an ability to analyze the image quality using transformed and spatial domain filters.
CO3	Gain ability to segment and represent the image for computer vision tasks.
CO4	Apply and analyse various techniques for object recognition and classification task.
CO5	Develop an ability to create and apply the image processing techniques in various applications in many areas, recognize the need to learn, to engage and to adapt in a world of constantly changing technology.

SYLLABUS

Module I:
Digital Image Fundamentals:

Fundamental steps in Digital Image Processing, Components of an Image processing system, DigitalImage Representation, Basic relationship between pixels, Basic Arithmetic/Logic operations on image: Image subtraction, Image averaging, Color image processing fundamentals: Color Modules, RGB, HIS, Lab colormodules, Convolution and Correlation theorems.

(8L)

Module 2:
Image Enhancement in Spatial and Frequency Domain:
Gray Level Transformations, Histogram Processing, Smoothing and Sharpening with Spatial Domain Filters, Fourier Transform, Fast Fourier Transform, Discrete Cosine Transform, Wavelet Transforms, Smoothing and Sharpening with Frequency Domain filters, Homomorphic filtering, Pseudo Color Image Enhancement.

(8L)

Module 3:
Image Restoration:
Noise Models, Restoration in the presence of Noise-Only Spatial filtering, Mean filters, Adaptivefilters Periodic Noise Reduction by Frequency Domain filtering , Inverse Filtering , Minimum Mean Square Error (Wiener) Filtering, Geometric Mean Filter.

(8L)

Module 4:
Image Segmentation and Representation:
Detection of Discontinuities, Point Detection, Line detection, Edge Detection, Thresholding, Optimal Global and Adaptive thresholding, Region-based Segmentation, Textural Images, Textural Featureextraction from Co-occurrence matrices, Chain codes, Signatures, Boundary Segments, Skeletons, Boundary Descriptors, Regional Descriptors.

(8L)

Module 5:
Object Recognition and Interpretation:
Elements of Image analysis, Pattern Classifier, Minimum distance classifier, Baye's Classifier, Neural Network algorithm, Fuzzy classifier, structural methods.

(8L)

Books recommended:
Textbooks:

1. Digital Image Processing. 2/E by Rafael C. Gonzalez and Richard E. Woods. Pearson Education
2. Digital Image Processing and Analysis. by B. Chanda and D. Dutta Mujumdar PHI

Reference books:

1. Fundamentals of Digital Image Processing. By Anil K. Jain, PHI Publication
2. Image Processing, Analysis and Machine Vision. Milan Sonka and Vaclav Hlavac,

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2		1
CO2	2	1	2	3		2
CO3	3	2	2	3		1
CO4	3	2	2	3	2	1
CO5	2	2	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC527
Course title: Speech Processing & Recognition
Pre-requisite(s): Digital Signal Processing
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE

Name of Teacher:

Course Objectives

This course enables the students to:

1	Explain fundamentals of speech production, its perception and inherent features.
2	Develop an ability to analyse parameter estimation and feature representations of speech signals.
3	Develop an ability to evaluate the pattern comparison and design issues of speech recognition.
4	Develop the concept and utilization of statistical and pattern recognition models.
5	Develop and apply different classifiers and features for different real life applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate the understanding on the speech production, its perception and features.
CO2	Analyse various components of parameter estimation and feature representations of speech signals.
CO3	Illustrate various models for speech synthesis and automatic recognition.
CO4	Analyse the speech recognition and implementation issues.
CO5	Develop an ability to create and apply the speech recognition techniques in various applications in different areas.

SYLLABUS

Module I:

Speech Production: Introduction, Speech Production Process, Representing Speech in Time and Frequency domains, Speech Sounds and Features, Statistical pattern recognition approach to speech recognition

(8L)

Module 2:

Signal Processing and Analysis Method for Speech Recognition: Introduction, Linear predictive coding model for Speech Recognition, LPC model, LPC analysis equations, Autocorrelation method, Covariance method, LPC processor for speech recognition, MFCC, Vector quantization: Elements of VQ, VQ training set, Similarity or Distance Measure, Clustering, Vector classification procedure

(8L)

Module 3:

Pattern comparison techniques: Introduction, Speech Detection, Distortion Measures, Spectral-Distortion Measures: Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Liftering, Likelihood Distortion, Variance of Likelihood distortion, Time Alignment and Normalization

(8L)

Module 4:

Hidden Markov Models: Introduction, Discrete-Time Markov Process, Extensions to HMM, Three Basic Problems for HMM, Types of HMM, Implementation issues for HMMs, HMM System for Isolated Word Recognition, Gaussian Mixture Model, HMM-GMM for isolated word recognition

(8L)

Module 5:

Applications of Automatic Speech Recognition and Support Vector Machine: Introduction, Support Vector Machines: Linear and Non-linear classifications, Computing the SVM classifier, Properties, Speech-Recognizer Performance Scores, Characteristic of

Speech- Recognition Applications, Broad classes of Speech-Recognition Applications, Command and Control Applications, Projections for Speech Recognition, Applications of Speech Recognition in Mobile Phones

(8L)

Books recommended:

Textbooks:

1. L.R. Rabiner, B.H. Juang and B. Yegnanarayana, "Fundamentals of Speech Recognition", Pearson, Education 2011.
2. Cristianini Nello and Shawe-Taylor, "An introduction to Support Vector Machines and other kernel based learning methods", Cambridge University Press, 2000.

Reference books:

1. L.R. Rabiner and R.W. Schafer, "Digital Processing of Speech Signals", Pearson Education, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	1	1

CO2	2	2	2	2	1	1
CO3	2	2	2	2	1	1
CO4	2	2	2	2	1	1
CO5	1	1	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC528
Course title: CMOS Digital VLSI Design
Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Understand design technique of Inverter and Combinational Logic Circuits in CMOS and model them with VHDL/Verilog/SystemVerilog.
2.	Grasp the design technique of Sequential Logic Circuits in CMOS and apply them for VHDL/Verilog/ SystemVerilog implementation.
3.	Appraise the Timing Issues in Digital Circuits and analyze Clock Generator and Test Bench implemented with VHDL/Verilog/SystemVerilog.
4.	Appraise and evaluate CMOS Fabrication Process and Manufacturing Issues.
5.	Comprehend the characteristics of data path, memory and control structure and create them.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Illustrate and Interpret Inverter and Combinational Logic Circuits in CMOS with given design specification such as propagation delay, power dissipation, PDP and EDP.
CO2	Sketch and explain the Sequential Logic Circuits in CMOS.
CO3	Diagram and explain the Digital Circuits in general and Clock Generator circuit in particular and Test Bench implemented with VHDL/Verilog/SystemVerilog.
CO4	Appraise and schematize CMOS Fabrication Process and criticise and summarize Manufacturing Issues.
CO5	Design and schematize Datapath, Memory and Control circuits and create their VHDL/ Verilog/ System Verilog.

SYLLABUS

Module 1:
Design of Inverter and Combinational Logic Circuits in CMOS and their VHDL/Verilog/ System Verilog Modelling:
Static and Dynamic Behaviour of CMOS Inverter: Switching Threshold, Noise Margin formulation, computing capacitance, Propagation Delay, Power, Delay, Power-Delay Product, Energy-Delay Product. Design of CMOS Combinational Logic Circuits: Static CMOS Design: Complementary CMOS, Ratioed Logic, Pass-Transistor Logic; Dynamic CMOS Design: Basic Principles of Dynamic Logic, Speed and Power Dissipation of Dynamic Logic, Signal Integrity Issues in Dynamic Design Cascading Dynamic Gates. Introduction to the SPICE/VHDL/Verilog/SystemVerilog with Design examples of inverter, NAND and NOR gates.

(8L)

Module 2:
Design of Sequential Logic Circuits in CMOS and their VHDL/Verilog/ SystemVerilog Modelling:
Timing Metrics for sequential Circuits, Static Latches and Registers: Bistability Principle, Multiplexer-Based Latches, Master-Slave Edge-Triggered Register, Low-Voltage Static Latches; Dynamic Latches and Registers: Dynamic Transmission-Gate Edge-triggered Registers, C2MOST – A Clock-Skewed Insensitive Approach, True Single-Phase Clocked Register (TSPCR), Alternative Register Styles: Pulse Registers, Sense-Amplifier Based Registers, Pipelining: Latch- versus Register-Based Pipelines, NORA-CMOS—A Logic Style for Pipelined Structures, Nonbistable Sequential Circuits: The Schmitt Trigger, Monostable Sequential Circuits, Astable Circuits, Clocking Strategy; Design examples of latch, flip-flop, register and Memory (RAM, ROM) using SPICE/VHDL/Verilog/SystemVerilog HDL.

(8L)

Module 3:
Timing Issues in Digital Circuits and VHDL/Verilog/SystemVerilog Modelling of Clock Generator and Test Bench:
Timing Classification of Digital Systems: Synchronous Interconnect – Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect; Synchronous Design — An In-depth Perspective - Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Based Clocking; Self-Timed Circuit Design: – Self-Timed Logic - An Asynchronous Technique, Completion-Signal Generation, Self-Timed Signalling, Practical Examples of Self-Timed Logic; Synchronizers and Arbiters: Synchronizers—Concept and Implementation, Arbiters; Clock Synthesis and Synchronization Using a Phase-Locked Loop: Basic Concepts. Building Blocks of a PLL; Future Directions and Perspectives: Distributed Clocking Using DLLs, Optical Clock Distribution, Synchronous versus Asynchronous Design, Design examples of clock and test bench using SPICE/VHDL/Verilog/SystemVerilog HDL.

(8L)

Module 4:
CMOS Fabrication Process and Manufacturing Issues:
CMOS Technologies, Layout Design Rules, CMOS Process Enhancements, Design Rule Checking (DRC), Inverter cross-section, Layout of CMOS Inverter, Layout of 2-input NAND gate, Layout of 2-input NOR gate, Layout of Complex logic gate, Layout of Domino AND gate, Stick Diagrams, Design Partitioning, Floor Planning; **Estimation of parasitics**: diffusion capacitance and interconnect parasitics, package parasitics, impact of parasitics on circuit performance. **Manufacturing Issues:** Antenna Rules, Layer Density Rules, Resolution Enhancement Rules, Metal Slotting Rules, Interconnect Wearout: Electromigration, Self-heating, Yield Enhancement Guidelines.

(8L)

Module 5:
Design of Datapath, Memory and Control in CMOS and their VHDL/Verilog/SystemVerilog Modelling:
Data operators: single-bit addition, carry-propagate addition, subtraction, multi-input addition, One/Zero detectors, magnitude comparators, equality comparators, counters, Boolean logic operators, Funnel shifters, Barrel Shifter, Array multiplier, Wallace tree multiplier; **Shifter:** Barrel Shifter, Logarithmic Shifter, **Power and Speed Trade-off's in Datapath Structures:** Design Time Power-Reduction Techniques, Run-Time Power Management, Reducing the Power in Standby (or Sleep) Mode; **Memory:** SRAM, DRAM, ROM, Flash memory, FIFO; **Control Structure Design**: Mealy and Moore FSM, state-transition diagram, state reduction technique, control logic implementation, Design examples of Datapath (adder, subtractor, multiplier, comparator, counter, decoder, multiplexer) and control unit (Mealy and Moore FSM) using SPICE/VHDL/Verilog/ SystemVerilog HDL.
(8L)

Books recommended:
Textbook:
1. J. M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits – A Design Perspective," 2nd ed., Upper Saddle River, New Jersey, USA: PHI, 2003.
2. N. H. E. Weste and D. M. Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 4th ed., Boylston Street, Boston, USA: PHI, 2011.
3. S. Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis," 1st ed., SunSoft Press, 1996.

Reference books
1. D. L. Perry, "VHDL Programming," 4th ed., Tata McGraw Hill, 2012.
2. Stuart Sutherland, Simon Davidmann, Peter Flake, SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling, 2/e, Springer, 2006

Gaps in the syllabus (to meet Industry/Profession requirements): Hands-on-practical for CMOS Digital IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus: PO6 will be met though CMOS Digital circuit design-based assignment in a group, which involves handling of appropriate equipment and/ or CAD tools.

Topics beyond syllabus/Advanced topics/Design: CMOS circuit design related to ADC and DAC.

