BIRLA INSTITUTE OF TECHNOLOGY MESRA

RANCHI, INDIA

CHOICE BASED CURRICULUM

Postgraduate Programme

M. Tech. in Instrumentation

Effective from academic year 2021 – 2022 onwards

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

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

Department Vision

Become a centre of excellence in teaching and research for creating technical manpower to meet the technological need of the country in the field of Electronics and Communications Engineering. Department exposes the undergraduate students to all fundamental and advanced technology in the field of Electronics and Communication.

Department Mission

1. 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.
2. To build national capabilities in Technology, Education and Research in emerging areas in the field of Electronics and Communication Engineering.
3. To create an environment to provide excellent Research and Development facilities to strengthen Ph.D. programmes and Research Projects.
4. To provide excellent Technological Services to bridge the gap between Academics and Industry in order to fulfil the overall academic needs of the society.
5. To provide high quality Course Structure in order to turn out qualified professionals to meet the engineering needs of the country.
6. To develop effective Teaching Skills and the Research Potentials of the faculty members.
7. 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.

Graduate Attributes

(The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all PG engineering programs. These Graduate Attributes are identified by National Board of Accreditation.)

I. **Scholarship of Knowledge**: Acquire in-depth knowledge of specific discipline or Professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

II. **Critical Thinking**: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

III. **Problem Solving**: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

IV. **Research Skill:** Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

V. **Usage of modern tools**: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

VI. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

VII. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one’s own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

VIII. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

IX. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

X. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

XI. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one’s actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

PEO (Programme Educational Objectives)

PEO1	To enable students to acquire in-depth knowledge in the field of Instrumentation 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 and find optimal solution.

PEO3	To train students to conduct research and experiments by applying appropriate techniques and modern tools for sustainable development of society with an understanding of the limitations.
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 and other multidisciplinary area.
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.

PO (Programme Outcomes)

After completion of the programme, students will be able to

PO1	Acquire in-depth knowledge in Instrumentation with an ability to evaluate existing technology and integrate new technology for enhancement of knowledge.
PO2	Analyze complex problems in the field of Instrumentation critically and conduct research.
PO3	Conceptualize Industrial problems in the specific domain and find optimal solutions, considering public health, safety, societal and environmental factors.
PO4	To contribute to the development of scientific/technological knowledge by solving unfamiliar problems through appropriate research methodologies in field of Instrumentation.
PO5	Use virtual instruments tools for product development with an understanding of the limitations/constraints.
PO6	Demonstrate understanding as a team member and contribute positively to collaborative multi-disciplinary scientific research to achieve common goals.
PO7	Demonstrate knowledge and understanding of engineering and management principles and apply the same as a member and leader in a team to manage projects efficiently in Instrumentation and other multidisciplinary area in terms of cost and finance.
PO8	Effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards to the engineering community and society.
PO9	Engage in life-long learning independently with enthusiasm and commitment to improve knowledge and competence continuously.
PO10	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 for sustainable development of society.
PO11	Observe and critically examine the outcomes of own actions, learn from own mistakes and make corrective measures without depending on external feedback.

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

NEWCOURSE STRUCTURE-***To be effective from academic session 2021- 22 Based on CBCS & OBE model***

Recommended scheme of study for M.Tech. in Instrumentation and Control

SEMESTER / Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits L-Lecture; T-Tutorial; P-Practical			Total Credits C- Credits
					L (Periods/week	T (Periods/week)	P (Periods/week)	C
FIRST / Monsoon	FIFTH	Programme Core (PC)	EC581	Applied Industrial Instrumentation	3	0	0	3
			EC520	Advanced sensing technique	3	0	0	3
			EC522	Advanced digital signal processing	3	0	0	3
			EC575	Artificial Intelligence System	3	0	0	3
		Programme Elective		PE-I	3	0	0	3
		LABORATORIES						
		Programme Core (PC)	EC582	Instrumentation Lab-I	0	0	4	2
			EC523	Advanced DSP lab	0	0	4	2
TOTAL								19
SECOND / Spring	FIFTH/ SIXTH	Programme Core (PC)	EC568	Process Control	3	0	0	3
			EC570	Embedded System Design	3	0	0	3
			EC572	Optoelectronic Instrumentation	3	0	0	3
		Programme Elective (PE)		PE-II	3	0	0	3
		Programme Elective (PE)		PE-III	3	0	0	3
		LABORATORIES						
		Programme Core (PC)	EC571	Embedded System Lab.	0	0	4	2
			EC583	Instrumentation Lab-II	0	0	4	2
								19
TOTAL FOR FIFTH LEVEL								38
THIRD / Monsoon	SIXTH	Programme Core	EC600	Thesis (Part I)				8
		Open Elective		**OE I / MOOC**	3	0	0	3
				OE II / MOOC	3	0	0	3
		TOTAL						14
FOURTH / Spring	SIXTH	Programme Core (PC)	EC650	Thesis (Part II)	0	0	16	16
	TOTAL							16
TOTAL FOR SIXTH LEVEL								30
GRAND TOTAL FOR M.TECH PROGRAMME (38 + 30)								68

PROGRAMME ELECTIVE (PE-I) 1st Semester

Course Type	Course Code	Course Title	Pre requisites / Co requisites	Credits
PE	EC524	Measurements and Statistics	EC313 Electronics Measurement	3
PE	EC525	High Frequency Measurements	EC257 Electromagnetic field and Waves	3
PE	EE515	Control System Design	EC313 Electronic Measurement, EE 305 Control Theory	3
PE	EC526	Digital Image Processing Technique	EC305 Signal Processing Techniques, EC251 probability and Random Process	3
PE	EC527	Speech Processing and Recognition	EC305 Signal Processing Techniques	3
PE	EC528	CMOS Digital VLSI Design	EC101 BECE	3

PROGRAMME ELECTIVE (PE-II) (*offered in SP session*): 2nd Semester

Course Type	Course Code	Course Title	Pre requisites / Co requisites	Credits
PE	EC574	Pattern recognition and Machine Learning	EC305 Signal Processing Techniques	3
PE	EC558	Modern Optimization Techniques	EC251 Probability and Random Process	3
PE	EC576	Micro-Electro Mechanical System	EC377 Sensor and Transducer	3
PE	EC577	Photonic Integrated Circuit	EC 201 Electronics Devices, EC 257 Electromagnetic Fields and Waves	3
PE	EC578	CMOS Analog VLSI Design	EC209 Analog Circuits (AC)	3

PROGRAMME ELECTIVE (PE-III) (*offered in MO session*): 3rd Semester

Course Type	Course Code	Course Title	Pre requisites / Co requisites	Credits
PE	EC610	Biomedical Signal Processing	EC522 Advanced Digital Signal Processing	3
PE	EC611	Virtual Instrumentation	Fundamental of Data Structure	3
PE	EC612	Instrumentation System Design	EC518 Advanced Instrumentation System (AIS)	3
PE	EC614	Adaptive system and Signal Processing	EC 305 Signal Processing Techniques	3

COURSE INFORMATION SHEET

Name of the Subject: Applied Industrial Instrumentation
Course Code: **EC581**
Course Title: Applied Instrumentation System
Pre-requisite(s): EC313 Electronics Measurement
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

A.	Explain the concept of intelligent instrumentation and impart knowledge on automation.
B.	Develop an ability to model and analyze a real time system.
C.	Develop an ability to evaluate the performance of a Automation system.
D.	Develop an ability to design an intelligent system for industrial automation.

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

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.

SYLLABUS

Module -1:
Introduction about Instrumentation system. Types of Instrumentation system. Industrial Instrumentation diagrams. Standards in industrial instrumentation. 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.

Module -2:
Data logger, DOS 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.

Module -3:
Actuators: Pneumatic cylinder, Relay, solenoid (Final Control Element), Converter (I to P). PLC: PLC architecture, PLC operation, Addressing modes of PLC, Languages used in PLC Programming, Instructions used in Ladder programming, Programming examples of different processes.

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. hydraulic, pneumatic and electrical circuits using automation studio.

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.

Text Books:
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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4

Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3		3	1	3	3	3	3
CO2	3	3	2	3		3	1	3	3	3	3
CO3	2	2	3	3	1	3	1	2	3	3	3
CO4	3	3	2	3	2	3	1	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Quizzes	CO1, CO2, CO3, CO4	CD2
CD3	Assignments/Seminars	CO5	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus.	T1	1		PPT Digi Class/Chock -Board	
	L2			Review of transducer,	T1	1		…. do …	

	L3			Introduction about Instrumentation system.					
	L4			Types of Instrumentation system.	T1	1		…. do …	
2	L5			Data acquisition system and its uses in intelligent Instrumentation system.					
	L6			Detail study of each block involved in making of DAS,					
	L7			Signal conditioners as DA, IA,					
	L8			signal converters (ADC), Sample and hold.					
3	L9			Designing application for Pressure, Temperature measurement system using DAS.					
	L10			Data logger.					
	L11			Introduction about Automation system. Concepts of Control Schemes,					
	L12			Types of Controllers.					
4	L13			DAS, DOS					
	L14			Converter (I to P)					
	L15			Actuators:					
	L16			cylinders					
5	L17			Relay, solenoid (Final Control Element)					
	L18			Computer Supervisory Control System,					
	L19			Direct Digital Control's Structure and Software.					
	L20			SCADA- Remote terminal units, Master station, Communication architectures and Open SCADA protocols					
6	L21			DCS- Evolution of Different architecture, Local unit, Operator Interface, Displays, Engineering interface,					
	L22			factors to be considered in selecting DCS, case studies in DCS					
	L23			PLC architecture, ,					

	L24			PLC operation					
7	L25			Addressing modes of PLC,					
	L26			Languages used in PLC Programming,					
	L27			Instructions used in Ladder programming,					
	L28			Programming examples of different processes.					
8	L29								
	L30								
	L31			Virtual Instrumentation- Introduction to LabVIEW, Block diagram and architecture of a virtual instrumentation,					
	L32			Graphical programming in data flow, comparison with conventional programming,					
9	L33			, Vis and sub-Vis, loops and charts,					
	L34			arrays, clusters and graph,					
	L35			case and sequence structures, formula nodes,					
	L36			local and global variables,					
10	L37			string and file I/O.					
	L38			Programming Examples					
	L39								
	L40								
11	L41			Introduction about Intelligent controllers, Model based controllers, Predictive control,					
	L42			Artificial Intelligent Based Systems, Experts Controller,					
	L43			Fuzzy Logic System and Controller,					
	L44			Artificial Neural Networks, Neuro-Fuzzy Control system.					
12	L45			Case study.					
	L46			Introduction to telemetry, Instrument interfacing, Current loop, RS232/485,					
	L47			Field bus, Modbus,					
	L48			GPIB,					

13	L49			USB Protocol, HART communication Protocol-					
	L50			Communication modes and networks.					

COURSE INFORMATION SHEET

Name of the Subject: Advanced Sensing Techniques
Course Code: **EC520**
Course Title: Advanced Sensing Techniques
Pre-requisite(s): EC377 Sensor and Transducer
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students to:

A.	Describe the operation of various smart sensors and their application
B.	Select an appropriate sensor for a given application
C.	Compare analogue and digital transducer.
D.	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	Solve design and modelling issue using complex engineering mathematics

SYLLABUS

Module -1: Introduction
Introduction to smart sensors, Principles of operation, design approach, interface design, configuration supports,

Module -2 : Electroanalytical Sensors
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

Module -3: sensor technologies:
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

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

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

Text Books:

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 Edition, 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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1