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	3	2	1
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2

$< 34\% = 1$, $34\text{-}66\% = 2$, $> 66\% = 3$

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

Open Elective-I

Course code: EC549
Course title: Modern Instrumentation Theory
Pre-requisite(s): Electronic Measurements
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students:

1.	The knowledge about Silicon Sensors and its application for measurement of pressure, level, flow and Temperature. Biosensors
2.	The knowledge about DAS, Controller and Components involved in implementation of Automation system

3.	The knowledge about Distributed Control Systems
4.	The knowledge about Artificial Intelligent Based Systems
5.	The knowledge about microcontroller and Telemetry

Course Outcomes:
After the completion of this course, students will be:

CO1	Gain knowledge of Silicon Sensors and its application for measurement of pressure, level, flow and Temperature. Biosensors
CO2	Gain knowledge of DAS, Controller and Components involved in implementation of Automation system
CO3	Gain knowledge of Distributed Control Systems
CO4	Gain knowledge of Artificial Intelligent Based Systems
CO5	Gain knowledge of about microcontroller and Telemetry

SYLLABUS

Module I:
Review of Transducer, Principles of operations and its classification, Characteristics, Technological trends in making transducers, Silicon sensors for the measurement of pressure, level, flow and Temperature. Biosensors, application and types

(8L)

Module 2:
Introduction about Instrumentation system. Types of Instrumentation system. Data acquisition system and its uses in intelligent Instrumentation system. Detail study of each block involved in making of DAS, Signal conditioners as DA, IA, signal converters (ADC), Sample and hold. Designing application for Pressure, Temperature measurement system using DAS. Data logger

(8L)

Module 3:
Introduction about Automation system. Concepts of Control Schemes, Types of Controllers. Components involved in implementation of Automation system i.e., DAS, DOS, Converter (I to P) and Actuators: Pneumatic cylinder, Relay, solenoid (Final Control Element), Computer Supervisory Control System (SCADA), Direct Digital Control's Structure and Software.

(8L)

Module 4:
Introduction about Distribution Digital Control, Functional requirements of process control system, system architecture, Distributed Control systems, Configuration, Some popular Distributed Control Systems. Industrial control applications like cement plant, thermal power plant. Introduction about Intelligent controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Control system

(8L)

Module 5:
Introduction to microcontroller 8051, its architecture, register, pin descriptions, addressing modes, instruction set and simple programs. Industrial application of micro controller-measurement applications, automation and control applications. Introduction to telemetry, telemetry links, signal characterisations in time and frequency domain, analog and digital signals. Data transmission system, Advantages and disadvantages of digital transmission over analog one. Time division multiplexing, pulse modulation, Digital modulation, Pulse code modulation and Modem.

(8L)

Books recommended:

Textbooks:

1. Computer Based Industrial Control – By Krishna Kant, PHI

2. Process Control Instrumentation – By Curtis D. Johnson, Pearson Education

Reference books:

1. Electrical & Electronics Measurements and Instrumentation by A. K. Shawhney, Dhanpat Rai & Sons.
2. Electronics Instrumentation by H. S. Kalsi,TMH

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	2	2	1
CO4	3	3	3	3	2	2
CO5	3	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method

CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

Programme Core

COURSE INFORMATION SHEET

Course code: EC519
Course title: Advanced Instrumentation Lab
Pre-requisite(s):
Co- requisite(s):
Credits: L: 0 T: 0 P: 4 C: 2
Class schedule per week: 04
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objective:
This course enables the students to:

A.	Understand the basics of Instrumentation.
B.	Develop basic and advanced techniques in Instrumentation.
C.	Implement various basic Instrumentation and Virtual Instrumentation Devices.
D.	Develop Ladder diagram for different applications
E	Understand to develop Logic-gate and Drink dispenser using PLC

Course Outcome:
After the completion of this course, students will be able to:

CO1	Develop virtual instruments using LabVIEW
CO2	Use Data acquisition system with LabVIEW
CO3	Implement PLC for different applications
CO4	Use of automation studio for interfacing PLC
CO5	Perform Logic-gate and Drink dispenser simulation using PLC

SYLLABUS

LIST OF EXPERIMENTS:

1. Logic gates implementation using case structure in LabVIEW.
2. Implementation of mathematical operations using Maths block in LabVIEW.
3. Design of function generator and CRO using case structure and for-loop in LabVIEW.
4. To blink LED externally using myRIO DAC card and LabVIEW.
5. To interface a seven-segment LED with myRIO in LabVIEW.
6. To implement a servo feedback control system using myRIO in LabVIEW.
7. To implement an IR range finder in the range of 0cm and 80cm using my RIO in LabVIEW.
8. To implement a sonic range finder with maximum range of 6m using my RIO in LabVIEW.
9. Use of automation studio for interfacing PLC
10. Study of Application of automation studio
11. Logic-gate simulation using PLC.

12. Drink dispenser simulation using PLC

Books recommended:
Text Books:

1. Computer Based Industrial Control – By Krishna Kant, PHI
2. Process Control Instrumentation – By Curtis D. Johnson, Pearson Education
3. National Instruments LabVIEW manual.

Reference Books:

1. "Principle of Industrial Instrumentation" By D. Patranabis, TMH publications
2. High performance Instrumentation and Automation, CRC Press, Taylor & Francis Group, 2005

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Evaluation	40

Progressive Evaluation	% Distribution
Day to day performance & Lab files	30
Quiz (zes)	10
Viva	20

End Semester Evaluation	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive Evaluation					
End Semester Evaluation					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	2	2	2	1	1
CO3	2	2	3	3	1	1
CO4	3	2	3	3	1	1
CO5	1	1	2	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC521
Course title: Advanced Sensing Techniques Lab
Pre-requisite(s): Measurement Lab
Co- requisite(s):
Credits: L: 0 T: 0 P: 4 C: 2
Class schedule per week: 04
Class: M. Tech**.**
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objective: This course enables the students:

A.	To understand the principle of operations of different sensors.
B.	To use of Test bench for calibration.
C.	To design fiber optic sensor
D.	To understand to measure speed using tacho-generator
E.	Understand sensitivity and crosss-ensitivity

Course Objective: After the completion of this course, students will be able to:

CO1	Perform physical parameters measurement and control using respective sensor
CO2	Use testbench for calibration
CO3	Design fiber optic sensor
CO4	Know the measurement for speed using tacho-generator
CO5	Calculate sensitivity and cross-sensitivity

SYLLABUS

LIST OF EXPERIMENTS:

1. Measurement of vibration
2. Measurement of torque
3. Measurement of conductivity of the liquid.
4. Design of wireless sensor network for room temp measurement.
5. Design of wireless sensor network for pressure ar different points in a process

6. Use of Test bench for calibration of temperature
7. Use of Test bench for calibration of Pressure
8. Use of Test bench for calibration of level
9. Measurement of speed using tacho-generator
10. Design of pressure sensor using fiber optic sensor.
11. Design temperature sensor using fiber optic sensor
12. Find sensitivity and cross sensitivity for pressure sensor at different temperature

Books recommended:

Text Books:

1. Sensors and Transducers, by D. Patranabis. 2nd Edition
2. Elctrical & Electronics Measurements and Instrumentation by A.K Sawhney, Dhanpat Rai & Sons.
3. Transducers and Instrumentation, by Murthy D. V. S., Prentice Hall, 2nd Edition, 2011.

Reference Books:

1. Sensor and signal conditioning by John G. Webster, Wiley Inter Science,2nd edt., 2008

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Evaluation	40

Progressive Evaluation	% Distribution
Day to day performance & Lab files	30
Quiz (zes)	10
Viva	20

End Semester Evaluation	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive Evaluation					
End Semester Evaluation					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	2	2	2	1	1
CO3	2	2	3	3	1	1
CO4	3	2	3	3	1	1
CO5	1	1	2	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC523
Course title: Advanced Digital Signal Processing Lab
Pre-requisite(s): Basic courses on Signal and System, DSP
Co- requisite(s):
Credits: L: 0 T: 0 P: 4 C: 2
Class schedule per week: 04
Class: M. Tech.
Semester / Level: I/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	To understand the basics of signals and systems and its characteristics.
2.	To develop basic and advanced techniques in signal processing.
3.	To implement various basic DSP and Advanced DSP techniques in Hardware Platform (DSP Processor kit).
4.	Develop an understanding in analysing a signal and system behaviour in transform domain.
5.	To develop to apply advanced DSP techniques to various engineering applications.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Demonstrate the theoretical knowledge acquired in Digital Signal Processing.
CO2	To illustrate various techniques for signal modeling, representation, synthesis and analysis.

CO3	Demonstrate applications of DSP to analyse signal in transformed domain.
CO4	To apply various DSP algorithms in real life applications with hardware platform.
CO5	Aspire for pursuing a carrier in signal processing, robotics and IOT, recognize the need to learn and adapt to the change in technology and play role of team leader or supporter of team.

SYLLABUS

LIST OF EXPERIMENTS:

1. Computation of the linear convolution and circular convolution of two finite-length sequences.
2. Obtain the Partial Fraction Expansion of the Z-Transform expression and to find its Inverse Z-Transforms. Test the stability of a Discrete Time System.
3. To write a program for finding the DFT and FFT of a Discrete time finite length sequence and implement it in TMS 320C6416 DSK Processor
4. Implement the Linear Convolution using TMS 320C6416 DSK Processor.
5. Development of the program for finding out DFT and FFT of a finite length sequence using TMS 320C6416 DSK Processor.
6. To write a program for designing a Digital Filter using TMS320C641 DSK Processor.
7. Implement LMS and RLS algorithm and perform the convergence analysis.
8. Representation of stationary and non-stationary signals using wavelet transformation.
9. Implementation of sub-band filtering approach using MATLAB.
10. Implement the system identification task in TMS 320C6713 DSK Processor.
11. Write a program for channel equalization and implement in TMS 320C6416 DSK Processor.
12. Write a program to implement the Image enhancement in Image.
13. Analyse the recording of an ECG Signals to measuring Heart Rate Variability.
14. Write an algorithm to perform the Noise cancellation using Adaptive filtering.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Evaluation	40

Progressive Evaluation	% Distribution
Day to day performance & Lab files	30
Quiz (zes)	10
Viva	20

End Semester Evaluation	% Distribution
Examination Experiment	30

Performance	
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive Evaluation					
End Semester Evaluation					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	2	2	2	1	1
CO3	2	2	3	3	1	1
CO4	3	2	3	3	1	1
CO5	1	1	2	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

2nd Semester

Programme Core

COURSE INFORMATION SHEET

Course Code: EC568
Course Title: Process Control Instrumentation
Pre-requisite(s): Control system, Electronics Instrumentation
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

1	To develop the mathematical model of the physical system
2.	To analyse the interdependency of multivariable controller.
3.	To design a controller for practical systems under different condition
4.	Explain the different processes involved in process industry with special reference to Power production

Course Outcomes:
After the completion of this course, students will be:

CO1	Analyse a physical system and develop the mathematical model of the physical system
CO2	Design a controller for practical systems under different condition.
CO3	Explain the operation of different complex control schemes.
CO4	Analyse the optimization technique for dynamic control system
CO5	Justify the need of process control in different plants and industries

SYLLABUS

Module -1: Introduction
Introduction to process control, Examples of surge tank, shower, Use of instrumentation in Process control, Process model and dynamic behaviour. Reason of modelling, Lumped parameter system models, Balanced equation, Material balances, Form of dynamic model.
(8L)

Module -2: Design of Controller
Closed loop controller design procedure. PID controller, tuning of PID controller. Internal model control: Introduction to model control, Static control law, Dynamic control law, Practical open loop controller design, Generation of open-loop controller design procedure, model uncertainty and disturbances.
(8L)

Module -3: Complex Control Schemes
Complex control schemes: Background, Introduction to cascade control, cascade control analysis and design, feed forward control, feed forward control design, examples of feed forward control. Ratio control, selective and override control, split -range control. Multivariable control, general pairing problem, Steady state effective gain, Relative Gain Array (RGA), Properties and application of RGA, Use of RGA to determine variable pairing
(8L)

Module -4: Plant wide control and Model predictive control:

Steady state and dynamic effect of recycle, compressor control, Heat exchanger, the control and optimisation hierarchy. Optimisation problem, dynamics matrix control (DMC).

(8L)

Module -5: Application of Process Control

Application of process control in thermal power plant: : Process of power generation in coal – fired and oil-fired thermal power plants, types of boilers, Combustion process, Super heater, Turbine.

Application of process control in Petrochemical Industries: Introduction to Refinery and Petrochemical processes, Control of distillation column, Catalytic cracking unit, Catalytic reformer, Pyrolysis unit, Automatic Control of polyethylene production, Control of vinyl chloride and PVC production.

(8L)

Books recommended:

Textbooks:

1. "Process control: Modelling Design and simulation" By B. Wayne Bequette,

Reference books:

1. "Principle of Industrial Instrumentation" By D. Patranabis, TMH publications
2. "Principles of Process Control" By D. Patranabis, TMH publication
3. "Power plant performance" By A. B. Gill, Elsevier, India, New Delhi.
4. J.G. Balchan. & K.I. Mumme, 'Process Control Structures and Applications', Van Nostrand Reinhold Company, New York, 1988.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids

CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Course Delivery Method

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	1
CO2	3	3	3	3	2	2
CO3	3	2	2	2	2	1
CO4	2	2	3	3	2	2
CO5	2	2	3	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EC570
Course title: Embedded System Design.
Pre-requisite(s): EC203 Digital System Design, EC303 Microprocessors & Microcontrollers
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand and explain the Fundamentals of Embedded Computing System
2.	Gain knowledge on the hardware connections and 8051 programming techniques and apply the same.
3.	Appraise and analyse the custom input /output peripheral interfacing examples
4.	Assess and evaluate the real-world interfacing of sensors and converters
5.	Create the real-world control device interfacing for FPGA-based embedded system

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe and illustrate the fundamentals of embedded system and 8051
CO2	Sketch and explain the hardware connections and 8051 programming techniques
CO3	Analyze and illustrate custom input /output peripheral interfacing
CO4	Develop and schematize real-world interface with sensors and converters and evaluate its performance.
CO5	Design/develop and schematize real-world control device Interface and justify its applications.

SYLLABUS

Module 1:

Fundamentals of Embedded System and 8051:

Embedded system overview, Design challenges, Common design metrics, Time-to-market design metric, Design Methodologies: Basic Design Methodologies, Embedded Systems Design Flows, Design Verification and Validation; Reliability, Safety, and Security, Why Reliable Embedded Systems? Basics of 8051.

(8L)

Module 2:

Hardware connections, 8051 programming techniques and Hardware Description Languages:

Hardware connection and Intel hex file, pin description, explaining the Intel hex file, programming timers and counters, serial port programming, interrupts, Programming timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, Interrupt priority, Basics of Hardware Description Languages, Basics of FPGA architecture.

(8L)

Module 3:

Custom Input/Output Interfacing:

Optical Display Interfacing, Buzzer Control, Liquid Crystal Display Interfacing, General-Purpose Switch Interfacing, Dual-Tone Multifrequency Decoder, Optical Sensor Interfacing, Special Sensor Interfacing, Wind-Speed Sensor Interfacing.

(8L)

Module 4:

Interfacing Digital Logic to the Real World: Sensors, ADC and DAC:

Basics of Signal Conditioning for Sensor Interfacing, Principles of Sensor Interfacing and Measurement Techniques, Multichannel Data Logging, Pseudorandom Binary Sequence Generator, Signal Generator Design and Interfacing.

(8L)

Module 5:

Real-World Control Device Interfacing:

Relay, Solenoid Valve, Opto-Isolator, and Direct Current Motor Interfacing and Control, Servo and BLDC Motor Interfacing and Control, Stepper Motor Control, Liquid/Fuel Level Control, Real-Time Process Controller Design.

(8L)

Books recommended:

Textbooks:

1. Wolf Wayne, "High-Performance Embedded Computing - Architectures, Applications, and Methodologies", Morgan Kaufmann Publishers, 2006.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", 2nd edition, Pearson, 2006.
3. A. Arockia Bazil Raj, "FPGA based embedded system developer's guide", Taylor & Francis, CRC Press, 2018.

Reference books:

1. Vahid G Frank and Givargis Tony, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons, 2001.

2. Wolf Wayne, "Computers as Components - Principles of Embedded Computing System Design, 2nd Edition, Morgan Kaufmann Publishers, 2008.
3. Ronald Sass, Andrew G. Schmidt, "Embedded Systems Design with Platform FPGAs - Principles and Practices, Morgan Kaufmann Publishers, 2010.

Gaps in the syllabus (to meet Industry/Profession requirements): Fabrication of designed embedded system.

POs met through Gaps in the Syllabus: PO4.

Topics beyond syllabus/Advanced topics/Design: ARM and PIC Microcontrollers.

POs met through Topics beyond syllabus/Advanced topics/Design: PO4.

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	3	2	1
CO4	2	2	2	2	3	1
CO5	2	2	2	2	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6, CD7
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course Code: EC572
Course Title: Optoelectronic Instrumentation
Pre-requisite(s): EC351 Fiber Optics Communication, EC313 Electronics Measurement
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Provide knowledge about the optical sources and Detectors
2	Provide Knowledge about Fiber Optic Instrumentation and its application for various measurements
3.	Provide Knowledge about LASER and its different types with their industrial and medical application
4.	Provide Knowledge about the Holography and its applications.

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Explain the characteristics of optical sources and Detectors
CO2	Demonstrate Fiber Optic Instrumentation and its application for various measurements
CO3	Choose LASER sources for civil engineering and industrial applications
CO4	Design LASER based instrumentation for medical applications.
CO5	Develop holographic and other non-destructive measurement methods.

SYLLABUS

Module -1:
Gaussian optics, Physical Optics, Fourier optics, optical sources, Heterojunction LED's and LASERS, semiconductor Lasers Optical interferometers, mono-chromators, Photon detectors, Photo-emissive cells, LDR, Light Activated SCR, Heterostructure solar cell, noise statistics and accuracy of measurements, Statistical approach to measurements, inaccuracy of indirect measurements.

(8L)

Module -2:
Fiber optic instrumentation, Optocoupler, optoelectronic Isolator, Fiber-optic Pressure and flow sensors, optical current sensor, Fiber-optic Displacement sensor, Interferometric Fiber optic sensors, Mach-Zehnder, Michelson, Fabry perot sensor, fiber Bragg grating sensors for strain and temperature measurements, Distributed sensors based on Rayleigh, Raman, Brillouin, Optical spectrum Analyser, Fiber-optic Endoscope

(8L)

Module -3:
Principles of operation of Lasers, Mode locking, Q switching in Lasers, Tunable lasers, Laser for Velocity Measurement. Angular Rotation Rate, Measurement of Product Dimension Measurement of Surface Finish Profile and Surface Position Measurement, Particle Diameter Measurement, Strain and Vibration Measurement, Cylindrical Form Measurement, Defect Detection, Surface Flaw Inspection Monitor

(8L)

Module -4:
Laser Doppler Anemometry, Laser microscope, Raman Spectroscopy in Medicine, Laser Doppler vibrometer, Heterodyne measurements of Air drums, Laser Lithotripsy, Laser induces thermos therapy of brain cancer, Atmospheric measurements of Lidar, Medical Applications of Lasers: Laser and Tissue Interaction, Laser Instruments for Surgery, Removal of Tumors of Vocal Cords, Brain Surgery, Plastic Surgery, Gynaecology and Oncology.

(8L)

Module -5:
Holography for Non–destructive Testing, Holographic recording and Reconstruction, Holographic Interferometry and applications, Double exposer Holography, Real time holography, Holographic vibrational Analysis, Morie pattern, Speckle pattern, Measurement of in plane and out of plane deformations,

(8L)

Books recommended:

Textbooks:

1. Amar K. Ganguly., "Optical and optoelectronic Instrumentation" , Narosa Press, 2010
2. Dr. M N Avadhanulu & Dr. R S Hemne, An Introduction to Lasers- Theory and Applications, S. Chand.

Reference books:

1. John F. Read, Industrial Applications of Lasers, Academic Press.
2. Keiser G., Optical Fiber Communication, McGraw-Hill.
3. John and Harry, Industrial Lasers and their Applications, Mc-Graw Hill, 1974.
4. Monte Ross, Laser Applications, McGraw-Hill

Gaps in the syllabus (to meet Industry/Profession requirements): PO5 & PO6

POs met through Gaps in the Syllabus: PO5 & 6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & 6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	2	3
CO5	3	3	3	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

Programme Elective – II

COURSE INFORMATION SHEET

Course Code: EC574
Course Title: Pattern Recognition and Machine Learning
Pre-requisite(s): EC305 Signal Processing Technique, EC251 probability and Random Processes
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Understand the basics of pattern recognition and learning.
2	Demonstrate various Linear models for learning and regression.
3	Understand Design neural Network, Deep learning and SVM for Classification.
4	Illustrate Machine independent and Unsupervised learning Techniques.

5	Identify and apply suitable classification methods for real life problem.

Course Outcomes
On the completion of this course, the students will be able to:

CO1	Demonstrate an understanding in pattern recognition and machine learning basics.
CO2	Design neural Network and deep learning techniques for Classification.
CO3	Develop and apply unsupervised learning techniques to various problems.
CO4	Identify and apply suitable machine learning methods for real life problems.
CO5	Develop an interest in pattern recognition and machine learning, recognize the need to learn and adapt to the change in technology and play role of leader in project implementation.

SYLLABUS

Module 1
Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error Analysis
(8L)

Module 2
Linear models: Linear Models for Regression, linear regression, logistic regression, multiple linear regression, Multivariate linear regression, Least square estimation, Bayesian Linear Regression, Linear models for classification, probabilistic discriminative models
(8L)

Module 3
Neural Network: perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Reinforcement learning, Deep Learning
(8L)

Module 4
Linear discriminant functions - decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine, Linear discriminant analysis, principal component analysis, Independent Component analysis.
(8L)

Module 5
Algorithm independent machine learning –bias and variance, re-sampling for classifier design, combining classifiers, Gaussian mixture model, Unsupervised learning and clustering – k-means clustering, fuzzy k-means clustering, hierarchical clustering.
(8L)

Books recommended:
Textbooks:

1. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001.
2. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2009.

Reference books:

3. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1		2
CO2	3	2	2	3		
CO3	2	2	2	3		1
CO4	3	2	2	3	1	2
CO5	3	1	1	1	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EC558
Course Title: Modern Optimization Techniques
Pre-requisite(s): EC251 probability and Random Processes
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Gain understanding on optimization theory and its elements
2	Demonstrate single variable optimization, linear programming, dynamic programming concepts and techniques.
3	Demonstrate multivariable and constraint optimization concepts and techniques.
4	Understand on advance single and multi-objective optimization techniques such as GA, PSO, Pareto font, NSGA
5	Demonstrate an ability to apply the optimization techniques to various areas of Engineering and Science.

Course Outcomes

On the completion of this course, the students will be able to:

CO1	Develop an understanding to formulate an optimization problem and its characteristics.
CO2	Have an ability to analyse and apply algorithms for design optimization.
CO3	Have an ability to find optimum solution by applying the single and multi-objective evolutionary techniques.
CO4	Develop an ability to apply use optimization techniques to finance, economics, medical applications, control, communication, power, mechanical problems, chemical and biology.
CO5	Aspire for pursuing a carrier in Optimization, recognize the need to learn and adapt to the change in technology and play role of team leader.

SYLLABUS

Module 1:

Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Search methods: optimality Criteria, Bracketing methods: Exhaustive search methods, Region – Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.

(8L)

Module 2:

Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's steepest descent and Newton's method. Linear Programming: Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), integer linear programming, Dynamic programming, Sensitivity analysis.

(8L)

Module 3:

Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method. Gradient based method, conjugate gradient method, concept of Lagrangian multiplier, complex search method, characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.

(9L)

Module 4:
Genetic algorithm and its working principle, GA variants, Particle swarm optimization and its working principle, Differential evolution, Ant Colony Optimization, Applications in Engineering problems.

(7L)

Module 5: Multi objective Optimization problem, Dominance and Pareto-Optimality, Pareto font, Multi-objective Evolutionary Algorithms, Multi Objective genetic Algorithm, NSGA, Constrained Multi-objective Evolutionary Algorithms, Application to communication, medical, clustering, bioinformatics, control, finance.