End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3		3	1	3	3	3	3
CO2	3	3	2	3		3	1	3	3	3	3
CO3	2	2	3	3	1	3	1	2	3	3	3
CO4	3	3	2	3	2	3	1	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Quizzes	CO1, CO2, CO3, CO4	CD2
CD3	Assignments/Seminars	CO5	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lec No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus.	T1	1		PPT Digi Class/Chock -Board	
	L2			Introduction to smart sensors	T1	1		…. do …	

	L3			Principles of operation and their classification	T1	1		…. do …	
2	L4			design approach	T1	1		…. do …	
	L5			interface design	T1	1		…. do …	
	L6			configuration supports,	T1	1		…. do …	
3	L7			Introduction, Electro-chemical Cell	T1	1		…. do …	
	L8			Cell potential	T1	1		…. do …	
	L9			Sd. Hydrogen Electrode (SHE),	T1	1		…. do …	
4	L10			Saturated Calomel Electrode(SCE)	T2	2		…. do …	
	L11			Liquid Junction and Other potentials, Polarization	T2	2		…. do …	
	L12			Sensor Electrodes, Electro-Ceramics in Gas Media	T2	2		…. do …	
5	L13			Analysers for different gas	T2	2		…. do …	
	L14			laboratory testing of chemicals	T2	2		…. do …	
	L15			MEMS sensor	T2	c		…. do …	
6	L16			Comparison between MEMS and Macro sensor	T2	2		…. do …	
	L17			Fabrication and packaging issue in sensor design	T2	2		…. do …	
	L18			Thick film and thin film technique Physical sensors	T2	2		…. do …	
7	L19			Bio sensor type	T2	1,2		…. do …	
	L20			Bio sensor Application	T2	1,2		…. do …	
	L21			Silicon sensor principle and application	T2	1,2		…. do …	
8	L22			RF Sensor principle and application	T2	1,2		…. do …	
	L23			Application of sensors in robotics	T2	1,2		…. do …	
	L24			Wireless Sensor, principle	T2	3		…. do …	
9	L25			Wireless Sensor working	T2	3		…. do …	
	L26			wireless sensing network	T2	3		…. do …	
	L27			protocols used in WSN	T2	3		…. do …	
10	L28			Application of wireless sensor for weather monitoring	T2	3		…. do …	
	L29			Design issue in advanced sensing technique	T2	4		…. do …	
	L30			Modeling issue in advanced sensing technique	T2	4		…. do …	

11	L31			Introduction of different mathematical tools used in sensor design	T2	4		…. do …	
	L32			Introduction of different mathematical tools used in sensor design	T2	4		…. do …	
	L33			Optimization techniques used in sensor design	T2	4		…. do …	
12	L34			Optimization techniques used in sensor design	T2	4		…. do …	
	L35			The role of PCA in sensor design	T2	4		…. do …	
	L36			The role of LDA in sensor design	T2	4		…. do …	
13	L37			Neural network in designing sensor array	T3	4		…. do …	
	L38			Neural network in designing sensor array	T3	4		…. do …	
	L39			Case study	T3	4		…. do …	
14s	L40			Case study	T3	4		…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Advanced Digital Signal Processing
Course Code: EC522
Course Title: Advanced Digital Signal Processing
Pre-requisite(s): EC305 Signal Processing Techniques
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Understand the concept of signals and systems and filters.
2	Impart knowledge on various transformation techniques.
3	Impart knowledge on multirate signal processing and its applications.
4	Understanding on optimum linear filters and power spectral estimation.

Course Outcomes
On the completion of this course, the students will 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.

SYLLABUS

Module 1: 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.

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

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.

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.

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

Text Books:

1. J.G.Proakis and D.G.Manolakis"Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
3. D. G. Manolokis, V. K. Ingle and S. M. Kogar, "Statistical and Adaptive Signal Processing", Mc Graw Hill International Edition, 2000.
4. 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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids

CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

1.Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	1		1	1	1	1	1	1
CO2	3	2	1	2		1	2	2	1	1	1
CO3	3	3	2	2		1	2	2	2	1	1
CO4	3	3	2	2	1	2	2	2	2	2	2

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Quizzes	CO1, CO2, CO3, CO4	CD2
CD3	Assignments/Seminars	CO5	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		

CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Plan Details

Week No.	Lect. No.	Tentative Date	Module No	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Introduction to the course Review of Signals and Systems	1	CO1		PPT and Chock-Board	
	2			Sampling theorem	1	CO1		...Do...	
	3			Z-transform, Chirp Z-transform	1	CO1		...Do...	
2	4			Goertzel's Algorithm	1	CO1		...Do...	
	5			linear phase FIR filters	1	CO1		...Do...	
	6			IIR filters by impulse invariance, bilinear transformation	1	CO1		...Do...	
3	7			FIR/IIR Cascaded lattice structures.	1	CO1		...Do...	
	8		2	Fourier transform, Discrete sine and cosine transform	2	CO1, CO2		...Do...	
	9			Discrete Hartely transform	2	CO1,		...Do...	
4	10			short time Fourier transform	2	CO1, CO2		...Do...	
	11			wavelet transform	2	CO1, CO2		...Do...	
	12			Continuous wavelet transform	2	CO1, CO2		...Do...	
5	13			Discrete wavelet transform	2	CO1, CO2		...Do...	
	14			Hilbert huang transform	2	CO1, CO2		...Do...	
	15			Stockwell transform	2	CO1, CO2		...Do...	
6	16			Stockwell transform	2	CO1, CO2		...Do...	
	17		3	Multi rate DSP, Decimators and Interpolators	1	CO3		...Do...	
	18			Sampling rate conversion	1	CO3		...Do...	
7	19			multistage decimator &interpolator	1	CO3		...Do...	
	20			multistage decimator &interpolator	1	CO3		...Do...	
	21			poly phase filters	1	CO3		...Do...	
8	22			Quadrature Mirror Filter	1	CO3		...Do...	
	23			digital filter banks	1	CO3		...Do...	
	24			Multi resolution signal analysis	1	CO3		...Do...	
9	25			wavelet analysis	1	CO3		...Do...	
	26			wavelet decomposition	1	CO3		...Do...	
	27			sub band coding	1	CO3			
10	28			Applications in subband coding	1	CO3		...Do...	

	29		4	Random signals and power spectra	1	CO4		...Do...	
	30			Forward and backward Linear prediction	1	CO4		...Do...	
11	31			Forward and backward Linear prediction	1,2	CO4		...Do...	
	32			solutions of the normal equations	1,2	CO4		...Do...	
	33			AR lattice filter	1,2	CO4		...Do...	
12	34			ARMA lattice-ladder filters,	1,2	CO4		...Do...	
	35			Wiener filters.	1,2	CO4		...Do...	
	36			Wiener filters.	1,2	CO4		...Do...	
13	37		5	Power spectrum estimation	1,R1	CO4		...Do...	
	38			Estimation of Spectra from Finite-Duration Observations of Signals.	1	CO4		...Do...	
	39			Nonparametric Methods forPower Spectrum Estimation	1,R1	CO4		...Do...	
14	40			Parametric Methods for Power Spectrum Estimation	1,R1	CO4		...Do...	
	41			Minimum-Variance Spectral Estimation	1,R1	CO4		...Do...	
	42			Eigenanalysis Algorithms for Spectrum Estimation	1, R1	CO4		...Do...	

COURSE INFORMATION SHEET

Name of the Subject: Artificial Intelligent System
Course Code: **EC575**
Course Title: Artificial Intelligent System
Pre-requisite(s): Fundamental of Data Structure, EC203 Digital System Design,EC 305 Signal Processing Techniques, EC 255 Analog Communication, EC570 Embedded System Design
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students to:

A.	Define the fundamental concepts of artificial intelligence
B.	Analyze the different search algorithms
C.	Show the application of intelligent system and its functionality
D.	Recognize the constraints and suitable algorithms for artificial intelligent systems

Course Outcomes

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

1.	Recognize the fundamental concepts of artificial intelligence
2.	Design the different search algorithms
3.	Analyze the constraint of intelligent system for solving the complex problems
4.	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.

Module -2: Optimization
Optimal problem formulation, Design variables constraints, Objective function. Gradient-based methods: Newton-Raphson method, Cauchy's steepest descent and Newton's method. Genetic algorithm and its working principle, GA variants, Particle swarm optimization

Module -3: Learning Models
Introduction to machine learning, Artificial neural network, radial basis functional neural network, functional link ANN, concept of deep learning, Convolutional neural network, reinforcement learning

Module -4:
Adaptive learning:
Adaptive systems, least mean square algorithm, Recursive Least Square algorithm, kalman filters and variance. System identification, inverse modelling. Optimal controller design.
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Module -5:
Fuzzy logic based system design:
Fuzzy logic, fuzzy rules, membership functions, FIS, Neuro- fuzzy system, Fuzzy logic controller.

Text books:-

1. S.J. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach (2nd edition)*, Prentice-Hall, 2010.
2. Optimization for Engineering Design - Kalyanmoy Deb, 2006, PHI
3. "Neuro-Fuzzy and Soft Computing"- J.S.R. Jang, C. T. Sun and E. Mizutani, PHI, NewDelhi

Reference books:-

1. ArtificialIntelligence-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:

S. No.--	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

Note: 1 *for fulfilling less than 40%,* ***2*** *for fulfilling less than 70% and* ***3*** *for fulfilling above 70 %*

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	3	3	3	2	3	3
CO2	2	3	3	2	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, CO2, CO3	CD1

CD2	Tutorials/Assignments		CO2, CO3	CD1
CD3	Seminars		CO3, CO4	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets		CO4	
CD9	Simulation			

COURSE INFORMATION SHEET

Name of the Subject: Measurements and Statistics
Course Code: **EC524**
Course Title: Measurements and Statistics
Pre-requisite(s): EC313 Electronics Measurement
Co-requisite(s):
Credits: L:3 T:0 P:0
Class schedule per week: 03
Class: M.E.
Semester / Level: I
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, how they are calibrated – both statically and dynamically, and how they are applied in engineering
4	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, 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
CO3	Apply differential equation analysis of first- and second-order dynamic systems to predict the behavior of sensors and instruments
CO4	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 flowmeters

Syllabus

Module 1: 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),

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,

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

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,

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

Text Books:

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

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

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:

Current technological developments advanced image processing techniques

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

S. No.	Course Delivery Methods	Used
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors	Yes
CDM 2	Quizzes	Yes
CDM 3	Assignments/Seminars	Yes
CDM 4	Mini projects/Projects	Yes
CDM 5	Laboratory experiments/teaching aids	No
CDM 6	Industrial/guest lectures	Yes
CDM 7	Industrial visits/in-plant training	No

CDM 8	Self- learning such as use of NPTEL materials and internets	Yes
CDM 9	Simulation	No

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	2	1	1	1	1	1	2	2
CO2	3	1	-	2	1	1	1	2	1	2	2
CO3	2	2	-	2	1	1	1	1	1	1	1
CO4	2	1	2	2	1	1	1	1	1	1	1

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Lecture Wise Lesson Plan Details

Week No.	Lect. No.	Tentative Date	Module No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Introduction to mechanical engineering measurements – purpose, dimensions and units, significant digits	1	CO1		PPT and Chock-Board	
	2			Dimensional analysis - primary dimensions , method of repeating variables;	1	CO1		...Do...	