(8L)

Books recommended:

Textbooks:

1. Optimization for Engineering Design - Kalyanmoy Deb, 2006, PHI
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley India publisher, 2010
3. S.S. Rao, Engineering Optimization, Theory and practice, New age International Publisher, 2012
4. D.E. Goldberg, genetic Algorithm in search, optimization and machine learning, Addison-Wesley Longman Publisher, 1989

Reference books:

1. Analytical Decision Making in Engineering Design - Siddal.
2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty

2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Course Delivery Method

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2		2
CO2	3	2	2	3		1
CO3	3	2	2	3	1	1
CO4	3	3	2	3	1	2
CO5		1	1	1		2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EC575
Course Title: Artificial Intelligent System
Pre-requisite(s): Fundamental of Data Structure, Digital Electronics, Signal Processing, Communication Systems, Embedded System
Co-requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Define the fundamental concepts of artificial intelligence
2.	Analyze the different search algorithms
3.	Show the application of intelligent system and its functionality
4.	Recognize the constraints and suitable algorithms for artificial intelligent systems

Course Outcomes

After the completion of this course, students will be able to:

CO1	Recognize the fundamental concepts of artificial intelligence

CO2	Investigate the different planning algorithms for an application
CO3	Design the different search algorithms for an artificial intelligence system
CO4	Analyse the constraints of intelligent system for solving the complex problems
CO5	Outline the suitable algorithms for artificial intelligent system & its functionality

SYLLABUS

Module -1:
Introduction to Artificial Intelligence:
Definition of AI, Turing test, brief history of AI, Problem solving and search, Uninformed search, informed search, Local search, local search in continuous spaces.
(8L)

Module -2:
Planning:
The STRIPS language, forward planning, backward planning, planning heuristics, partial-order planning, planning using propositional logic, planning vs. scheduling.
(8L)

Module -3:
Constraint Satisfaction Problems:
Basic definitions of constraint satisfaction problems, finite vs infinite vs continuous domains, constraint graphs, relationship with propositional satisfiability, conjunctive queries, linear integer programming, and Diophantine equations, NP-completeness of CSP, extension to quantified constraint satisfaction (QCSP).
(8L)

Module -4:
Solving Constraint Satisfactions Problem:
Constraint satisfaction as a search problem, backtracking search, variable and value ordering heuristic, degree heuristic, least-constraining value heuristic, forward checking, constraint propagation, dependency-directed backtracking, independent sub-problems.
(8L)

Module -5:
Intelligent Games Strategy:
Playing game, game tree, utility function, optimal strategies, minimax algorithm, alpha-beta pruning, games with an element of chance.
(8L)

Books recommended:
Textbooks:-
1. S.J. Russell and P. Norvig. Artificial Intelligence: A Modern Approach (2nd edition), Prentice-Hall, 2010.

Reference books:-
1. Artificial Intelligence-Definition- Wikibooks, open books for an open; https://en.wikibooks.org/wiki/Artificial_Intelligence/Definition
2. Patterson, Dan W. - Introduction to Artificial Intelligence and Expert Systems (Pearson Education)

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Course Delivery Method

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	3	3
CO2	2	2	3	3	1	2
CO3	3	2	3	3	2	2
CO4	2	3	3	2	2	3
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course Code: EC576
Course Title: Micro-Electro Mechanical System
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05

Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Develop an ability, enthusiasm critical thinking in microengineering process, materials and design issues
2.	Develop the Fundamental concepts of MEMS technology & their applications in different areas
3	Study various sensing and transduction technique
4.	Develop an ability and understanding of microscale physics for use in designing MEMS devices
5.	Develop an inclination towards electronics system design and manufacturing

Course Outcomes:
After the completion of this course, students will:

CO1	Have an ability to demonstrate knowledge on fundamental principles and concepts of MEMS Technology
CO2	Have an ability to analyse various techniques for building micro-devices in silicon, polymer, metal and other materials
CO3	Critically analyse micro-systems technology for technical feasibility as well as practicality using modern tools and relevant simulation software to perform design and analysis.
CO4	Have an ability to evaluate design parameters using mechanical and electrical modelling for different MEMS structure
CO5	Have an ability to analyse physical, chemical, biological, and engineering principles involved in the design and operation of current and future micro-devices

SYLLABUS

Module 1: INTRODUCTION
Intrinsic Characteristics Of MEMS – Energy Domains And Transducers- Sensors And Actuators – Introduction To Micro Fabrication – Silicon Based MEMS Processes – New Materials – Review Of Electrical And Mechanical Concepts In MEMS – Semiconductor Devices – Stress And Strain Analysis – Flexural Beam Bending- Torsional Deflection.
(8L)

Module 2: SENSORS AND ACTUATORS-I
Electrostatic Sensors – Parallel Plate Capacitors – Applications – Interdigitated Finger Capacitor – Comb Drive Devices – Micro Grippers – Micro Motors – Thermal Sensing And Actuation – Thermal Expansion – Thermal Couples – Thermal Resistors – Thermal Bimorph – Applications – Magnetic Actuators – Micromagnetic Components – Case Studies Of MEMS In Magnetic Actuators- Actuation Using Shape Memory Alloys.
(8L)

Module 3: SENSORS AND ACTUATORS-II
Piezoresistive Sensors – Piezoresistive Sensor Materials – Stress Analysis Of Mechanical Elements – Applications To Inertia, Pressure, Tactile And Flow Sensors – Piezoelectric Sensors And Actuators – Piezoelectric Effects – Piezoelectric Materials – Applications To Inertia , Acoustic, Tactile And Flow Sensors.
(8L)

Module 4: MICROMACHINING
Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching Of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case Studies – Basic Surface Micro Machining Processes – Structural And Sacrificial

Materials – Acceleration Of Sacrificial Etch – Striction And Antistriction Methods – LIGA Process – Assembly Of 3D MEMS – Foundry Process.

(8L)

Module 5: POLYMER AND OPTICAL MEMS
Polymers In MEMS– Polimide – SU-8 – Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon – Application To Acceleration, Pressure, Flow And Tactile Sensors- Optical MEMS – Lenses And Mirrors – Actuators For Active Optical MEMS.

(8L)

Books recommended:

Textbooks:

1. Chang Liu, 'Foundations Of MEMS', Pearson Education Inc., 2012.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
3. Tai Ran Hsu, "MEMS & Micro Systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.

Reference books:

1. Nadim Maluf, "An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
2. Mohamed Gad-El-Hak, Editor, "The MEMS Handbook", CRC Press Baco Raton, 2001.
3. Julian W. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS And Smart Devices, John Wiley & Son LTD, 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5. Thomas M.Adams And Richard A.Layton, "Introduction MEMS, Fabrication And Application," Springer,

<u>Gaps in the syllabus (to meet Industry/Profession requirements):</u>

<u>POs met through Gaps in the Syllabus:</u>

<u>Topics beyond syllabus/Advanced topics/Design:</u>

<u>POs met through Topics beyond syllabus/Advanced topics/Design:</u>

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

<u>Direct Assessment</u>

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

<u>Indirect Assessment</u>

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Course Delivery Method

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	-	2	1
CO2	1	2	2	3	2	-
CO3	-	3	3	2	3	2
CO4	3	3	3	3	3	2
CO5	1	-	2	2	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course Code: EC577
Course title: Photonic Integrated Circuits
Pre-requisite(s): EC 201 Electronics Devices, EC 257 Electromagnetic Fields and Waves
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher

Course Objectives:
This course enables the students to:

1.	Understand the light-guiding properties in optical waveguides.
2.	Understand the operating principle of waveguide devices.
3.	Understand the methods for fabrication of optical waveguides in silicon.
4.	Understand the system on-chip perspective and applications of Photonic Integrated circuits in different fields.

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Explain the key properties of Optical Waveguides.
CO2	Explain the characteristics of silicon waveguide devices.
CO3	Fabricate and test the silicon waveguide devices.
CO4	Design and integrate complex systems with SoC (System on Chip)

CO5	Apply the photonic integrated circuits in various applications

SYLLABUS

Module -1:
Light propagation in optical waveguide, symmetrical planar waveguide, Asymmetrical planar waveguide, Ideal slave waveguide, 3D optical waveguide, Analysis of guided modes, Loss mechanisms in waveguides, Coupling to optical circuit.

(8L)

Module -2:
Waveguide devices, Directional couplers, Phase-matched and non-phase-matched couplers, Distributed Bragg reflectors, Mach- Zehnder Interferometers, Optical phase modulator , Variable optical attenuators, Arrayed Waveguide Grating (AWG), PHASER-based devices, Silicon-on-Insulator (SOI).

(8L)

Module -3:
Fabrication of silicon waveguide devices, SOI substrate design, waveguide integration, Photolithography, Oxidation, Formation of submicron waveguides, Silicon doping, Metallization, Design verification and device models, Design and testing infrastructure.

(8L)

Module -4:
System on-chip perspective, On-chip communication, SoC Integration Issues, On-chip optical interconnect, PICMOS, WADIMOS, High speed performance of Stand-Alone-Silicon MZM, Performance of standalone MUX/DEMUX, High speed performance of silicon PIC.

(8L)

Module -5:
Green Integrated Photonics, Non-linear optical losses in integrated Photonics, Two-Photon Photovoltaic effect, Non-linear Photovoltaic effect, Silicon photonic in Biosensing, Bioreceptors, Surface chemistry and passivation for biosensing, Optical reflectors Transducers in Porous Silicon, Photoluminescence Transducers, MOEMS, Photonic bandgap structures.

(8L)

Books recommended:

Textbooks:

1. Graham T. Reed, Silicon Photonics: An Introduction, John Willey & Sons.
2. M. JAMAL DEEN & P. K. BASU, Silicon Photonics Fundamentals and Devices, Willey.

Reference books:

1. Sasan Fathpour & Bahram Jalali., Silcon Photonics for Telecommunications and biomedicine, CRC Press.
2. David J. Lockwood & Lorenzo Pavesi, Silicon Photonics II: Components and Integration, Springer.
3. L.A.Coldren, S.W.Corzine & M.L.Masanovic, Diode Lasers and Photonic Integrated Circuits, Willey.
4. Marco Pisco, Andrea Cusano and Antonello Cutolo, Photonic Bandgap Structures, Bentham Science Publishers.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: **PO8 will be met though report-writing/presentation-based assignment**

Topics beyond syllabus/Advanced topics/Design: **Teaching through paper**

<u>POs met through Topics beyond syllabus/Advanced topics/Design:</u> Teaching through paper

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

<u>Direct Assessment</u>

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

<u>Indirect Assessment</u>

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Course Delivery Method

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	1
CO2	3	2	3	3	3	2
CO3	3	2	3	3	3	2
CO4	3	2	3	3	2	3
CO5	3	3	3	2	3	3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EC578

Course title: CMOS Analog VLSI Design

Pre-requisite(s): EC253 Analog Circuits

Co- requisite(s):

Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Understand CMOS amplifiers.
2.	Apply Analog CMOS Subcircuits.
3.	Analyze Frequency Response of CMOS Amplifiers.
4.	Evaluate CMOS Differential Amplifier.
5.	Create CMOS Operational-Transconductance Amplifier.

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Describe and illustrate CMOS Amplifiers.
CO2	Sketch and explain Analog CMOS Subcircuits
CO3	Illustrate CMOS Amplifiers and analyze its Frequency Response
CO4	Appraise the operation of CMOS Differential Amplifier and schematize its characteristics, assess and summarize their features.
CO5	Design and schematize CMOS Operational-Transconductance Amplifier and prepare an inference

SYLLABUS

Module -1:
Single-Stage Amplifiers:
Review of MOS Large-Signal Model, Small-Signal Model, MOS Transconductance, Determination of the small-signal resistances of diode-connected NMOS and PMOS.
MOS Amplifier Topologies, Biasing, Realization of Current Sources; Common-Source Stage: CS Core, CS stage with Current-Source Load, CS stage with Diode-Connected Load, CS Stage with Degeneration, CS Core with Biasing; Common-Gate Stage: CG Stage with Biasing; Source Follower: Source Follower Core, Source Follower with Biasing.
(8L)

Module -2:
Analog Subcircuits:
Analog CMOS subcircuits: MOS Diode/ Active resistor, Current Sink and Sources, Impractical biasing of MOS current sources, Current Mirrors, Application of Current Mirror as Current Steering Circuit, illustration of NMOS and PMOS current mirrors in a typical circuit, Current and Voltage Reference, Bandgap Reference; NMOS cascode current source and its equivalent circuit, PMOS cascode current source, Cascode Stage as an Amplifier, CMOS Cascode Amplifier;
(8L)

Module -3:
Frequency Response of Single-State Amplifiers:
General Considerations: Relationship Between Transfer Function and Frequency Response, Bode Rules, Association of Poles with Nodes, Miller’s Theorem; High-Frequency Model of Transistor: High-Frequency Model of MOSFET, Transit Frequency; Frequency Response of Common Source Stage: Use of Miller’s Theorem, Direct Analysis, Input Impedance; Frequency Response of Common Gate Stage, Frequency Response of Source Follower: Input and Output Impedances, Frequency Response of Cascode Stage: Input and Output Impedances.