	3			Review of basic electronics and circuits	1	CO1		...Do...	
2	4			Errors and uncertainties - bias and precision error, accuracy, calibration	1	CO1		...Do...	
	5			Basic statistics – mean, standard deviation, variance, median, mode, etc	1	CO1		...Do...	
	6			**Histograms**; Probability density functions;	1	CO1		...Do...	
3	7		2	The normal (Gaussian) distribution, Central limit theorem	1	CO1		...Do...	
	8			Other PDF distributions - lognormal, student's t, chi-squared	1	CO1		...Do...	
	9			Correlation and regression analysis (least-squares curve fits)	1	CO2		...Do...	
				Outliers - single variables and data pairs; Experimental uncertainty analysis - RSS uncertainty					
4	10			Experimental design - full vs. fractional factorial tests	1	CO2		...Do...	
	11			Taguchi design arrays,	1	CO2		...Do...	
	12			RSM - Response surface methodology - an efficient way to hunt for an optimum result	1	CO2		...Do...	
5	13			Hypothesis testing - how to use statistics to make decisions	1	CO2		...Do...	
	14			Digital data acquisition - introduction to digital data	1	CO2		...Do...	
	15			A/D conversion, discrete sampling	1	CO2		...Do...	
6	16		3	clipping, aliasing, Signal reconstruction - the Cardinal series	1	CO2		...Do...	
	17			Spectral analysis - introduction to Fourier series, harmonic amplitude plots	1	CO3		...Do...	
	18			Fourier transforms - introduction to Fourier transforms, DFTs and FFTs,	1	CO3		...Do...	
7	19			FFTs (continued) - Windowing - a technique to reduce leakage in FFTs	1	CO3		...Do...	
	20			How to analyze the frequency content of a signal	1	CO3		...Do...	
	21			Filters - first-order low-pass filter, first-order high-pass filter, other filters	1	CO3		...Do...	
8	22		4	Operational amplifiers (Op-Amps) - introduction	1	CO3		...Do...	
	23			some circuits in which op-amps are used	1	CO3		...Do...	

	24			Clipping circuits and examples,	1	CO3		...Do...	
9	25			common-mode rejection ratio, gain-bandwidth product	1	CO4		...Do...	
	26			Stress, strain, and strain gages	1	CO4		...Do...	
	27			review of stress and strain	1	CO4			
10	28			Hooke's law; Description of strain gages and how to use them;	1	CO4		...Do...	
	29			Wheatstone bridge circuits	1	CO4		...Do...	
	30			how they are used to measure strain	1	CO4		...Do...	
11	31		5	dynamic system response - dynamic measuring systems	1	CO4		...Do...	
	32			zero-, first-, and second-order systems	1	CO4		...Do...	
	33			Temperature measurement - types of temperature measurement including mechanical	1	CO4		...Do...	
12	34			Thermoresistive, thermojunctive radiative methods	1	CO4		...Do...	
	35			Mechanical measurements - mechanical measuring devices, such as potentiometers	1	CO4		...Do...	
	36			linear variable displacement transducers, ultrasonic transducers	1	CO4		...Do...	
13	37			capacitance displacement sensors	1	CO4		...Do...	
	38			accelerometers, tachometers, and dynamometers,	1	CO4		...Do...	
	39			Fluid flow measurements - pressure, velocity,	1	CO4		...Do...	
	40			Fluid flow measurements volume flow rate measurements		CO4		--D0--	

COURSE INFORMATION SHEET

Name of the Subject: High Frequency Measurement
Course Code: EC525
Course Title: High Frequency Measurement
Pre-requisite(s): EC257 Electromagnetic field and Waves

Co-requisite(s):
Credits: L:3 T:0 P:0
Class schedule per week: 03
Class: M.E.
Semester / Level: I
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables 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, Magnetic loop and related loop techniques.
3	Study current probes theory and uses for current probes limitations, Magnetic core saturation
4	Study the measurement of pulsed EMI effects on Electronic circuits

Course Outcomes

On the completion of this course, the students will 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, compensation and waveform distortion, Differential measurements, Magnetic loop and related loop techniques.
CO3	Gain the knowledge of current probes theory and uses for current probes limitations, Magnetic core saturation
CO4	Measure the pulsed EMI effects on Electronic circuits

Syllabus

Module 1:
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

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

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.

Module 4: Current probes theory and uses, DC coupled, AC Coupled, Theory of operation, uses for current probes, limitations and Magnetic core saturation.

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.

Text Books:

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, Ilona Rolfes, Wiley-Interscience, A john Wiley & sons inc. pub., 2006

Reference Book:

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

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

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:

Current technological developments advanced image processing techniques

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

S. No.	Course Delivery Methods	Used
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors	Yes
CDM 2	Quizzes	Yes
CDM 3	Assignments/Seminars	Yes
CDM 4	Mini projects/Projects	Yes
CDM 5	Laboratory experiments/teaching aids	No
CDM 6	Industrial/guest lectures	Yes
CDM 7	Industrial visits/in-plant training	No
CDM 8	Self- learning such as use of NPTEL materials and internets	Yes
CDM 9	Simulation	No

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
AssignmentMarks	1	1	1	1
End SemExamination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

1.Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	2	1	1	1	1	1	2	2
CO2	3	1	-	2	1	1	1	2	1	2	2
CO3	2	2	-	2	1	1	1	1	1	1	1
CO4	2	1	2	2	1	1	1	1	1	1	1

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Lecture Wise Lesson Plan Details

Week No.	Lect. No.	Tentative Date	Module No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Oscilloscope probes: types, examples of Noise sources, effect of high frequency noise	T1, T2,R1			PPT and Chock-Board	
	2			Electric Field Coupling, Inductive Voltage drop, Magnetic field coupling	T1, T2,R1			...Do...	
	3			Coaxial cable operation, resistive/Capacitive Voltage Divider	T1, T2,R1			...Do...	
2	4			High and low impedance Passive oscilloscope probes and High impedance Active oscilloscope probes	T1, T2,R1			...Do...	
	5			Current probes, current probe specification,	T1, T2,R1			...Do...	
	6			Current probe electric field response	T1, T2,R1			...Do...	
3	7		2	Probe ground lead effects, lead inductance, lead inductance and probe response	T1, T2,R1			...Do...	
	8			probe type with improved response, tell-tale signs of probe resonance	T1, T2,R1			...Do...	
	9			Wiggly scope patterns, Ground lead common impedance induced error, The null experiment	T1, T2,R1			...Do...	
4	10			ground loading, use of ferrite on probes, More wiggly scope patterns	T1, T2,R1			...Do...	
	11			High Frequency passive probe compensation, Probe compensation	T1, T2,R1			...Do...	

	12		3	compensation and measurement frequency response, compensation and waveform distortion	T1, T2,R1			...Do...	
5	13				T1, T2,R1			...Do...	
	14			compensation adjustment	T1, T2,R1			...Do...	
	15			compensation adjustment location, when to compensate	T1, T2,R1			...Do...	
6	16			probe compensation effects	T1, T2,R1			...Do...	
	17		4	Differential measurements	T1, T2,R1			...Do...	
	18			need of differential measurements, advantages of differential measurements	T1, T2,R1			...Do...	
7	19			available options for differential measurements	T1, T2,R1			...Do...	
	20			FET differential probes,	T1, T2,R1			...Do...	
	21			two hi-Z 10X passive probe using A-B	T1, T2,R1			...Do...	
8	22			balance coaxial probe,	T1, T2,R1			...Do...	
	23			probe correction techniques	T1, T2,R1			...Do...	
	24			Magnetic loop and other noncontact measurements	T1, T2,R1			...Do...	
9	25			Square magnetic pickup loop- theory of operation	T1, T2,R1			...Do...	
	26			factors affecting size and shape of pickup loop,	T1, T2,R1			...Do...	
	27		5	orientation of loop	T1, T2,R1				
10	28			current response of the pickup loop	T1, T2,R1			...Do...	
	29			pickup loop null experiments	T1, T2,R1			...Do...	
	30			effect of the pickup loop on circuit operation	T1, T2,R1			...Do...	
11	31			Pickup loop technique of locating noise sources,	T1, T2,R1			...Do...	
	32			Other non-contact measurements.	T1, T2,R1			...Do...	
	33			Current probes theory and uses	T1, T2,R1			...Do...	
12	34			DC coupled, AC Coupled,	T1, T2,R1			...Do...	
	35			Theory of operation, uses for current probes	T1, T2,R1			...Do...	
	36			limitations and Magnetic core saturation	T1, T2,R1			...Do...	
13	37			Measurement of pulsed EMI effects on Electronic circuits	T1, T2,R1			...Do...	
	38			Introduction, Technical background, inductive and capacitive coupling	T1, T2,R1			...Do...	
	39			the skin effect, and Measurement pitfalts	T1, T2,R1			...Do...	

	40			realistic options for system level pulsed	T1, T2,R1			--D0--	

COURSE INFORMATION SHEET

Name of the Subject: Control System Design
Course Code: **EE515**
Course Title: Control System Design
Pre-requisite(s): EC313 Electronic Measurement, EE 305 Control Theory
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE

Name of Teacher:

Course Objectives:

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.

Course Outcomes:

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

CO1	Identify the design objectives and requirements of control systems and Interpret the concepts of PD, PI, PID, lead, lag, lag lead, and discrete data controller design and apply it to solve some design problems;
CO2	Apply the state feedback controller design and techniques and outline its effects on system's performance which includes transient response and robustness;
CO3	To develop methodologies to design real time digital and analogy compensators and reproduce the results and write effective reports suitable for quality journal and conference publications
CO4	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.

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.

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.

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

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.

Books recommended:
Text Books:

1. B.C. Kuo, "Automatic Control System", 7th Edition PHI. (T1)
2. M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH. (T2)
3. J.G. Truxal, "Automatic Feedback Control System", McGraw Hill, New York. (T3)
4. K. Ogata, "Discrete Time Control Systems", 2nd Edition, Pearson Education. (T4)

Reference Books:

1. Norman Nise, "Control System Engineering", 4th Edition. (R1)
2. M. Gopal, "Digital Control & State Variable Method", TMH. (R2)
3. B.C. Kuo, "Digital Control System", 2nd Edition, Oxford. (R3)
4. Stephanie, “Design of Feedback Control Systems”, 4th Edition, Oxford. (R4)

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Quizes	30
End Sem Examination Marks	60
Assignment	10

Assessment Compoents	CO1	CO2	CO3	CO4	CO5
Endterm (60%)					
Quiz (30%)					
Assignment (10%)					

Indirect Assessment –

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

Overall Assessment

	CO1	CO2	CO3	CO4	CO5
Direct Assessment (DA)					
Indirect Assessment (IA)					
Overall Attainment =(0.6*DA + 0.4*IA)					

COURSE INFORMATION SHEET

Name of the Subject: Digital Image Processing Techniques
Course Code: **EC526**
Course Title: Digital Image Processing Techniques
Pre-requisite(s): EC305 Signal Processing Techniques, EC251 probability and Random Process
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives:

This course enables the students:

1	To gain understanding on digital image formation, characteristics and its processing steps.
2	To demonstrate the use of different spatial and frequency domain processing techniques to improve the image quality.
3	To apply various segmentation techniques of an image.
4	To introduce various object recognition and analysis methods for computer vision applications.

Course Outcomes

On the completion of this course, the students will 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	Have an ability to segment and represent the image for computer vision tasks.
CO4	Develop an ability to create and apply the image processing techniques in various applications in many areas.

SYLLABUS

Module 1: Fundamental steps in Digital Image Processing, Components of an Image processing system, Digital Image 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.

Module 2: Image Enhancement in Spatial and Frequency Domain: Grey 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.

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

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 Feature extraction from Co-occurrence matrices, Chain codes, Signatures, Boundary Segments, Skeletons, Boundary Descriptors, Regional Descriptors.