(8L)

Module -4:
Differential Amplifier:
General Considerations: Initial Thoughts, Differential Signals, Differential Pair; MOS Differential Pair: Qualitative Analysis, Large-Signal Analysis, Small-Signal Analysis; Cascode Differential Amplifiers, Common-Mode Rejection, Differential Pair with Active Load: Qualitative Analysis, Quantitative Analysis; Frequency Response of Differential Pairs. Variability and Mismatch: Systematic Variations Including Proximity Effects, Process Variations, Random Variations and Mismatch; Analog Layout Considerations: Transistor Layouts, Capacitor Matching, Resistor Layout, Noise Considerations.

(8L)

Module -5:
Operational-Transconductance Amplifier:
Performance Analysis of Current-sink CMOS inverting Amplifier, building blocks an CMOS operational-transconductance amplifier and Voltage Operational Amplifier, block diagram a general CMOS Operational-Transconductance Amplifier and Voltage Operational Amplifier, General Characteristics of the ideal CMOS Operational-Transconductance Amplifier, Division of a two-stage uncompensated CMOS Operational-Transconductance Amplifier into voltage-to-current and current-to-voltage stages, Functions of different stages, Characterization of two-stage CMOS Operational-Transconductance Amplifier: Slew Rate, CMRR, Design guidelines of two-stage CMOS Operational-Transconductance Amplifier based on given boundary conditions.

(8L)

Books recommended:
Textbooks:

1. Behzad Razavi, Fundamentals of Microelectronics, Wiley, 2009.
2. Phillip E. Allen & Douglas R. Holberg, CMOS Analog Circuit Design, 3/e, Oxford University Press, 2012.

Reference books:

1. Tony Chan Carusone, David A. Johns and Kenneth W. Martin, Analogue Integrated Circuit Design, 2/e, John Wiley & Sons, 2012.
2. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis and Roberst G. Meyer, Analysis and Design of Analog Integrated Circuits, 5/e, Wiley, 2009

Gaps in the syllabus (to meet Industry/Profession requirements): Fabrication challenges for analog circuits.

POs met through Gaps in the Syllabus: PO6.

Topics beyond syllabus/Advanced topics/Design: ADC, DAC, and PLL.

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	3	2	1
CO4	2	2	2	2	3	1
CO5	2	2	2	2	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6, CD7
CO2	CD1, CD2, CD3, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

Open Elective-II

COURSE INFORMATION SHEET

Course code: EC599
Course title: Sensors and Actuators
Pre-requisite(s):
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Describe the operation of various sensors and actuators.
2.	Select an appropriate sensor and actuator for sensing and control action respectively.
3.	Differentiate between smart sensor and conventional sensor.
4.	Compare analog and digital transducer with actuators.
5.	Discuss the latest technology in sensor development

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Understand the principle of operation of different sensors and actuators.
CO2	Classify sensors and actuators on different basis.
CO3	Select proper sensor electrode for electrochemical application.
CO4	Design a smart sensor using conventional sensors and microcontroller.
CO5	Demonstrate the operation of various actuators.

SYLLABUS

Module I:
Introduction: Principles of operation **S**ensors and transducers, classification, characteristics. Recent trends in sensors technology: Fibre Optic Sensors, Film Sensors, Semiconductor IC Technology, Microelectromechanical System (MEMS), Nano Sensors.

(8L)

Module II:
Transducers: Electrostatic and Piezoelectric Transducers, Quartz Resonators and Ultrasonic Sensors, Hall effect and Inductance and Eddy current sensors. Angular/Rotary movement Transducer, Electromagnetic Flowmeter. Acoustic Temp Sensor, Nuclear Thermometer, Magnetic Thermometer, Resistance Change Type, Thermoelectric.

(8L)

Module III:
Electroanalytical Sensors: Introduction, Electro-chemical Cell, Cell potential, Sd. Hydrogen Electrode (SHE), Liquid Junction and Other potentials, Polarization, Reference Electrodes, Sensor Electrodes, Radiation Sensors: Basic Characteristics, Photo-emissive Cell and Photomultiplier, Photovoltaic Cell, X-ray and Nuclear Radiation Sensors.

(8L)

Module IV:
Digital Transducers: Digital Encoder, Shaft Encoder, Switches: Pressure, Level, Flow, Temperature, Proximity Switches, Limit Switches and its types, Isolators (or Barriers).Application of Sensors, Automotive Sensors, Home Appliance Sensors, Aerospace Sensors, Sensors for manufacturing, Medical Diagnostic Sensors, Sensors for Environmental Monitoring Introduction to Intelligent sensor architecture, Primary Sensors Excitation, Amplification, Fitters, Converters, Compensation, Information Coding/Processing, Data Communication, Smart Transmitters.

(8L)

Module V:
Actuators: Introduction to actuators, transducer, Types of actuators, Pneumatic and hydraulic actuators, Pneumatic cylinders, Single acting, Double acting and Rotary cylinders, I to P converter, Electrical actuators, Motors, Servomotors, Stepper motors, Relay, Solenoid valves, Pneumatic Valves

(8L)

Books recommended:
Textbooks:
1. "Sensors and Transducers", 2/E by D. Patranabis.
2. Electrical & Electronics Measurements and Instrumentation by A.K.Shawhney, Dhanpat Rai & Sons.

3. Electronics instrumentation by H. S. Kalsi [TMH]
4. Hand Books of Instrumentation.

Reference books:

1. Process control Instrumentation Technology by CD Johnson, PHI Learning

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: Nano sensor technology.

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/seminar
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	3	2	3	2	2	2
CO3	3	3	2	2	3	2
CO4	3	3	2	3	2	3
CO5	3	2	3	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD7
CO2	CD1, CD2, CD3, CD7
CO3	CD1, CD2, CD3, CD7
CO4	CD1, CD2, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

Programme Core

COURSE INFORMATION SHEET

Course Code: EC569
Course Title: Process Control Instrumentation Lab
Pre-requisite(s): Control system, Electronics Instrumentation
Co-requisite(s):
Credits: L: 0 T: 0 P: 4 C: 2
Class schedule per week: 04
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objective:
This course enables the students to:

1.	Understand the basics of process control.
2.	Develop basic and advanced pneumatic circuits.
3.	Implement complex control scheme using labview.
4.	Use automation studio for pneumatic devices

Course Outcome:
After the completion of this course, students will be able to:

CO1	Analyse physical parameters measurement and control using respective trainer
CO2	Use automation studio for pneumatic devices
CO3	Use automation studio for Electrical devices
CO4	Design complex control schemes using LabVIEW
CO5	Perform advance pneumatic operations

<u>SYLLABUS</u>

<u>List of experiments:</u>

1. Flow-measurement and control using flow-loop control trainer.
2. Liquid-level measurement and control using level loop control trainer.
3. Pressure control loop using Pressure loop trainer
4. Operation of Cylinders using Advanced Pneumatic setup.
5. Operation of valves using Advanced Pneumatic setup.
6. Design of Pneumatic setup.
7. Design of Electro pneumatic relays using Advanced Pneumatic setup.
8. Use of automation studio for pneumatic devices
9. Use of automation studio for Electrical devices
10. Design of feedforward controller using LabVIEW

11. Design of cascade controller using Labview
12. Design of IMC structure using Lab VIEW

Books recommended:
Textbooks:

1. "Process control: Modelling Design and simulation" By B.Wayne Bequette,

Reference books:

1. "Principle of Industrial Instrumentation" By D. Patranabis, TMH publications
2. "Principles of Process Control" By D. Patranabis, TMH publication
3. "Power plant performance" By A. B. Gill, Elsevier, India, New Delhi.
4. J.G. Balchan. and K.I. Mumme, 'Process Control Structures and Applications', Van Nostrand Reinhold Company, New York, 1988.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands on experience on solution of Real time Industrial Project and management

POs met through Gaps in the Syllabus: PO5, PO6

Topics beyond syllabus/Advanced topics/Design: through experiments involving design of circuits on advanced topics

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Evaluation	40

Progressive Evaluation	% Distribution
Day to day performance & Lab files	30
Quiz (zes)	10
Viva	20

End Semester Evaluation	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive Evaluation					
End Semester Evaluation					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures

CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	3	2	3	2	2	2
CO3	3	2	3	2	2	2
CO4	3	2	3	3	2	3
CO5	2	2	2	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EC571
Course title: Embedded System Lab
Pre-requisite(s): EC203 Digital System Design, EC303 Microprocessors & Microcontrollers.
Co- requisite(s): EC571 Embedded System Design
Credits: L: 0 T: 0 P: 4 C: 2
Class schedule per week: 4
Class: M. Tech.
Semester / Level: II/5
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the programmable hardware and its programming.
2.	Apply their understanding to write 8051 based assembly language/C programs.
3.	Analyse programs for designing components of embedded system for on-chip applications with other components.
4.	Evaluate and test programs for designing components of embedded system for on-chip commercial applications.
5.	Create/develop programs for designing components of embedded system for consumer electronics applications after integration of all necessary components.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Translate their theoretical knowledge to write assembly language/C programs and burn into flash ROM of AT89S51 or AT89S52 Microcontroller for its application on wish-board.
CO2	Write assembly language/C programs and burn into flash ROM of AT89S51 or AT89S52 Microcontroller and simulate/ the same and experiment on wish-board.

CO3	Outline and write the Verilog/VHDL program for designing a component of an embedded system and simulate/test the same using Xilinx ISE 8.1i and experiment on prototyping board such as **Xilinx XC9572 CPLD in Milman VLSI Trainer** kit after downloading the configuration file.
CO4	Write the Verilog/VHDL program for designing a component of an embedded system and simulate/evaluate the same using Xilinx ISE 10.1i and test for verification on prototyping board such as **Xilinx Spartan-3E Starter kit** after downloading the configuration file.
CO5	Write the Verilog/VHDL program for designing a component of an embedded system and simulate/validate the same using Xilinx ISE 10.1i and test for verification on prototyping board such as **Xilinx Spartan-3E Starter kit** after downloading the configuration file.

SYLLABUS

List of Experiments

Part – I:

1. Write an assembly language/C programs and assemble/compile the same to find error, if any; generate Intel HEX file and burn into flash ROM of AT89S51 or AT89S52 Microcontroller to perform the following: (a) Keep monitoring the P1.2 bit until it becomes high (b) When P1.2 becomes high, write value 45H to port 0 (c) Send a high-to-low (H-to-L) pulse to P2.3. Use wish-board of ANALOG AND DIGITAL TRAINER to show the result.
2. Assume that bit P2.3 is an input and represents the condition of an oven. If it goes high, it means that the oven is hot. Monitor the bit continuously. Whenever it goes high, send a high-to-low pulse to port P1.5 to turn on a buzzer. Write an assembly language/C program and assemble/compile the same to find error, if any; generate Intel HEX file and burn into flash ROM of AT89S51 or AT89S52 Microcontroller. Use wish-board of ANALOG AND DIGITAL TRAINER to show the result.
3. Write an assembly language/C program to toggle the bits of PORT 1 and assemble/compile the same to find error, if any; generate Intel HEX file and burn into flash ROM of AT89S51 or AT89S52 Microcontroller. Use wish-board of ANALOG AND DIGITAL TRAINER to show the result.
4. A switch is connected to P1.0 and an LED to pin P2.7. Write an assembly language/C program to get the status of the switch through the LED; assemble/compile the same to find error, if any; generate Intel HEX file and burn into flash ROM of AT89S51 or AT89S52 Microcontroller. Use wish-board of ANALOG AND DIGITAL TRAINER to show the result.
5. Write an assembly language/C program to generate a square wave of 50% duty cycle on bit 0 of port 1; assemble/compile the same to find error, if any; generate Intel HEX file and burn into flash ROM of AT89S51 or AT89S52 Microcontroller. Use wish-board of ANALOG AND DIGITAL TRAINER to show the result.
6. Write an assembly language/C program to read data from P1 and write the read data to P2 continuously while giving a copy of it to the serial COM port to be transferred serially; assemble/compile the same to find error, if any; generate Intel HEX file and burn into flash ROM of AT89S51 or AT89S52 Microcontroller. Use wish-board of ANALOG AND DIGITAL TRAINER to show the result.

Part – I: Optional

1. Assume that the INT1 pin (external hardware interrupt) is connected to a switch that is normally high. Whenever it goes low, it should turn on an LED. The LED is connected to P1.3 and is normally off. When it is turned on it should stay on for a fraction of a second. As long as the switch is pressed low, the LED should stay on. Write an assembly language program to show the result in hardware by burning the

program into flash ROM (use AT89S51 or AT89S52, burner kit, wish-board, necessary hardware and tester).

2. Assume that pin 3.3 (INT1) is connected to a pulse generator, write a program in which the falling edge of the pulse will send a high to P1.3, which is connected to an LED (or buzzer). In other words, the LED is turned on and off at the same rate as the pulses are applied to the INT1 pin. Write an assembly language program to show the result in hardware by burning the program into flash ROM (use AT89S51 or AT89S52, burner kit, wish-board, necessary hardware and tester).
3. Write the assembly code for Intelligent Traffic Light Controllers QTLC) at Zebra Crossing.
4. Design an Auto Toll Billing System
5. Design a microcontroller based embedded system for agricultural surveillance.
6. Design a system using AT89S5l, ADC0848, LM34135, LM336 & POT l0K for reading the output of temperature sensor.
7. Design a microcontroller based embedded system for smart power grids.
8. Write a assemble program to generate saw tooth wave & triangular wave using DAC.
9. Develop a simple hardware/software partitioning tool that accepts as input a task graph and the execution times of the software implementations of the tasks. Allocate processes to hardware or software and generate a feasible system schedule.
10. Develop a tool that allows you to quickly estimate the performance and area of an accelerator, given a hardware description.

Part – II:

1. Outline and write a VHDL/Verilog code for designing an ALU using IP core on Xilinx ISE. Test your VHDL/Verilog code by simulating it, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit /Spartan-3E Starter kit and test its operation.
2. Outline and write a VHDL/Verilog code for designing a FPGA-based digital system to display your name. Test your VHDL/Verilog code by simulating it, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit /Spartan-3E Starter kit and show your name on LCD.
3. Outline and write a VHDL/Verilog code for designing a FPGA-based digital system to rotate your name. Test your VHDL/Verilog code by simulating it, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit /Spartan-3E Starter kit and show your rotating name on LCD.
4. Outline and write a VHDL/Verilog code for designing a 2-bit adder using System Generator. Test your VHDL/Verilog code by simulating it, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit /Spartan-3E Starter kit and verify its operation without Chip Scope Pro.
5. Sixteen LEDs are connected to the FPGA in common cathode configuration. Develop VHDL/Verilog code to make the first eight LEDS glow in a downward direction while the other eight LEDs glow in an upward direction. This has to happen five times; then all the LEDs have to blink two times. Simulate your VHDL/Verilog code, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit and show the results.
6. Develop a digital system in FPGA to drive a buzzer at different duty cycles 0%, 40%, 80%, and 100% whenever the input (data_in) is ($0 \leq$ data_in ≤ 10), ($10 <$ data_in ≤ 100), ($100 <$ data_in ≤ 200) and ($200<$ data_in), respectively. Assume that the inputs are given

via a port of eight bits. Simulate your VHDL/Verilog code, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit and show the results.

Part – II: Optional

1. Design a 2-bit adder using System Generator on Xilinx ISE 10.1i. Synthesize the circuit, download the configuration file to the prototyping board (use use Spartan-3E Starter kit) and verify its operation with Chip Scope Pro.
2. Design a 4-bit Johnson counter using Verilog on Xilinx ISE 10.1i. Synthesize the circuit, download the configuration file to the prototyping board (use Xilinx XC9572 CPLD in Milman VLSI Trainer kit) and verify its operation.
3. Design a circuit to implement GCD (greatest common divisor) algorithm using Verilog on Xilinx ISE 8.1i. Synthesize the circuit, download the configuration file to the prototyping board (use Spartan-3E Starter kit) and verify its operation.
4. Develop a digital system to display "DIAT" on a multi-segment LED display panel. The scrolling of the word has to be in the right-to-left direction. Assume each segment of the LED display panel has eight rows and eight columns.
5. Develop a digital system to display digital pulses on pages 1 and 6 of a GLCD. Use both segments and display two cycles in each page. Use the onboard DIP switch for resetting the GLCD.
6. Develop a digital system in the FPGA to control appliances from a remote station using DTMF (Dual-Tone Multifrequency Decoder) tones as per the following requirements.
    a) There are nine electrical appliances that have to be controlled.
    b) DTMF tone "0" has to be used to switch off all the appliances.
    c) DTMF tone data (1–9) have to be used to select a particular appliance.
    d) "*" and "#", that is, A ("1010") and C ("1100"), have to be used to switch the appliances "on" and "off", respectively.
7. Develop a FPGA-based digital system to continuously monitor and automatically fill the chemical fluid in a tank. A proximity sensor is placed inside the tank so as to get IR radiation reflected back to the phototransistor from the chemical fluid surface. The output of the phototransistor is given to an 8-bit A/D convertor. Hence, the fluid level is measured by A/D and given to the FPGA via 8-bit data. The system has to indicate the fluid level in the first row of an LCD and switch on the fluid inlet motor if the level goes below "00001111".

Books recommended:

Textbooks:

4. Wolf Wayne, "High-Performance Embedded Computing - Architectures, Applications, and Methodologies", Morgan Kaufmann Publishers, 2006.
5. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", 2nd edition, Pearson, 2006.
6. A. Arockia Bazil Raj, "FPGA based embedded system developer's guide", Taylor & Francis, CRC Press, 2018.

Reference books:

4. Vahid G Frank and Givargis Tony, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons, 2001.
5. Wolf Wayne, "Computers as Components - Principles of Embedded Computing System Design, 2nd Edition, Morgan Kaufmann Publishers, 2008.
1. Ronald Sass, Andrew G. Schmidt, "Embedded Systems Design with Platform FPGAs - Principles and Practices, Morgan Kaufmann Publishers, 2010.

Gaps in the syllabus (to meet Industry/Profession requirements): Fabrication of designed embedded system.

POs met through Gaps in the Syllabus: PO4

Topics beyond syllabus/Advanced topics/Design: ARM, PIC Microcontroller.

POs met through Topics beyond syllabus/Advanced topics/Design: PO4

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Progressive Evaluation	60
End Semester Evaluation	40

Progressive Evaluation	**% Distribution**
Day to day performance & Lab files	30
Quiz (zes)	10
Viva	20

End Semester Evaluation	**% Distribution**
Examination Experiment Performance	30
Quiz	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Progressive Evaluation					
End Semester Evaluation					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	2	3
CO2	3	3	3	3	2	3
CO3	3	3	2	3	2	3
CO4	2	2	2	2	3	3
CO5	2	2	2	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6, CD7
CO2	CD3, CD6, CD7
CO3	CD1, CD3, CD6, CD7
CO4	CD3, CD6, CD7
CO5	CD3, CD6, CD7

COURSE INFORMATION SHEET

Course Code: EC573
Course Title: Optoelectronic Instrumentation Lab
Pre-requisite(s):
Co-requisite(s):
Credits: L: 0 T: 0 P: 4 C: 2
Class schedule per week: 04
Class: M. Tech.
Semester / Level: II/05
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the Losses in optical Fiber
2.	Characterize the optical fiber sources and detectors
3.	Understand the analog TDM, Digital TDM, WDM Mux and DMUX
4.	Understand the various fiber optic sensors

Course Outcomes
After the completion of this course, students will be able to:

CO1	Estimate the fiber parameters and Losses in optical Fiber
CO2	Estimate the parameters of optical sources and detectors
CO3	Demonstrate the analog TDM, Digital TDM, WDM Mux and DMUX
CO4	Demonstrate the various fiber optic sensors
CO5	Design the modulators required for Laser and fiber based instrumentation

SYLLABUS

LIST OF EXPERIMENTS

1. To measure attenuation of optical fiber.
2. To measure Numerical Aperture (NA) of a multimode fiber using He-Ne Laser source.
3. To visualize fiber modes using He-Ne laser.
4. To measure coupling losses due to
    a) Lateral offset
    b) Angular Offset and
    c) Longitudinal Offset
5. To demonstrate analog TDM and digital TDM in fiber optic link.
6. To demonstrate Interferometric Fiber Optic sensor.
7. To demonstrate Wavelength Division Multiplexing and Demultiplexing in optical fiber system.
8. To measure gain of Erbium doped fiber amplifier.
9. To measure strain using fiber Bragg grating sensor.

10. To determine the beat length of an elliptical core fiber.
11. To implement Mach-Zehnder Electro-Optic Modulator.
12. To determine output characteristics of laser diode and spectral response of photodiode.

Books recommended:
Textbooks:

1. Amar K. Ganguly., “Optical and optoelectronic Instrumentation” , Narosa Press, 2010
2. Keiser G., Optical Fiber Communication, McGraw-Hill. d.

Reference books:

1. John F. Read, Industrial Applications of Lasers, Academic Press.
2. Dr. M N Avadhanulu & Dr. R S Hemne, An Introduction to Lasers- Theory and Applications, S. Chan
3. John and Harry, Industrial Lasers and their Applications, Mc-Graw Hill, 1974.
4. Monte Ross, Laser Applications, McGraw-Hill

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: PO5, PO6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Progressive Evaluation	60
End Semester Evaluation	40

Progressive Evaluation	**% Distribution**
Day to day performance & Lab files	30
Quiz (zes)	10
Viva	20

End Semester Evaluation	**% Distribution**
Examination Experiment Performance	30
Quiz	10

End Semester Evaluation	**% Distribution**
Examination Experiment Performance	25
Viva Voce	15

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Progressive Evaluation					
End Semester Evaluation					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	1
CO2	3	3	3	2	2	3
CO3	3	3	3	3	2	3
CO4	3	3	3	3	3	3
CO5	3	3	3	2	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

3rd Semester

Programme Core

EC600 Thesis (Part I)   Credit: 8

COURSE INFORMATION SHEET

Course Code: EC609
Course Title: Industrial Instrumentation
Pre-requisite(s): Advance Instrumentation System (AIS)
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III/06
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	Explain the role of instrumentation in Industrial Automation and Control
2.	Classify the various control schemes used in industry for process control

3.	Discuss the working of PLC and CNC machines for controlling various Industrial processes
4.	Outline the construction and working of commonly used Actuators and Control Elements in industry and to state and outline the networking of sensors and actuators.

Course Outcomes:
After the completion of this course, students will be:

CO1	Draw instrumentation diagram of a given system
CO2	Analyse the select suitable control scheme for controlling a given process.
CO3	Demonstrate the working of PLC and CNC machines.
CO4	Will be able to suggest the suitable actuator and valve for give control action and Architect and design networking of sensors and actuators on field bus
CO5	Design application specific circuits using Automation studio

SYLLABUS

Module -1:
Industrial Instrumentation:
Introduction to Industrial Instrumentation diagrams. Introduction to Standards of Industrial instrumentation, Wiring and piping hook-up diagrams, Preparation of Instrument Index, Tagging of Instruments and Preparation of Bill of materials. Testing process of Controller loop, Pneumatic and Hydraulic systems.

(8L)

Module -2:
Process Control:
On /off control, PID control, Controller Tuning, Implementation of PID Controllers, feed forward control, ratio control, Predictive Control, Control of Systems with Inverse Response, Cascade Control, Overriding Control, Selective Control, Split Range Control

(8L)

Module -3:
Concepts of Logical Controller:
Introduction to Sequence Control, PLCs and Relay Ladder Logic, PLC Architecture, Scan Cycle, Structured Design Approach, RLL syntax and programming. Hardware, CNC Machine tools

(8L)

Module -4:
Actuators and Final Control Elements:
Flow control valves, Hydraulic actuators, Pumps and Motors, Servo valves, Pneumatic, controllers, Electric drives, DC motor drives, Induction motor drives, adjustable speed and servo drives.