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.

Text Books:
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 Book:
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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects

CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	2	2		1		1	2		
CO2	2	3	2	3		2		1	3	1	1
CO3	3	3	1	3		2		1	3	1	1
CO4	3	3	1	3	1	3		2	3	1	1

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

S. No.	**Course Delivery Methods**
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures

CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Lecture Wise Lesson Plan Details

Week No.	Lect. No.	Tentative Date	Module No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Introduction to Digital Image Processing Techniques. Course objectives	1	CO1		PPT and Chock-Board	
	2			Fundamental steps in Digital Image Processing, Components of an Image processing system	1	CO1		...Do...	
	3			Digital Image Representation	1	CO1		...Do...	
2	4			Basic relationship between pixels, Basic Arithmetic/Logic operations on image: Image subtraction, Image averaging,	1	CO1		...Do...	
	5			Color image processing fundamentals: Color Modules, RGB,HIS, Lab color modules	1	CO1		...Do...	
	6			Convolution and Correlation theorems.	1	CO1		...Do...	
3	7		2	Image Enhancement in Spatial domain fundamentals.	1	CO1		...Do...	
	8			Gray Level Transformations, Histogram Processing	1	CO1		...Do...	
	9			Smoothing and Sharpening with Spatial Domain Filters, ,	1	CO2		...Do...	
4	10			Frequency Domain Enhancement: Fourier Transform, Fast Fourier Transform	1	CO2		...Do...	
	11			Discrete Cosine Transform	1	CO2		...Do...	
	12			Wavelet Transforms,	1	CO2		...Do...	
5	13			Smoothing and Sharpening with Frequency Domain filters Homomorphic filtering,	1	CO2		...Do...	
	14		3	Pseudo Color Image Enhancement.	1	CO2		...Do...	
	15			Image Restoration: Noise Models	1	CO2		...Do...	
6	16			Restoration in the presence of Noise-Only Spatial filtering,	1	CO2		...Do...	
	17			Mean filters, Adaptive filters.	1	CO3		...Do...	
	18			Periodic Noise Reduction by Frequency Domain filtering,	1	CO3		...Do...	
7	19			Inverse Filtering. , , Geometric Mean Filter.	1	CO3		...Do...	

	20		4	Minimum Mean Square Error (Wiener) Filtering	1	CO3		...Do...	
	21			Image Segmentation Fundamentals and its application	1	CO3		...Do...	
8	22			Detection of Discontinuities: Point Detection, Line detection,	1	CO3		...Do...	
	23			Edge Detection	1	CO3		...Do...	
	24			Thresholding: , Optimal, Global , Adaptive thresholding,	1	CO3		...Do...	
9	25			Region-based Segmentation	1	CO4		...Do...	
	26			Textural Images, ,	1	CO4		...Do...	
	27		5	Textural Feature extraction from Co-occurrence matrices	1	CO4			
10	28			Chain codes, Signatures, Boundary Segments,	1	CO4		...Do...	
	29			Skeletons, Boundary Descriptors,	1	CO4		...Do...	
	30			Regional Descriptors.	1	CO4		...Do...	
11	31			Object Recognition : Fundamentals	1	CO4		...Do...	
	32			Elements of Image analysis	1	CO4		...Do...	
	33			Pattern Classifier	1	CO4		...Do...	
12	34			Minimum distance classifier,	1	CO4		...Do...	
	35			Baye's Classifier	1	CO4		...Do...	
	36			Neural Network algorithm,	1	CO4		...Do...	
13	37			Fuzzy classifier	1	CO4		...Do...	
	38			Structural methods.	1	CO4		...Do...	
	39			Application of image processing techniques	1	CO4		...Do...	
	40			Recapsulization of the course		CO4		--D0--	

COURSE INFORMATION SHEET

Name of the Subject: Speech Processing & Recognition
Course Code: **EC527**
Course Title: Speech Processing & Recognition
Pre-requisite(s): **EC305 Signal Processing Techniques**
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

1	To explain fundamentals of speech production, its perception and inherent features.
2	To develop an ability to analyse parameter estimation and feature representations of speech signals.
3	To develop an ability to evaluate the pattern comparison and design issues of speech recognition.
4	To develop the concept and utilization of statistical and pattern recognition models. To develop the ability to apply the speech analysis and recognition methods 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. 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

Module-II
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

Module-III
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

Module-IV
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

Module-V
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.

Text Book:

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 Book:

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

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

Mapping between Course Outcomes and Program Outcomes

	Program Outcomes

Course Outcome #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	3	1	0	2	1	1
CO2	3	3	3	2	3	2	0	0	3	2	2
CO3	3	2	3	3	3	2	0	0	3	1	2
CO4	3	3	3	3	3	2	3	1	2	2	3

***Note:* 1** *for fulfilling less than 40%,* **2** *for fulfilling less than 70% and* **3** *for fulfilling above 70 %*

CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1,C02,C03, C04	
CD2	Tutorials/Assignments	CO2,C03,C04	
CD3	Seminars	CO3,C04	
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids	CO1,C02,C03, C04	
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets	CO1,C02,C03, C04	
CD9	Simulation	CO1,C02,C03, C04	

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus.	T1	1		PPT, Board, Notes	
	L2			Speech production process	T1	1		---do----	
	L3			Representation of speech in time and frequency domain	T1	1		---do----	
2	L4			Speech sound and features	T1	1		---do----	
	L5			Speech sound and features	T1	1		---do----	
	L6			Approaches to automatic speech recognition	T1	1		---do----	
3	L7			Approaches to automatic speech recognition	T1	1		---do----	
	L8			Introduction to signal processing techniques for speech analysis	T1	1		---do----	

	L9			Linear predictive coding model for Speech Recognition	T1	2		---do----	
4	L10			Linear predictive coding : LPC model, Analysis equations	T1	2		---do----	
	L11			Linear predictive coding : Autocorrelation method	T1	2		---do----	
	L12			Linear predictive coding : Covariance method, Analysis Parameters	T1	2		---do----	
5	L13			Vector quantization	T1	2		---do----	
	L14			Introduction to pattern recognition	T1	2		---do----	
	L15			Speech detection methods	T1	2		---do----	
6	L16			Various distortion measures	T1	2		---do----	
	L17			Spectral distortion measures	T1	2		---do----	
	L18			Spectral dynamic features to distortion measure	T1	2		---do----	
7	L19			Time alignment &normalization : Dynamic Programming, Constraints	T1	2		---do----	
	L20			Time alignment &normalization : Dynamic Time – Warping Solutions	T1	2		---do----	
	L21			Discrete-Time Markov Process	T1	3		---do----	
8	L22			Hidden Markov Model	T1	3		---do----	
	L23			Types of HMMs	T1	3		---do----	
	L24			Continuous observation densities in HMM	T1	3		---do----	
9	L25			Auto regressive HMMs	T1	3		---do----	
	L26			Variants on HMM structures	T1	3		---do----	
	L27			Explicit state duration density in HMMs	T1	3		---do----	
10	L28			Comparison of HMMs	T1	3		---do----	
	L29			Implement issues for HMM	T1	3		---do----	
	L30			Model clustering and Splitting	T1	3		---do----	
11	L31			HMM for isolated word recognition	T1	3		---do----	
	L32			Gaussian Mixture Model, Speaker recognition using GMM	T1	3		---do----	
	L33			Introduction to Kaldi toolkit	RB2	3		---do----	
12	L34			Introduction to SVM, Linear and Non-linear classifications	T2	3		---do----	
	L35			Computing the SVM classifier, Properties, Implementation	T2	3		---do----	
	L36			Speech –recognizer performance score	T1	4		---do----	
13	L37			Characteristics of speech recognition applications	T1	4		---do----	

	L38			Classes of speech recognition applications	T1	4		---do----	
	L39			Command and Control Applications	T1	4		---do----	
14	L40			Speech recognition in Mobile Phones	T1	4		---do----	

COURSE INFORMATION SHEET

Name of the Subject: CMOS Digital VLSI Design
Course code: EC528
Course title: CMOS Digital VLSI Design
Pre-requisite(s): EC101 BECE
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: **3**
Class period per week: 03
Class: M. Tech.
Semester / Level: 01/01
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	To apprehend Design technique of Inverter and Combinational Logic Circuits in CMOS and model them with VHDL/Verilog/SystemVerilog.
B.	To perceive Design technique of Sequential Logic Circuits in CMOS and model them using VHDL/Verilog/ SystemVerilog.
C.	To understand Timing Issues in Digital Circuits, model Clock Generator, Test Bench using VHDL/Verilog/System-Verilog Modelling,s data path, memory and control structure design techniques
D.	To grasp CMOS Fabrication Process and Manufacturing Issues.

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

1	Design and analyze Inverter and Combinational Logic Circuits in CMOS with given design specification such as propagation delay, power dissipation, PDP and EDP.
CO2	Design and analyze Sequential Logic Circuits in CMOS with given design specification.
CO3	Synthesize Digital Circuits using VHDL/Verilog/SystemVerilog and model Clock Generator and Test Bench.
CO4	Appraise CMOS Fabrication Process and Manufacturing Issues.

SYLLABUS

Module -1:
Design of Inverter and Combinational Logic Circuits in CMOS and their VHDL/Verilog/ SystemVerilog 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.

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.

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.

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.

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.

Text Books:

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 Book:

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): N/A

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

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

CD #	**Course Delivery methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes
CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Assignment Marks	10
Quizzes	30
End SEM Examination Marks	60

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Quizzes	**3**	**3**	**3**	
Assignment Marks				**3**
End Sem Examination Marks	**3**	**3**	**3**	**3**

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**1**	**1**	**3**	**3**

CO2	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**1**	**1**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Methodology used	Remarks by faculty if any
1	L1		3	Static and Dynamic Behaviour of CMOS Inverter: Switching Threshold,	T1, T2, T3	1	PPT Digi Class/Chock -Board	
	L2		5	Noise Margin formulation, computing capacitance, Propagation Delay, Power	T1, T2, T3	1	…. do …	
	L3		5	Delay, Power-Delay Product, Energy-Delay Product.	T1, T2, T3	1	…. do …	
2	L4		6	Design of CMOS Combinational Logic Circuits: Static CMOS Design: Complementary CMOS, Ratioed Logic, Pass-Transistor Logic;	T1, T2, T3	1	…. do …	
	L5		6	Dynamic CMOS Design: Basic Principles of Dynamic Logic, Speed and Power Dissipation of Dynamic Logic	T1, T2, T3	1	…. do …	
	L6		6	Signal Integrity Issues in Dynamic Design Cascading Dynamic Gates	T1, T2, T3	1	…. do …	
3	L7		1	Introduction to the VHDL with design examples of inverter, NAND and NOR gates	R1	1	…. do …	
	L8		1	Introduction to the Verilog with design examples of inverter, NAND and NOR gates	T3	1	…. do …	
	L9		1	Introduction to the SystemVerilog with design examples of inverter, NAND and NOR gates	R2	1	…. do …	
4	L10		7	Timing Metrics for sequential Circuits, Static Latches and Registers: Bistability Principle	T1, T2, T3	2	…. do …	