(8L)

Module -5:
Application software for industrial instrumentation and networking:
Hydraulic, Pneumatic, Electrical and PLC circuits using Automation studio. Networking of sensors, Actuators and field bus, Communication protocol, Production control

(8L)

Books recommended:
Textbooks:

1. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S.Sen and A.K. Deb, Jaico Publishing House
2. Electric Motor Drives, Modelling, Analysis and Control, R.Krishnan,Prentice Hall India,

3. Hydraulic Control Systems, Herbert E. Merritt, Wiley

Reference books:

1. Process control Instrumentation Technology by CD Johnson, PHI Learning
2. D. M. Considine, Process/Industrial Instruments and Control Handbook, Fourth Edition, McGraw-Hill Inc., 1993.
3. www.automationstudio.com/

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	1
CO2	2	2	3	3	2	2
CO3	2	2	3	3	2	1
CO4	3	3	3	2	2	2
CO5	3	2	3	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

Programme Elective – III

COURSE INFORMATION SHEET

Course Code: EC610
Course Title: Biomedical Signal Processing
Pre-requisite(s): EC522 Advanced Digital Signal Processing
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III/06
Branch: ECE
Name of Teacher:
Course Objectives
This course enables the students to:

1	Understand the fundamentals of Digital Signal Processing and Biomedical Signal Processing.
2	Grasp the concept of stochastic processes to develop advanced Biomedical signal processing concept.
3	Comprehend Digital Signal Processing and Biomedical Signal Processing.
4	Explain how can measure and extract information from Muti-channel Biomedical Signals
5	Grasp how to integrate the concept of matrix algebra, probability models, random processes and linear algebra to Separate information Source using Spatial filters.

Course Outcomes
After the completion of this course, students will be able to:

CO1.	Distinguish between Digital Signal Processing and Biomedical Signal Processing.
CO2.	Use the concept of stochastic processes to develop advanced Biomedical signal processing concept.
CO3.	Analyse Biomedical signals using PCA, BSS and ICA to separate or decorrelate the Multichannel Biomedical Signal.
CO4	Extract and Measure information from Multichannel Biomedical Signal.
CO5.	Integrate the concept of matrix algebra, probability models, random processes and linear algebra to develop Spatial filters for pattern classification.

SYLLABUS

Module-1
Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters, Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of

electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering

(8L)

Module-2

Biomedical signal processing by Fourier analysis, biomedical signal processing by wavelet (time frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)

(8L)

Module-3

Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.

(8L)

Module-4

Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis (MRA) and wavelets, Principal component analysis (PCA), Independent component analysis (ICA)

(8L)

Module-5

Pattern classification–supervised and unsupervised classification, neural networks, support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.

(8L)

Books recommended:

Textbooks:

1. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.
2. Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Son's _publication, 2001.
3. Myer Kutz, "Biomedical Engineering & Design Handbook, Volume I", McGraw Hill, 2009

Reference books:

1. D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005.
2. Katarzyn J. Blinowska, Jaroslaw Zygierewicz, "Practical Biomedical Signal Analysis Using
3. MATLAB", 1st Edition, CRC Press, 2011.

<u>Gaps in the syllabus (to meet Industry/Profession requirements):</u>

<u>POs met through Gaps in the Syllabus:</u>

<u>Topics beyond syllabus/Advanced topics/Design:</u>

<u>POs met through Topics beyond syllabus/Advanced topics/Design:</u>

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

<u>Direct Assessment</u>

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)

Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1	1	1
CO2	3	3	3	1	2	2
CO3	3	3	3	2	2	2
CO4	3	3	3	3	2	3
CO5	3	3	3	2	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course Code: EC611
Course Title: Virtual Instrumentation
Pre-requisite(s): Fundamental of Data Structure
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III/06
Branch: ECE
Name of Teacher:

Course Objective

This course enables the students to:

1.	Define the concept of the virtual instruments
2.	Analyse the analogue and digital measurement principles
3.	Show the data acquisition operations using LabVIEW
4.	Develop the components of the virtual instruments and the suitable graphical program for practical applications

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain the concept of virtual instrument and components
CO2	Identify the different components of graphical programming language
CO3	Recognize the dataflow in the graphical programming environment
CO4	Determine the device driver and interface buses to interface an instrument
CO5	Create the graphical program using LabVIEW for any application

SYLLABUS

Module -1:

Introduction to Virtual Instrument:

Introduction and Historical perspective, Need of VI, Define VI, Advantages of VI Block diagram & architecture of VI, Data flow techniques, Graphical programming in data flow, Comparison with conventional programming.

(8L)

Module -2:

Graphical programming components

VIS and sub-VIS, Creating sub-VI, Loops, Case structure sequence structures, formula nodes Arrays, Clusters, charts, graphs String & file input and output graphical Programming in data flow.

(8L)

Module -3:

Data Acquisition Basics:

Data Acquisition, ADC, DAC, DIO, Counters and timers, Timing, Interrupts, DMA, MAX, NI-DAQmx, PXI, RTSI, SCC, SCXI, SISTA USB, RS232C/ RS485, VISA, GPIB System buses, Interface buses, Analog and Digital I/O, NI-DAQmx Tasks, DAQmx Timing and Trigger, Networking basics, VISA

(8L)

Module -4:

Advanced LabVIEW Structures and Functions

Local, Global, and Shared Variables, Property Nodes, Invoke Nodes, Event-Driven Programming: The Event Structure, Type Definitions, The State Machine and Queued Message Handler, Messaging and Synchronization, Structures for Disabling Code.

(8L)

Module -5:

Applications

Applications of VI. Advanced analysis tools, Correlation methods, windowing & filtering, Application in Process Control projects, Data Visualization, Imaging, and Sound, embedding LabVIEW for Linux in a Virtual Machine

(8L)

Books recommended:

Text books:-

1. LabVIEW for Everyone: Graphical Programming Made Easy and Fun, Third Edition, By Jeffrey Travis, Jim Kring.
2. Hands-On Introduction to LabVIEW for Scientists and Engineers, Third Edition John Essick

3. LABVIEW Graphical Programming, by Gary Johnson, McGraw Hill, 1997, 2nd Edition.

Reference books:-

1. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2nd Edition

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	**Course Delivery Methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	2	3
CO2	3	3	3	2	2	3
CO3	3	2	3	3	3	3
CO4	3	2	3	2	3	3
CO5	3	2	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course Code: EC612
Course Title: Instrumentation System design
Pre-requisite(s): Advance Instrumentation System (AIS)
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III/06
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Explain the concept and need of Signal Conditioning and impart knowledge on the designing of signal conditioning circuit for different application.
2.	State the design of signal conditioners for different applications
3.	Framework the design of DAS, DATA Loggers and transmitters
4.	Discuss the design of analog and digital controllers and alarm generators and design various actuators and final control element.

Course Outcomes:
After the completion of this course, students will be:

CO1	Explain individual blocks of instrumentation systems and their interactions
CO2	Design the signal conditioning circuit for given application.
CO3	Architect and design DAS, DATA Loggers and transmitter
CO4	Design computer based controller for industrial applications
CO5	Able to identify suitable control scheme for given process and design the controller for the given requirement and select appropriate actuator according to the process requirement.

SYLLABUS

Module -1:
Introduction to Instrumentation System Design:
Review of Instrumentation System, Sensing Elements, and Signal Conditioners, Transmitters, and Data presentation, Controllers, Actuators and Final Control Elements. Instrumentation system for measuring: Temperature, Level, Pressure and flow.

(8L)

Module -2:
Design of Signal Conditioners:
Principles of signal conditioning, signal level and bias change, linearization, conversion, filtering and impedance matching, loading, Design of passive signal conditioners, Bridge circuits, RC filters, Design of active signal conditioners, OPAMPS circuits, Design of digital signal conditioners, Comparator, Bipolar DAC, ADC, S/H for different applications.

(8L)

Module -3:
Design of Data Acquisition system, Data loggers and transmitters:
Design of Microprocessor/microcontroller-based DAS and DATA logger, Two wire and 4 wire transmitters, temperature transmitters, Level transmitters, pressure transmitters, flow transmitters, Design of Smart transmitters.

(8L)

Module -4:
Design of computer based controllers:
Design of on/off controller, design of Microprocessor/Microcontroller based PID controller, Design of Alarm and Annunciation circuits, Design of PLC, Design of configurable sequential controller using PLDs.

(8L)

Module -5:
Design of Actuators and Final control elements:
Comparison of Pneumatic, Hydraulic and Electrical/Electronic instrumentation systems and their selection for present process industry requirement, Control Valve and their Selection, Pumps, Motors,

(8L)

Books recommended:
Textbooks:
1. Process control Instrumentation Technology by CD Johnson, PHI Learning
2. John P. Bentley, Principles of Measurement Systems, Addison-Wesley publication,
3. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer-Verlag Publications

Reference books:
1. B. G. Liptak, Instrument Engineers Handbook, Vol. I and II, Third Edition, Chilton and Book Company, 1990.
2. D. M. Considine, Process/Industrial Instruments and Control Handbook, Fourth Edition, McGraw-Hill Inc., 1993.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	3	2	3	2	2	2
CO3	3	3	2	2	3	2
CO4	3	3	2	3	2	3
CO5	3	2	3	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EC613
Course title: Applied Industrial Instrumentation
Pre-requisite(s): EC518 Advance Instrumentation System
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III/06
Branch:
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Explain the concept of industrial instrumentation and impart knowledge on industrial automation.
2.	Develop an ability to measure and analyze the various process variable of thermal power station
3.	Develop an ability to evaluate the parameters in Petrochemical Plant.

4.	Develop an ability to design energy conserved, intrinsically safe instrumentation
5.	Discuss special purpose instruments and control systems

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Demonstrate on the understanding of various industrial processes and related instrumentation.
CO2	Identify and analyze various components of a thermal power plant and petrochemical industry.
CO3	Illustrate various components of a petrochemical industry.
CO4	Design energy conserved, intrinsically safe instrumentation and update on the recent trends in automation technologies
CO5	Identify special purpose instrumentation used in process industry

SYLLABUS

Module -1:
Introduction to Industrial Instrumentation: Measurement of Force, Torque, Velocity, Acceleration, Pressure, Temperature, Flow, Level, Viscosity, Humidity & Moisture (Qualitative Treatment Only)

(8L)

Module -2:
Measurements in thermal power plant: Selection, Installation and maintenance of Instruments used for the measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature and other parameters in thermal power plant – Analyzers-Dissolved Oxygen Analyzers- Flue gas Oxygen Analyzers-pH measurement- Coal/Oil Analyzer – Pollution Controlling Instruments

(8L)

Module -3:
Measurement in Petrochemical Industry: Parameters to be measured in refinery and petrochemical industry-Temperature, Flow and Pressure measurements in Pyrolysis, catalytic cracking, reforming processes-Selection and maintenance of measuring instruments – Intrinsic safety

(8L)

Module -4:
Instrumentation for energy conservation & management: Principle of energy audit, management & conservation and measurement techniques –Instrumentation for renewable energy systems – Energy management device (Peak load shedding),Electrical and intrinsic safety - Explosion suppression and deluge systems – Flame arrestors, conservation vents and emergency vents – Flame, fire and smoke Detectors- Metal detectors

(8L)

Module -5:
Special Purpose Instrumentation: Toxic gas monitoring- Detection of Nuclear radiation – Water quality monitoring- Monitor measurement by neutron-Thermo-luminescent detectors – Measurement of length, mass, thickness, flow, level using nuclear radiation

(8L)

Books recommended:
Textbooks:

1. Process control Instrumentation Technology by CD Johnson, PHI Learning(T1)
2. D.Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1999, (T2)

Reference books:

1. John G Webster, Measurement, Instrumentation and Sensors Handbook, CRC press IEEE press
2. Liptak B.G, Instrumentation Engineers Handbook (Measurement), Chilton Book Co.,1994.
3. Reay D.A, Industrial Energy Conservation, Pergamon Press,1977.
4. Hodge B.K, Analysis and Design of energy systems, Prentice Hall, (1988).
5. Liptak B.G, Instrument Engineers Handbook, Clinton Book Company, (1982)
6. Ness S.A. Air monitoring for Toxic explosions, Air integrated Approach, Von a. Nostrand (1991).
7. Ewing G., Analytical Instrumentation hand book, Dekker (1991). 8. Alans V., Water and Waste water examination manual, Lewis Chele

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: Teaching Through Paper

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	3	2	2

CO2	3	2	1	3	2	1
CO3	3	1	2	3	2	1
CO4	3	2	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping of Course Outcomes onto Program Outcomes

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course Code: EC614
Course Title: Adaptive System and Signal Processing
Pre-requisite(s): EC305 Signal Processing Technique
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III/06
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Understand the concept of adaptive systems and its characteristics.
2	Impart knowledge on adaptive algorithms and adaptive filter for optimal control.
3	Understand the concept of adaptive filters such as LMS algorithm, RLS algorithm and their applications for adaptive noise cancellation, adaptive line enhancement and interference cancellation
4	Design and apply adaptive filters for real- time applications.
5	Demonstrate an ability to apply the adaptive techniques to various areas of Engineering and Science.