	L11		7	Multiplexer-Based Latches, Master-Slave Edge-Triggered Register, Low-Voltage Static Latches	T1, T2, T3	2	…. do …	
	L12		7	Dynamic Latches and Registers: Dynamic Transmission-Gate Edge-triggered Registers	T1, T2, T3	2	…. do …	
5	L13		7	C^2MOST – A Clock-Skewed Insensitive Approach, True Single-Phase Clocked Register (TSPCR)	T1, T2, T3	2	…. do …	
	L14		7	Alternative Register Styles: Pulse Registers, Sense-Amplifier Based Registers	T1, T2, T3	2	…. do …	
	L15		7	Pipelining: Latch- versus Register-Based Pipelines, NORA-CMOS—A Logic Style for Pipelined Structures	T1, T2, T3	2	…. do …	
6	L16		7	Nonbistable Sequential Circuits: The Schmitt Trigger	T1, T2, T3	2	…. do …	
	L17		7	Monostable Sequential Circuits, Astable Circuits, Clocking Strategy;	T1, T2, T3	2	…. do …	
	L18		7	Design examples of latch, flip-flop, register and Memory (RAM, ROM) using VHDL/Verilog/SystemVerilog HDL	T1, T2, T3	2	…. do …	
7	L19		10	Timing Classification of Digital Systems: Synchronous Interconnect – Mesochronous interconnect	T1, T2, T3	3	…. do …	
	L20		10	Plesiochronous Interconnect, Asynchronous Interconnect; Synchronous Design — An In-depth Perspective - Synchronous Timing Basics	T1, T2, T3	3	…. do …	
	L21		10	Sources of Skew and Jitter, Clock-Distribution Techniques, Latch-Based Clocking	T1, T2, T3	3	…. do …	
8	L22		10	Self-Timed Circuit Design: – Self-Timed Logic - An Asynchronous Technique	T1, T2, T3	3	…. do …	
	L23		10	Completion-Signal Generation, Self-Timed Signalling, Practical Examples of Self-Timed Logic	T1, T2, T3	3	…. do …	
	L24		10	Synchronizers and Arbiters: Synchronizers—Concept and Implementation, Arbiters	T1, T2, T3	3	…. do …	
9	L25		10	Clock Synthesis and Synchronization Using a Phase-Locked Loop: Basic Concepts. Building Blocks of a PLL	T1, T2, T3	3	…. do …	
	L26		10	Future Directions and Perspectives: Distributed Clocking Using DLLs, Optical Clock Distribution, Synchronous versus Asynchronous Design	T1, T2, T3	3	…. do …	
	L27		10	Design examples of clock and test bench using VHDL/Verilog/SystemVerilog HDL	T1, T2, T3	3	…. do …	

10	L28		2	CMOS Technologies, Layout Design Rules, CMOS Process Enhancements	T1, T2	4	…. do …	
	L29		2	Design Rule Checking (DRC), Inverter cross-section, Layout of CMOS Inverter	T1, T2	4	…. do …	
	L30		2	Layout of 2-input NAND gate, Layout of 2-input NOR gate, Layout of Complex logic gate	T1, T2	4	…. do …	
11	L31		2	Layout of Domino AND gate, Stick Diagrams, Design Partitioning, Floor Planning	T1, T2	4	…. do …	
	L32		2	Estimation of parasitics: diffusion capacitance and interconnect parasitics, package parasitics	T1, T2	4	…. do …	
	L33		2	impact of parasitics on circuit performance	T1, T2	4	…. do …	
12	L34		2	Manufacturing Issues: Antenna Rules, Layer Density Rules	T1, T2	4	…. do …	
	L35		2	Resolution Enhancement Rules, Metal Slotting Rules	T1, T2	4	…. do …	
	L36		2	Interconnect Wearout: Electromigration, Self-heating, Yield Enhancement Guidelines	T1, T2	4	…. do …	
13	L37		11	Data operators: single-bit addition, carry-propagate addition, subtraction, multi-input addition	T1, T2, T3	4	…. do …	
	L38		11	One/Zero detectors, magnitude comparators, equality comparators, counters, Boolean logic operators	T1, T2, T3	4	…. do …	
	L39		11	Funnel shifters, Barrel Shifter	T1, T2, T3	4	…. do …	
14	L40		11	Array multiplier, Wallace tree multiplier	T1, T2, T3	4	…. do …	
	L41		11	Shifter: Barrel Shifter, Logarithmic Shifter	T1, T2, T3	4	…. do …	
	L42		11	Power and Speed Trade-off's in Datapath Structures: Design Time Power-Reduction Techniques	T1, T2, T3	4	…. do …	
15	L43		11	Run-Time Power Management, Reducing the Power in Standby (or Sleep) Mode	T1, T2, T3	4	…. do …	
	L44		12	Memory: SRAM, DRAM, ROM, Flash memory, FIFO, Control Structure Design: Mealy and Moore FSM, state-transition diagram, state reduction technique, control logic implementation	T1, T2, T3	4	…. do …	
	L45		11, 12	Design examples of Datapath (adder, subtractor, multiplier, comparator, counter, decoder, multiplexer) and control unit (Mealy and Moore FSM) using Verilog/ SystemVerilog HDL.	T1, T2, T3	4	…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Instrumentation Lab-1
Course Code: EC582
Course Title: Instrumentation Lab-1
Pre-requisite(s):
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objective: This course enables the students:

A.	To understand the basics of Instrumentation.
B.	To develop basic and advanced techniques in Instrumentation.
C.	To implement various basic Instrumentation and Virtual Instrumentation Devices.
D.	To develop Ladder diagram for different applications

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

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 myRIO in LabVIEW.
8. To implement a sonic range finder with maximum range of 6m using myRIO 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

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11
CO1	3	2	1	1	3	1	2	3	1	2	2
CO2	2	2	1	2	3	2	2	1	1	2	2
CO3	2	2	3	2	1	1	1	2	3	2	2
CO4	2	3	3	3	3	1	2	2	1	2	2

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		
CD2	Tutorials/Assignments/Quiz (s)		
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids	CO1, CO2, CO3, CO4	CD5
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation	CO1, CO2, CO3, CO4	CD9

Lab Turn Wise Experiment Planning Details:

Week No.	Exp. No.	Tentative Date	Ch. No.	Topic/experiment to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	-		-		-	-		CAD tools	
2	Exp. 1		App. – A & B		T3, T2	1		…. do …	
3	Exp. 2		6		T1, T2	2		…. do …	
4	Exp. 3		App. – A & B		T3, T2	1		…. do …	
5	Exp. 4		App. – A & B		T3, T2	1		…. do …	
6	Exp. 5		App. – A & B		T3, T2	1		…. do …	
7	Exp. 6		App. – A & B		T3, T2	1		…. do …	
8	Exp. 7		2		T2	3		…. do …	
9	Exp. 8		2		T2	3		…. do …	
10	Exp. 9		6		T1	2		…. do …	
11	Exp. 10		7		R1	4		…. do …	
12	Exp. 11		10		R1	4		…. do …	
13	Exp. 12		8		R1	4		…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Advanced Sensing Techniques Lab

Course Code: **EC521**
Course Title: Advanced Sensing Techniques Lab
Pre-requisite(s): EC208 Electronics Measurement Lab
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
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.	Understand sensitivity and crosss-ensitivity

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

CO1	Physical parameters measurement and control using respective sensorr
CO2	Use testbench for calibration
CO3	Design fiber optic sensor
CO4	Calculate sensitivity and cross-sensitivity

<u>List of experiments</u>

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

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 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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

<u>Mapping between Objectives and Outcomes</u>

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	3	2	1	2	2	3	1	2
CO2	2	3	3	2	2	1	2	2	1	2	1
CO3	2	2	3	2	1	2	3	2	1	1	1
CO4	2	3	3	2	1	1	2	1	2	2	1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		
CD2	Tutorials/Assignments/Quiz (s)		
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids	CO1, CO2, CO3, CO4	CD5
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation	CO1, CO2, CO3, CO4	CD9

Lab Turn Wise Experiment Planning Details:

Week No.	Exp. No.	Tentative Date	Ch. No.	Topic/experiment to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	-		-		-	-			
2	Exp. 1		App. – A & B		T3, T2	1		…. do …	
3	Exp. 2		6		T1, T2	2		…. do …	
4	Exp. 3		App. – A & B		T3, T2	1		…. do …	
5	Exp. 4		App. – A & B		T3, T2	1		…. do …	
6	Exp. 5		App. – A & B		T3, T2	1		…. do …	
7	Exp. 6		App. – A & B		T3, T2	1		…. do …	
8	Exp. 7		2		T2	3		…. do …	
9	Exp. 8		2		T2	3		…. do …	
10	Exp. 9		6		T1	2		…. do …	
11	Exp. 10		7		R1	4		…. do …	
12	Exp. 11		10		R1	4		…. do …	
13	Exp. 12		8		R1	4		…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Advanced Digital Signal Processing Lab
Course Code: **EC523**
Course Title: Advanced Digital Signal Processing Lab
Pre-requisite(s): EC305 signal Processing techniques
Co-requisite(s):

Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:
+

A.	To understand the basics of DSP.
B.	To develop basic and advanced techniques in signal processing.
C.	To implement various basic DSP and Advanced DSP techniques in Hardware Platform (DSP Processor kit).
D.	To develop to apply advanced DSP techniques to various engineering applications.

Course Outcomes

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

CO1	To implement the theoretical knowledge acquired in DSP.
CO2	To illustrate various models signal modelling, representation, synthesis and analysis.
CO3	To apply various DSP algorithms in real life applications.
CO4	Have the ability to prepare reports and analyze the results.

List of Compulsory experiments:

1. Computation of the linear convolution and circular convolution of two finite-length sequences using MATLAB.
2. Obtain the Partial Fraction Expansion of the Z-Transform expression and to find its Inverse Z-Transforms using MATLAB.
3. Testing for the stability of given Discrete Time Systems using MATLAB
4. To write a program for finding the DFT and FFT of a Discrete time finite length sequence.
5. To write a program and simulate using C language for computation of Linear Convolution using TMS 320C6713 DSK Processor.
6. Development of the program for finding out DFT and FFT of a finite length sequence using TMS 320C6713 DSK Processor.
7. To write a program and simulate using C language for designing a Digital Filter (LP/ HP / BP / BR) using TMS 320C6713 DSK Processor.
8. To write a program to implement LMS and RLS algorithm using MATLAB.
9. Representation of stationary and non-stationary signals using wavelet transformation.
10. Implementation of sub-band filtering approach using MATLAB.
11. To write a program for system identification using MATLAB and also implement in TMS 320C6713 DSK Processor.
12. To write a program for channel equalization using MATLAB and also implement in TMS 320C6713 DSK Processor.
13. Signal Processing of ECG Signals and Measuring Heart Rate, Spectrum analysis of Noisy and pure Biosignal
14. Noise cancellation using Adaptive filtering

15. Study and observation of full precision, low precision and differential error between two using precision filter.
16. Noise control using a combination of Low pass and High pass filters.

Text Books:
1. Digital Signal Processing 3/E by Proakis & Manolakis, PHI Edition
2. Adaptive Signal Processing, Widrow and Stearns, Pearson Education

Reference Books:
1. Digital Signal Processing 3/E by S.K.Mitra TMH Edition.
2. Discrete-Time Signal Processing 2/E by Oppenheim, Schafer & Buck, PHI 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:

S. No.	**Course Delivery Methods**
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note:* **1** *for fulfilling less than 40%,* **2** *for fulfilling less than 70% and* **3** *for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	3	2		1		1	3		1
CO2	2	3	3	2		2	1	2	3	1	2
CO3	2	3	3	2		2	1	2	3	2	2
CO4	3	3	3	3		2	1	2	3	1	2

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		
CD2	Tutorials/Assignments/Quiz (s)		
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids	CO1, CO2, CO3, CO4	CD5
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation	CO1, CO2, CO3, CO4	CD9

Lab Turn Wise Experiment Planning Details:

Week No.	Exp. No.	Tentative Date	Ch. No.	Topic/experiment to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	-		-		-	-		CAD tools	
2	Exp. 1				T3, T2	1		…. do …	
3	Exp. 2				T1, T2	2		…. do …	
4	Exp. 3				T3, T2	1		…. do …	
5	Exp. 4				T3, T2	1		…. do …	
6	Exp. 5				T3, T2	1		…. do …	
7	Exp. 6				T3, T2	1		…. do …	
8	Exp. 7				T2	3		…. do …	
9	Exp. 8				T2	3		…. do …	
10	Exp. 9				T1	2		…. do …	
11	Exp. 10				R1	4		…. do …	
12	Exp. 11				R1	4		…. do …	
13	Exp. 12				R1	4		…. do …	

II-Semester

COURSE INFORMATION SHEET

Name of the Subject: Process Control Instrumentation
Course Code: **EC568**
Course Title: Process Control Instrumentation
Pre-requisite(s): EE351 **Control Theory, EC313 Electronics Measurement**
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	To develop the mathematical model of the physical system
B.	To analyze the interdependency of multivariable controller.
C.	To design a controller for practical systems under different condition
D.	Explain the different processes involved in power generation

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

CO1	Analyze a physical system and develop the mathematical model of the physical system
CO2	Design a controller for practical systems under different condition.
CO3	Understand the operation of different complex control schemes.
CO4	Understand 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.

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.

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,

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).

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.

Text Books:

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):

POs met through Gaps in the SYLLABUS:

Topics beyond SYLLABUS/Advanced topics/Design:

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

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note:* 1** *for fulfilling less than 40%,* **2** *for fulfilling less than 70% and* **3** *for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3		3	1	3	3	3	3
CO2	3	3	2	3		3	1	3	3	3	3
CO3	2	2	3	3	1	3	1	2	3	3	3
CO4	3	3	2	3	2	3	1	3	3	3	3

Mapping between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Quizzes	CO1, CO2, CO3, CO4	CD2
CD3	Assignments/Seminars	CO5	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus.		1		PPT Digi Class/Chock -Board	
	L2			Introduction to process control	T1	1		…. do …	
	L3			Analyze the physical system with example of surge tank.					
	L4			Analyze the physical system with the example of shower	T1	1		…. do …	
2	L5			Use of instrumentation in Process control					

	L6			Process model and dynamic behaviour					
	L7			Mathematical model of the physical system. Back ground, Reason of modelling,					
	L8			Lumped parameter system models					
3	L9			Balanced equation: Material balance					
	L10			integral balance and instantaneous balance					
	L11			Closed loop controller design procedure.					
	L12			Development of control system block diagram					
4	L13			PID controller,					
	L14			tuning of PID controller					
	L15			Internal model control: Introduction to model control					
	L16			Static control law, Dynamic control law					
5	L17			Practical open loop controller design					
	L18			Generation of open-loop controller design procedure					
	L19			Model uncertainty and disturbances.					
	L20			Comparison between closed loop controller and open loop controller.					
6	L21			Complex control schemes: Background, multivariable controller					
	L22			Introduction to cascade control, cascade control					

				analysis and design					
	L23			feed forward control, feed forward control design					
	L24			examples of feed forward control. Ratio control,					
7	L25			selective and over ride control					
	L26			split -range control					
	L27			multivariable control, interdependency					
	L28			Relative gain Array					
8	L29			Properties and application of RGA,					
	L30			Use of RGA to determine variable pairing,					
	L31			Steady state and dynamic effect of recycle					
	L32			Snow ball effect in recycler					
9	L33			compressor control, Heat exchanger					
	L34			the control and optimisation hierarchy					
	L35			Model predictive control					
	L36			Optimisation problem,					
10	L37			dynamics matrix control (DMC)					
	L38			Error estimation					
	L39			Process of power generation in coal –fired thermal power plants					
	L40			Process of power generation in oil-fired thermal power plants					
11	L41			types of boilers, Combustion process					
	L42			Super heater, Turbine					
	L43			Importance of Instrumentation in					

				thermal power plant.					
	L44			Introduction to Refinery					
12	L45			Introduction Petrochemical processes					
	L46			Control of distillation column					
	L47			Catalytic cracking unit, Catalytic reformer					
	L48			Pyrolysis unit					
13	L49			Automatic Control of polyethylene production					
	L50			Control of vinyl chloride and PVC production.					

COURSE INFORMATION SHEET

Name of the Subject: Embedded System Design
Course Code: **EC570**
Course Title: Embedded System Design
Pre-requisite(s): EC203 Digital System Design
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

A.	Define the fundamental of embedded systems
B.	Show the correlation between hardware & software in embedded system
C.	Design the highly secure optimized embedded systems and show the application of embedded system in present market
D.	Develop the suitable software for embedded system

Course Outcomes

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

1.	Recognize the interfacing and integration of component in SoC.
2.	Design the highly secure ATM.
3.	Develop the programmable kit to check the entire components in a board.
4.	Develop the embedded systems & corresponding software as per demand of current market.

SYLLABUS

Module 1:
Introduction to Embedded System:
The concept of embedded systems design, Embedded microcontroller cores, embedded memories, Examples of embedded systems, partitioning, partition by feature, partition with CPU, finding missing interrupts.

Module 2:
Technological aspects of embedded systems:
Interfacing between analog and digital blocks, signal conditioning, digital signal processing, ISR Debugging, Measuring performance, Guessti matching performance, a poor man's performance analyzer, RTOS,

Module 3:
Sub-System Design & Interfacing:
Sub-system interfacing, interfacing with external systems, user interfacing; hacking peripheral driver, selecting stack size, the curse of Malloc(), Banking, logical to physical, hardware issues, software, predicting ROM requirements, RAM diagnostic, Inverting bits, noise issues, notes of software prototyping.

Module 4:
Design Trade Off & Hardware Musings:
Design trade-offs due to process compatibility, thermal considerations; Debug gable design, test point galore, resistors, unused inputs, clocks, reset, small CPUs, watchdog timers, making PCBs, changing PCB, Planning.

Module 5:
Software aspects of embedded systems & Trouble shooting tools:
Real time programming languages and operating systems for embedded systems; Emulators, BDMs, ROM Monitors, ROM emulators, Oscilloscopes, Scoping Tricks, Fancy tools and big bucks, Tool woes, reliable connections, nonintrusive myths, add debugging resources, ROM burnout, speed up by slowing down.

Text books:

1. J.W. Valvano, "Embedded Microcomputor System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.

Reference Books:

1. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
2. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
3. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

4. Gaps in the SYLLABUS (to meet Industry/Profession requirements):

5. POs met through Gaps in the SYLLABUS:

6. Topics beyond SYLLABUS/Advanced topics/Design:

7. POs met through Topics beyond SYLLABUS/Advanced topics/Design:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

8. Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	3	3	3	2	3	3
CO2	2	3	3	2	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**

CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, CO2, CO3	CD1
CD2	Tutorials/Assignments		CO2, CO3	CD1
CD3	Seminars		CO3, CO4	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets		CO4	
CD9	Simulation			

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		1	The concept of embedded systems design	T1, R2,R3	1, 2		PPT Digi Class/Chock -Board	
	L2		1	The concept of embedded systems design	T1, R2,R3	1, 2		-do-	
	L3		1	The concept of embedded systems design	T1, R2,R3	1, 2		-do-	
2	L4		1	Embedded microcontroller cores	T1, R2,R3	1, 2		-do-	
	L5		1	Embedded microcontroller cores	T1, R2,R3	1, 2		-do-	
	L6		1	Embedded microcontroller cores	T1, R2,R3	1, 2		-do-	
3	L7		1	embedded memories	T1, R2,R3	1, 2		-do-	
	L8		1	embedded memories	T1, R2,R3	1, 2		-do-	
	L9		1	embedded memories	T1, R2,R3	1, 2		-do-	
4	L10		1	Examples of embedded systems	T1, R2,R3	1, 2		-do-	
	L11		1	Examples of embedded systems	T1, R2,R3	1, 2		-do-	
	L12		1	Examples of embedded systems	T1, R2,R3	1, 2		-do-	
5	L13		2	Interfacing between analog and digital blocks	T1, R1,R3	1, 2		-do-	
	L14		2	Interfacing between analog and digital blocks	T1, R1,R3	2, 3		-do-	

	L15		2	Interfacing between analog and digital blocks	T1, R1,R3	2, 3		-do-	
6	L16		2	signal conditioning	T1, R1,R3	2, 3		-do-	
	L17		2	signal conditioning	T1, R1,R3	2, 3		-do-	
	L18		2	signal conditioning	T1, R1,R3	2, 3		-do-	
7	L19		2	digital signal processing	T1, R1,R3	2, 3		-do-	
	L20		2	digital signal processing	T1, R1,R3	2, 3		-do-	
	L21		2	digital signal processing	T1, R1,R3	2, 3		-do-	
8	L22		3	Sub-system interfacing	T2, R1,R3	2, 3		-do-	
	L23		3	Sub-system interfacing	T2, R1,R3	2, 3		-do-	
	L24		3	Sub-system interfacing	T2, R1,R3	2, 3		-do-	
9	L25		3	interfacing with external systems,	T2, R1,R3	2, 3		-do-	
	L26		3	interfacing with external systems	T2, R1,R3	2, 3		-do-	
	L27		3	interfacing with external systems	T2, R1,R3	2, 3		-do-	
10	L28		3	user interfacing	T2, R1,R3	2, 3		-do-	
	L29		3	user interfacing	T2, R1,R3	2, 3		-do-	
	L30		3	user interfacing	T2, R1,R3	2, 3		-do-	
11	L31		6	Design tradeoffs due to process compatibility,	T2, R1,R3	3, 4		-do-	
	L32		6	Design tradeoffs due to process compatibility	T2, R1,R3	3, 4		-do-	
	L33		6	Design tradeoffs due to process compatibility	T2, R1,R3	3, 4		-do-	
12	L34		6	thermal considerations	T2, R1,R3	3, 4		-do-	
	L35		6	thermal considerations	T2, R1,R3	3, 4		-do-	
	L36		6	thermal considerations	T2, R1,R3	3, 4		-do-	
13	L37		10	Real time programming languages	T2, R1,R3	4		-do-	
	L38		10	Real time programming languages	T2, R1,R3	4		-do-	
	L39		10	operating systems for embedded systems	T2, R1,R3	4		-do-	

14	L40		10	operating systems for embedded systems	T2, R1,R3	4		-do-	

COURSE INFORMATION SHEET

Name of the Subject: Optoelectronic Instrumentation
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 (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	To provide knowledge about the optical sources and Detectors
B	To provide Knowledge about Fiber Optic Instrumentation and its application for various measurements
C.	To provide Knowledge about LASER and its different types with their industrial and medical application
D.	To provide Knowledge about the Holography and its applications.

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

CO1	To provide knowledge about the optical sources and Detectors
CO2	Gain Knowledge about Fiber Optic Instrumentation and its application for various measurements
CO3	Gain Knowledge about LASER and its different types with their industrial and medical application
CO4	Gain Knowledge about the Holography and its applications.

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.

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 Raleigh, Raman, Brillouin, Optical spectrum Analyser, Fiber-optic Endoscope

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

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.