Course Outcomes

On the completion of this course, the students will be able to:

CO1	Demonstrate the adaptive systems and its characteristics.
CO2	Devise filtering solutions for optimising the cost function indicating error in estimation of parameters and appreciate the need for adaptation in design.
CO3	Evaluate the performance of various methods for designing adaptive control system through estimation of different parameters of stationary random process considering practical application specifications.
CO4	Be able to design adaptive filters for adaptive noise cancellation, adaptive line enhancement and interference cancellation, prediction considering present day challenges and recent research development.
CO5	Aspire for pursuing a carrier in system design and optimization, recognize the

	need to learn and adapt to the change in technology and play role of team leader.

SYLLABUS

Module 1:

Introduction to adaptive systems - definitions and characteristics, Adaptive linear combiner: input signal and weight vector, the performance function, gradient and minimum mean square error, alternative expression of gradient, LMS, NLMS, sign-error, sign-data and FXLMS algorithms, transform domain LMS.

(8L)

Module 2:

Recursive least square algorithm, windowed RLS, computational complexity, Block adaptive filter (time and DFT domains), adaptive lattice filters, Adaptive filters with Orthogonal signals, Kalman Filter, Extended Kalman filter

(8L)

Module 3:

Adaptive model control, Adaptive inverse control and model reference controls. Plant noise and the filtered-X LMS Algorithm, Inverse control using Filtered-X LMS algorithm.

(8L)

Module 4:

Adaptive array and adaptive beam forming: Sidelobe cancellation, Beam forming with a Pilot signal, Narrowband experiments , Broadband experiments, Characteristics of receiving arrays, Griffiths LMS Beamformer, Adaptive beamformer with pole and zeros, signal cancellation and distortion.

(8L)

Module 5:

Applications of Adaptive Filters: Adaptive Noise Cancelling, Adaptive Line Enhancement, System identification, Channel equalization, cancelling antenna side lobe Interference, adaptive self-tuning filter

(8L)

Books recommended:

Textbooks:

1. B. Widrow and S. D. Sterns, Adaptive Signal Processing, Pearson Education, 2nd Indian reprint, 2002.
2. D. G. Manolokis, V. K. Ingle and S. M. Kogar, “Statistical and Adaptive Signal Processing”, Mc Graw Hill International Edition, 2000.
3. S. Haykin and T. Kailath, Adaptive Filter Theory, Pearson Education, 4th Edition, 2005.

Reference books:

1. Digital Signal Processing 3/E by S.K.Mitra TMH Edition.
2. Fundamentals of adaptive filtering, A. H. Sayed, Wiley, 2003.
3. Monson H. Hayes, Statistical Digital Signal Processing and Modelling, Wiley, 2002

<u>Gaps in the syllabus (to meet Industry/Profession requirements):</u>

<u>POs met through Gaps in the Syllabus:</u>

<u>Topics beyond syllabus/Advanced topics/Design:</u>

<u>POs met through Topics beyond syllabus/Advanced topics/Design:</u>

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	Course Delivery Methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2		1
CO2	3	2	2	3	1	1
CO3	2	1	2	2		1
CO4	3	2	2	3	1	2
CO5		1	1	1	1	2

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

Massive Open Online Course (MOOC)

COURSE INFORMATION SHEET

Course code: EC617
Course title: Nanoelectronic Devices and Materials
Pre-requisite(s): EC201 Electronic Devices

Co- requisite(s):
Credits: L: 0 T: 0 P: 0 C: 2
Class schedule per week: N/A
Class: M. Tech.
Semester / Level: III/6
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Understand the issue in scaling MOSFET in the sub-100 nm regime and the state of the art in the areas of semiconductor device physics.
2.	Appraise and apply Fundamental Properties of Carbon Nanotube and its Synthesis techniques.
3.	Analyze how to assemble Carbon Nanotubes toward Practical Applications and Separation of Metallic and Semiconducting Single-Wall Carbon Nanotubes.
4.	Evaluate Electronic Applications of Single-Walled Carbon Nanotubes.
5.	Comprehend the characteristics of the Spintronics and Molecular electronics and create their structures.

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Describe and illustrate the Basic CMOS Process flow and MOS Scaling theory
CO2	Sketch and explain Gate oxide scaling trend and integration Issues
CO3	Illustrate with the sketch the heterostructure growth techniques, diagram their characteristics and analyze them.
CO4	Appraise the Nonclassical CMOS structures and integration issues and schematize, assess and summarize their features.
CO5	Schematize the structure and design Heterostructure device and write down its synthesis techniques

SYLLABUS

Module -1:
MOS process flow and scaling theory
Overview: Nano devices, Nano materials, Nano characterization, Definition of Technology node, Basic CMOS Process flow, MOS Scaling theory, Issues in scaling MOS transistors: Short channel effects, Description of a typical 65 nm CMOS technology, Requirements for Nonclassical MOS transistor.

Module -2:
Gate oxide scaling trend and integration Issues:
MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO2, versus High-k gate dielectrics; Integration issues of high-k , Interface states, bulk charge, band offset, stability, reliability, Metal gate transistor: Motivation, requirements, Integration Issues, Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot.

Module -3:
Heterostructure growth techniques:
Compound semiconductor heterostructure growth and characterization: Quantum wells and, thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM. Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc.;

Applications and interpretation of results; emerging nanomaterials: Nanotubes, nanorods and other nanostructures, LB technique, Soft lithography etc. Microwave assisted synthesis, Self-assembly etc.

Module -4:
Nonclassical CMOS structures and integration issues:
SOI - PDSOI and FDSOI, Ultrathin body SOI - double gate transistors, integration issues, Vertical transistors - FinFET and Surround gate FET, Metal source/drain junctions - Properties of Schottky junctions on Silicon, Germanium and compound semiconductors - work function pinning.

Module -5:
Heterostructure devices and synthesis:
Germanium Nano MOSFETs: strain, Advantages of Germanium over Silicon, PMOS versus NMOS; MOSFETs in the context of channel strain; Compound semiconductors - material properties, MESFETs; Hetero structure FETs exploiting novel materials, strain; Synthesis of Nanomaterials: CVD, Nucleation growth, ALD, Epitaxy, MBE.

Books recommended:
Textbooks:
1. Yuan Taur and T H Ning, Fundamentals of Modern VLSI Devices, 2nd Edition, Cambridge, reprint 2016.
2. Qing Zhang, Carbon Nanotubes and Their Applications - Pan Stanford Series on Carbon-Based Nanomaterials, CRC Press, 2012.
3. George W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
4. Nanoelectronics: Devices and Materials, NPTEL video lectures by Prof. Navakanta Bhat, Indian Institute of Science, Bangalore.

Reference books:
1. The Physics of Low-Dimensional Semiconductors, John H. Davies, Cambridge University Press, 1998.
2. Introduction to Nanotechnology, C. P. Poole Jr., F. J. Owens, Wiley (2003).
3. Silicon VLSI Technology, Plummer, Deal, Griffin, Pearson Education India.
4. Encyclopedia of Materials Characterization, Edited by: Brundle, C. Richard; Evans, Charles A. Jr.; Wilson, Shaun; Elsevier.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands-on-practical for fabrication of nanoelectronic devices.

POs met through Gaps in the Syllabus: PO6.

Topics beyond syllabus/Advanced topics/Design: CNFET, SET, Memristor, MTJ.

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)

Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	1	3	2	1
CO4	2	2	2	2	3	1
CO5	2	2	2	2	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD2, CD3, CD6, CD7
CO2	CD2, CD3, CD6, CD7
CO3	CD2, CD3, CD6, CD7
CO4	CD2, CD3, CD6, CD7
CO5	CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: EC618
Course title: Biophotonics
Pre-requisite(s): EC201 Electronic Devices
Co- requisite(s):
Credits: L: 0 T: 0 P: 0 C: 2
Class schedule per week: N/A
Class: M. Tech.
Semester / Level: III/6
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

1.	Understand EM and Quantum Picture of Light
2.	Understand Light-matter interactions
3.	Understand optical imaging and tomography
4.	Understand characteristics and application of biological materials and biomedical sensors

Course Outcomes:
After the completion of this course, students will be able to:

CO1	Explain EM and Quantum Picture of Light
CO2	Justify the interaction of Light and matter
CO3	Illustrate the application of optical imaging
CO4	Illustrate biomedical Imaging application and Tomography
CO5	Characterise the biological materials and demonstrate biomedical sensors

SYLLABUS

Module 1:
Introductory Optics: Geometric, Wave, EM and Quantum Picture of Light., Concept of phase, polarization and coherence, Diffraction and Interference.

Module 2:
Light-matter interactions: Energy level picture of materials, Photons, Photoelectric effect, Interaction of photons with materials, Phosphorescence and fluorescence, Stimulated emission of photons, Principle of laser action, Laser types and applications (CW, Pulsed, Ultra-fast, Solid state, Gas, Dye), Spectroscopy: Types and applications (UV-Vis, Infrared, Raman, FTIR).

Module 3:
Optical Imaging I: Basic imaging theory, concept of diffraction limit, Optical microscope, Methods for contrast-generation (Dark-field, Phase contrast, DIC, Polarization), Fluorescence microscopy, Fluorescence techniques (FRET, FLIM, FRAP, FCS …), Nanoparticle fluorescence, 3D sectioning: Confocal and multi-photon imaging. Nanoparticle fluorescence. Super-resolution techniques (STED, STEM, STORM, PALM …), Super-resolution image reconstruction methods.

Module 4:
Optical Imaging II: Biomedical Imaging (Physiological Imaging), Light Scattering phenomena, Tomographic techniques: OCT, Image reconstruction techniques.

Module 5:
Other applications: Optical biosensors, Optical manipulation of biological materials, Optical tweezers, Laser dissection and surgery. Neural excitation.

Books recommended:
Textbooks:
1. Bahaa Saleh and Malvin Teich,Fundamentals of Photonics, Wiley & Sons,(1991).

Reference books:
1. Paras N. Prasad, Introduction to Biophotonics, Wiley & Sons (2003).

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	**Course Delivery Methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	2	3
CO5	3	3	3	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EC619
Course title: Neural Networks and Applications
Pre-requisite(s):
Co- requisite(s):
Credits: L: 0 T: 0 P: 0 C: 2
Class schedule per week: N/A
Class: M. Tech.
Semester / Level: III/6
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

1.	Define the fundamental concepts of artificial neuron
2.	Analyze the different neural network algorithms
3.	Show the application of neural network and its functionality
4.	Recognize the constraints and suitable algorithms for classification using ANN
5	Understand Radial Basis Function Networks

Course Outcomes:
After the completion of this course, students will be:

CO1	Recognize the fundamental concepts of ANN
CO2	Design the different ANN algorithms
CO3	Analyze the constraint of ANN for solving the complex problems
CO4	Outline the suitable algorithms for artificial intelligent system & its functionality
CO5	Demonstrate Radial Basis Function Networks

SYLLABUS

Module -1:
Introduction to Artificial Neural Networks, Artificial Neuron Model and Linear Regression, Gradient Descent Algorithm, Nonlinear Activation Units and Learning Mechanisms. Learning Mechanisms-Hebbian, Competitive, Boltzmann

Module -2:
Associative memory, Associative Memory Model, Condition for Perfect Recall in Associative Memory, Statistical Aspects of Learning, V.C. Dimensions: Typical Examples.

Module -3:
Single-Layer Perceptions, Unconstrained Optimization: Gauss-Newton's Method, Linear Least Squares Filters, Least Mean Squares Algorithm, Perceptron Convergence Theorem, Bayes Classifier & Perceptron: An Analogy, Bayes Classifier for Gaussian Distribution

Module -4:
Back Propagation Algorithm, Practical Consideration in Back Propagation Algorithm, Solution of Non-Linearly Separable Problems Using MLP, Heuristics for Back-Propagation, Multi-Class Classification Using Multi-layered Perceptrons

Module -5:
Radial Basis Function Networks: Cover's Theorem, Radial Basis Function Networks: Separability & Interpolation, Posed Surface Reconstruction, Solution of Regularization Equation: Greens Function, Use of Greens Function in Regularization Networks, Regularization Networks and Generalized RBF

Books recommended:
Textbooks:

1. Simon Haykin , "Neural Networks and Learning Machines", , Third Edition, Pearson

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure
Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

S. No.	**Course Delivery Methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/teaching aids/Seminars
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	2	3
CO5	3	3	3	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
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CO2	CD1, CD6,CD7
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CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

4th Semester

Programme Core

EC650 Thesis (Part II) Credit: 16