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,

Text Books:
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 Book:
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):

POs met through Gaps in the SYLLABUS:

Topics beyond SYLLABUS/Advanced topics/Design:

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

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10

Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	3	3	3	2	3	3
CO2	2	3	3	2	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed				PPT Digi Class/Chock -Board	

				introduction of the course syllabus.					
	L2			Introduction to Gaussian optics, Physical Optics, Fourier optics	T1, T2			…. do …	
	L3			Discuss optical sources, Heterojunction LED’s and LASERS, semiconductor Lasers	T1, T2			…. do …	
2	L4			Monochromators, Photon detectors,	T1, T2			…. do …	
	L5			Photo-emissive cells, LDR	T1, T2			…. do …	
	L6			Light Activated SCR	T1, T2			…. do …	
3	L7			Heterostructure solar cell,	T1, T2			…. do …	
	L8			Noise statistics and accuracy of measurements,	T1, T2			…. do …	
	L9			Statistical approach to measurements, inaccuracy of indirect measurements.	T1, T2			…. do …	
4	L10			Introduction to Fiber optic instrumentation	T1, T2			…. do …	
	L11			Optocoupler, optoelectronic Isolator	T1, T2			…. do …	
	L12			Fiber-optic Pressure and flow sensors,	T1, T2			…. do …	
5	L13			Optical current sensor, Fiber-optic Displacement sensor	T1, T2			…. do …	
	L14			Interferometric Fiber optic sensors, Mach-Zehnder	T1, T2			…. do …	
	L15			Michelson, Fabry perot sensor	T1, T2			…. do …	
6	L16			Fiber Bragg grating sensors for strain and temperature measurements	T1, T2			…. do …	
	L17			Distributed sensors based on	T1, T2			…. do …	

				Raleigh, Raman, Brillouin					
	L18			Optical spectrum Analyser, Fiberoptic Endoscope	T1, T2			…. do …	
7	L19			Principles of operation of Lasers	T1, T2			…. do …	
	L20			Mode locking, Q switching in Lasers	T1, T2			…. do …	
	L21			Tunable lasers	T1, T2			…. do …	
8	L22			Laser for Velocity Measurement. Angular Rotation Rate	T1, T2			…. do …	
	L23			Measurement of Product Dimension Measurement of Surface Finish Profile and Surface Position Measurement	T1, T2			…. do …	
	L24			Particle Diameter Measurement, Strain and Vibration Measurement,	T1, T2			…. do …	
9	L25			Cylindrical Form Measurement	T1, T2			…. do …	
	L26			Defect Detection,	T1, T2			…. do …	
	L27			Surface Flaw Inspection Monitor	T1, T2			…. do …	
10	L28			Laser Doppler Anemometry	T1, T2			…. do …	
	L29			Laser microscope	T1, T2			…. do …	
	L30			Raman Spectroscopy in Medicine	T1, T2			…. do …	
11	L31			Laser Doppler vibrometer	T1, T2			…. do …	
	L32			Heterodyne measurements of Air drums, Laser Lithotripsy	T1, T2			…. do …	
	L33			Laser induces thermos therapy of brain cancer	T1, T2			…. do …	
12	L34			Atmospheric measurements of Lidar	T1, T2			…. do …	
	L35			Laser and Tissue Interaction, Laser	T1, T2			…. do …	

				Instruments for Surgery					
	L36			Removal of Tumors of Vocal Cords, Brain Surgery, Plastic Surgery, Gynaecology and Oncology.	T1, T2			…. do …	
13	L37			Introduction to Holography for Non–destructive Testing, Holographic recording and Reconstruction	T1, T2			…. do …	
	L38			Holographic Interferometry, Double exposer Holography, Real time holography	T1, T2			…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Pattern Recognition and Machine Learning
Course Code: **EC574**
Course Title: Pattern Recognition and Machine Learning
Pre-requisite(s): EC305 Signal Processing Techniques
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

1	Study the parametric and linear Model for Classification.
2	Understand Design neural Network and SVM for Classification.
3	Illustrate Machine independent and Unsupervised learning Techniques.
4	Identify and apply suitable classification methods for real life data classification

Course Outcomes

After the completion of this course, students will be:

CO1.	Explain the parametric and linear Model for Classification.
CO2.	Design neural Network and SVM for Classification.

CO3.	Develop Machine independent and Unsupervised learning Techniques.
CO4.	Identify and apply suitable classification methods for real life data classification

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

Module 2
Linear models: Linear Models for Regression, linear regression, logistic regression, multiple linear regression, Multivariate linear regression, Least square estimation, maximum likelihood estimation for regression, Linear Models for Classification,

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

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

Module 5
Algorithm independent machine learning – lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers, Unsupervised learning and clustering – k-means clustering, fuzzy k-means clustering, hierarchical clustering

References:

1. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001.
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.
3. C. Bishop, "Pattern Recognition and Machine Learning", Springer, 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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	2	1	1	3	2	3	3
CO2	3	3	3	2	2	1	1	3	2	3	3
CO3	3	3	3	2	2	1	1	3	2	3	3
CO4	3	3	3	2	2	1	1	3	2	3	3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

Week No.	Lect. No.	Tentative Date	Module No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Introduction, Course objectives	1	CO1		PPT and Chock-Board	
	2			Problems, applications,	1	CO1		...Do...	
	3			design cycle, learning and adaptation, examples,	1	CO1		...Do...	
2	4			Probability Distributions,	1	CO1		...Do...	
	5			Parametric Learning - Maximum likelihood and Bayesian Decision Theory-	1	CO1		...Do...	
	6			Bayes rule, discriminant functions,	1	CO1		...Do...	
3	7		2	loss functions and Bayesian error Analysis	1	CO1		...Do...	
	8			Linear Models for Regression,	1	CO2		...Do...	
	9			linear regression, logistic regression,	1	CO2		...Do...	
4	10			multiple linear regression, ,	1	CO2		...Do...	
	11		3	Multivariate linear regression,	1	CO2		...Do...	
	12			Least square estimation,	1	CO2		...Do...	
5	13			maximum likelihood estimation for regression,	1	CO2		...Do...	
	14			Linear Models for Classification	1	CO2		...Do...	
	15			perceptron,	1	CO3		...Do...	
6	16			multi-layer perceptron,	1	CO3		...Do...	
	17			backpropagation algorithm, error surfaces,	1	CO3		...Do...	
	18			practical techniques for improving backpropagation,	1	CO3		...Do...	
7	19		4	additional networks and training methods,	1	CO3		...Do...	
	20			Adaboost,	1	CO3		...Do...	
	21			Reinforcement learning,	1	CO3		...Do...	
8	22			Deep Learning	1	CO3		...Do...	
	23			Deep Learning applications	1	CO3		...Do..	
	24			decision surfaces,	1	CO4		...Do...	
9	25			two-category, multi-category,	1	CO4		...Do...	
	26			minimum squared error procedures,	1	CO4		...Do...	
	27			the Ho-Kashyap procedures,	1	CO4			

10	28		5	linear programming algorithms, Support vector machine,	1	CO4		...Do...	
	29			Linear discriminant analysis,	1	CO4		...Do...	
	30			principal component analysis,	1	CO4		...Do...	
11	31			Independent Component analysis	1	CO4		...Do...	
	32			lack of inherent superiority of any classifier,	1	CO4		...Do...	
	33			bias and variance,	1	CO4		...Do...	
12	34			re-sampling for classifier design,	1	CO4		...Do...	
	35			combining classifiers,	1	CO4		...Do...	
	36			Unsupervised learning	1	CO4		...Do...	
3	37			Clustering: introduction	1	CO4		...Do...	
	38			clustering – k-means clustering,	1	CO4		...Do...	
	39			fuzzy k-means clustering,	1	CO4		...Do...	
	40			hierarchical clustering		CO4		--D0--	

COURSE INFORMATION SHEET

Name of the Subject: Modern Optimization Techniques
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 (Instrumentation)
Semester / Level: 01
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

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 analyze and apply algorithms for design optimization.
CO3	Have an ability to find optimum solution to engineering optimization problem.

CO4	Develop an ability to apply use optimization techniques to finance, economics, medical applications, control, communication, power, mechanical problems, chemical and biology.

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.

Module 3: 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.

Module 4: 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.

Module 4: Genetic algorithm and its working principle, GA variants, Particle swarm optimization and its working principle, Differential evolution, Multi-objective optimization principle, pareto font, NSGA.

Module 5: Application to communication, dynamic spectrum allocation, medical, clustering, bioinformatics, control, finance, mechanical structure optimization, power system

Text Books:

1. Optimization for Engineering Design - Kalyanmoy Deb, 2006, PHI
2. S.S. Rao, Engineering Optimization, Theory and practice, New age International Publisher, 2012
3. D.E. Goldberg, genetic Algorithm in search, optimization and machine learning, Addison-Wesley Longman Publisher, 1989

Reference Book:

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures

CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

Note: 1 *for fulfilling less than 40%,* ***2*** *for fulfilling less than 70% and* ***3*** *for fulfilling above 70 %*

Indirect Assessment

1.Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	1	2	2	1			2		1
CO2	2	3	2	3	3	1		1	2		1
CO3	2	3	2	3	3	1		1	2		1
CO4	3	3	3	3	3	2	1	2	3		1

Note: 1 *for fulfilling less than 40%,* ***2*** *for fulfilling less than 70% and* ***3*** *for fulfilling above 70 %*

Lecture Wise Lesson Plan Details

Week No.	Lect. No.	Tentative Date	Module No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Introduction to the course, Optimal problem formulation	1,2	CO1		PPT and Chock-Board	

	2			Design variables constraints, Objective function, Variable bounds,	1,2	CO1		...Do...	
	3			Search methods: optimality Criteria,	1,2	CO1		...Do...	
2	4			Bracketing methods: Exhaustive search methods,	1,2	CO1,CO2		...Do...	
	5			Region – Elimination methods;	1,2	CO2		...Do...	
	6			Interval halving method,	1,2	CO2		...Do...	
3	7			Fibonacci search method, Golden section search method,	1,2	CO2		...Do...	
	8			Point-estimation method;	1,2	CO2		...Do...	
	9			Successive quadratic estimation method.	1,2	CO2		...Do...	
4	10		2	Gradient-based methods:	1,2	CO2		...Do...	
	11			Bisection method,	1,2	CO2		...Do...	
	12			Newton-Raphson method, Secant method,	1,2	CO2		...Do...	
5	13			Cauchy’s steepest descent and Newton’s method.	1,2	CO2		...Do...	
	14			Linear Programming:	1,2	CO2		...Do...	
	15			Graphical method,	1,2	CO2		...Do...	
6	16			Simplex Method, Revised simplex method,	1,2	CO2		...Do...	
	17			Duality in Linear Programming(LP),	1,2	CO2		...Do...	
	18			integer linear programming,	1,2	CO2		...Do...	
7	19			Dynamic programming,	1,2	CO2		...Do...	
	20			Sensitivity analysis.	1,2	CO2		...Do...	
	21		3	Optimality criteria,	1,2	CO1,CO2		...Do...	
8	22			Direct search methods: Simplex search method,	1,2	CO2		...Do...	
	23			Unidirectional search, Hooke-Jeeves pattern search method.	1,2	CO2		...Do...	
	24			Gradient based method, conjugate gradient method,	1,2	CO2		...Do...	
9	25			concept of lagrangian multiplier,	1,2	CO2		...Do...	
	26			complex search method. Characteristics of a constrained problem.	1,2	CO2		...Do...	
	27			Direct methods: The complex method, Cutting plane method,	1,2	CO2			
10	28			Indirect method: Transformation Technique,	1,2	CO2		...Do...	

	29			Basic approach in the penalty function method, Interior penalty function method,	1,2	CO2		...Do...	
	30			convex method.	1,2	CO2		...Do...	
			4	Genetic algorithm and its working principle,					
	32			GA variants,	1,3	CO2		...Do...	
	33			Particle swarm optimization and its working principle,	1,3	CO2		...Do...	
12	34			Differential evolution,	1,3	CO2		...Do...	
	35			Multi-objective optimization principle,	1,3	CO3,CO4		...Do...	
	36			pareto font,	1,3	CO3		...Do...	
13	37			NSGA.	1,3	CO3,CO4		...Do...	
	38		5	Application to communication	1,3	CO4		...Do...	
	39			dynamic spectrum allocation,	1,3	CO4		...Do...	
14	40			medical, clustering, bioinformatics,	1,3	CO4		...Do...	
	41			Application to finance, control	1,3	CO4		...Do...	
	42			mechanical structure optimization, power system	1,3	CO4		...Do...	

COURSE INFORMATION SHEET

Course Code: **EC576**
Course Title: Micro-Electro Mechanical System
Pre-requisite(s): EC377 Sensor and Transducer
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

This course enables the students:

A.	To develop an ability, enthusiasm critical thinking in microengineering process, materials and design issues
B.	To develop the Fundamental concepts of MEMS technology & their applications in different areas
C.	To develop an ability and understanding of microscale physics for use in designing MEMS devices
D.	To develop an inclination towards electronics system design and manufacturing

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

CO1	Demonstrate knowledge on fundamental principles and concepts of MEMS Technology

CO2	Have an ability to analyze various techniques for building micro-devices in silicon, polymer, metal and other materials
CO3	Have an ability to critically analyze 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 analyze physical, chemical, biological, and engineering principles involved in the design and operation of current and future micro-devices

SYLLABUS

Module-I:
Introduction: The History of MEMS Development ,Intrinsic characteristics of MEMS,MEMS sensors and Design complexity.
Introduction to micro-fabrication: Essential overview of frequently used micro fabrication processes. Thin film deposition techniques ,wafer bonding Silicon Based MEMS processes ,MEMS Materials

Module-II:
Essential Electrical and Mechanical Concepts: Crystal planes & orientations, General Scalazr relation between Tensile stress and strain, Mechanical properties of silicon and related thin films, Flexural Beam bending Analysis ,Dynamic System ,Resonant Frequency and quality factor ,Electromechanical and Direct Analogy in Electrical and Mechanical domain.

Module -III: Sensing and Actuation schemes: Electrostatic Sensors and Actuators, Thermal sensors and actuators, Piezoresistive Sensors, Piezoelectric Sensors and Actuators, Magnetic Actuators.

Module IV: Comparison of Major Sensing and Actuation Methods and their Applications, MEMS Packaging and Integration.

Module V: Case studies for selected MEMS Products: Blood Pressure Sensor, Microphone, Accelerometer Performance and Accuracy

Text Books:

Books/ References:

1)Foundations of MEMS by Chang Liu, Second Edition ,Pearson, ISBN 978-81-317-6475-6
2)RF MEMS and Their Applications**,** Vijay K.Varadan, K.J.Vinoy and K.A.Jose, Wiley India Pvt Ltd.,Wiley India Edition, ISBN 978-81-265-2991-9

Reference Books

1. Marc Madou, Fundamentals of Microfabrication by, CRC Press, 1997.Gregory Kovacs, Micromachined Transducers Sourcebook WCB McGraw-Hill, Boston, 1998.
2. M.-H. Bao, Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes by Elsevier, New York, 2000

Gaps in the SYLLABUS (to meet Industry/Profession requirements) By attending workshop and hands on training in Industry or Institute

POs met through Gaps in the SYLLABUS

Topics beyond SYLLABUS/Advanced topics/Design –Research Paper

POs met through Topics beyond SYLLABUS/Advanced topics/Design

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments

CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	**3**	**3**	**3**	**3**
Assignment Marks	**1**	**2**	**3**	**3**
End Sem Examination Marks	**3**	**3**	**3**	**3**

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3						2	2	
CO2	3	3	3	3	2		2		2	3	1
CO3		3	3		3	2	3	1	2	3	
CO4 4	3	3	3	3							

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

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1
CD2	Tutorials/Assignments	CO1,CO2	CD1
CD3	Seminars	CO3	CD1 and CD2
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids	CO3,CO4	CD5,CD6
CD6	Industrial/guest lectures	CO3,CO4	CD5,CD6.
CD7	Industrial visits/in-plant training	CO1,CO2	CD7
CD8	Self- learning such as use of NPTEL materials and internets	CO1,CO2,CO3,CO4	CD8
CD9	Simulation		

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		1,1	Introduction	TB1, TB2	1, 2	The history of MEMS From the beginning to present	PPT Digi Class/Chock -Board	
1	L2		1,1	Future trends	TB1,TB2	1,2	Expectations in the next 10 years MEMS research field	PPT/Board	
1	L3		1	The intrinsic characteristics of MEMS	TB1	1,2	Miniaturization ,Microelectronics Integration and parallel fabrication	PPT/Board	
2	L4		1	Miniaturization	TB1,	1,2	Scaling law analysis	PPT/Board	
2	L5		1	Monolithic integration	TB1,	1,2	Wafer level process flow and parallel fabrication with precision	PPT/Board	
2	L6		1	MEMS Devices and applications	TB1	1,2	Sensors and Actuators	PPT/Board	
3	L7		1,1	Energy domain s and transducers	TB1,TB2,	1,2	Electrical, Mechanical, Chemical, ,Magnetic, Thermal	PPT/Board	
3	L8		1,	Sensor considerations	TB1	1,2,3	Sensor characteristics	PPT/Board	
3	L9		1	Sensor Noise and Design Complexity	TB1,	2,3	Electronics, Mechanical and noise in circuitry	PPT/Board	
4	L10		1	Actuators Considerations	TB1	2,3	General criteria for Actuator Design and Selections	PPT/Board	
4	L11		2,10,11,1,2	Overview of Micro fabrications	TB1,TB2	2,3	General framework of micro fabrication using silicon wafers,	PPT/Board	
4	L12		2 2	Thin film Deposition Techniques	TB1,TB2	1,2,3	Physical and Chemical Vapour deposition technique	PPT/Board	
5	L13		2,10 1	Isotropic and An isotropic Etching	TB1 TB2	2,3	Plasma and Reactive Ion Etching	PPT/Board	

5	L14		2 2	Wafer dicing & Wafer bonding	TB1,TB2	1,2,3	Different type of wafer bonding & their comparison	PPT/Board	
5	L15		2 2	Silicon based MEMS processes	TB1 TB2	2,3	Three different forms of Silicon	PPT/Board	
6	L16		2 1	MEMS fabrication Technology	TB1 TB2		Surface Bulk and Lithography	PPT/Board	
6	L17		2 1	MEMS material	TB1,TB2	1,2,3	Metal, Insulator, Semiconductor ,Composite material and Polymer	PPT/Board	
6	L18		3	Review of Essential Electrical and Mechanical concepts	TB1	1,2,3	Concept of semiconductor crystal, planes and orientations, stress strain relation	PPT/Board	
7	L19		3	Mechanical design aspects	TB1	1,2,3	Bending of flexural beams under loading conditions, deformation of torsion bars	PPT/Board	
7	L20		3,	Intrinsic stress	TB1	1,2,3	Origin of intrinsic stresses ,Methods for characterization ,control and compensation	PPT/Board	
7	L21		1	Electromechanical Analogies	TB2	1,2,3	Electro mechanical mobility analogies ,Direct Analogy of electrical and Mechanical domains	PPT/Board	
8	L22		3	Dynamics Analysis of MEMS system	TB1,	1,2,3	Dynamic system and governing equations, Resonant frequency and Quality factor	PPT/Board	
8	L23		4 1	Electrostatic sensing and actuation	TB1 TB2	2,3,4	Basic principle ,Advantages and drawback	PPT/Board	
8	L24		4 1	Types of Electrostatic transducer	TB1 TB2	2,3,4	Parallel plate and Inter digital comb drive & its application	PPT/Board	
9	L25		4 1	Thermal sensing and actuation	TB1 TB2	2,3,4	Basic principle and fundamental of Thermal transfer	PPT/Board	

9	L26		4 1	Types of thermal sensor	TB1,TB2	2,3,4	Different types & their applications	PPT/Board	
9	L27		4 1	Thermal Actuation	TB1 TB2	2,3,4	Basic principle And applications	PPT/Board	
10	L28		5 1	Types of thermal actuator	TB1 TB2	2,3,4	Different types & their applications	PPT/Board	
10	L29		6 1	Piezoresistive Sensors	TB1 TB2	2,3,4	Origin and basic principle of Piezoresistivity	PPT/Board	
10	L30		6 1	Piezoresistive sensor materials	TB1 TB2	2,3,4	Metal strain gauges and their comparison	PPT/Board	
11	L31		6 1	Stress analysis of mechanical Elements	TB1 TB2	1,2,3,4	Stress in flexural cantilevers	PPT/Board	
11	L32		6	Stress and deformation in Membrane	TB1	1,2,3,4	Stress analysis in membrane	PPT/Board	
11	L33		6 1	Application of Piezoresistive sensors	TB1 TB2	3,4	Applications with example	PPT/Board	
12	L34		7 1	Piezoelectric Sensing and actuation	TB1 TB2	3,4	Basic principle and Mathematical Description	PPT/Board	
12	L35		7	Cantilever Piezoelectric Actuator	TB1	3,4	Actuator Model	PPT/Board	
12	L36		7	Properties of piezoelectric materials	TB1	1,2,3	Commonly used piezoelectric materials and comparison	PPT/Board	
13	L37		7	Applications of piezoelectric materials	TB1	2,3,4	Types of different sensors and applications	PPT/Board	
13	L38		8 1	Magnetic Actuation	TB1 TB2	2,3,4	Basic principle and essential concepts	PPT/Board	
13	L39		8	Magnetic materials	TB1	2,3,4	Different materials and fabrication of micro magnetic components	PPT/Board	
14	L41		2 9	Packaging & Integration	TB1 TB2	3,4	Integrated options And Encapsulations	PPT/Board	
14	L42		15	Case studies for selected MEMS Products	TB1	3,4	Blood pressure, Microphones, Accelerometer	PPT/Board	

COURSE INFORMATION SHEET

Name of the Subject: Photonic Integrated Circuits
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
Class schedule per week: 03
Class: M. Tech. (Instrumentation)
Semester / Level: I
Name of Teacher:

Course Objectives:
This course enables the students to:

A.	Understand the light-guiding properties in optical waveguides.
B	Understand the operating principle of waveguide devices.
C.	Understand the methods for fabrication of optical waveguides in silicon.
D.	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	Design and integrate complex systems with SoC (System on Chip)
CO4	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.

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).

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.

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.

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.

Text Books:
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 Book:

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): N/A

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

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

CD #	**Course Delivery methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes
CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Assignment Marks	10
Quizzes	30
End SEM Examination Marks	60

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Quizzes	**3**	**3**	**3**	
Assignment Marks			**3**	
End Sem Examination Marks	**3**	**3**	**3**	**3**

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

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	2	2	2	1	1	2
CO2	3	3	3	3	2	2	2	2	2	1	2
CO3	3	3	3	3	3	2	2	2	3	2	2

CO4	3	2	3	3	3	3	3	2	2	2	2

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

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus				PPT Digi Class/Chock -Board	
	L2			Light propagation in optical waveguide	T1,T2			…. do …	
	L3			Symmetrical planar waveguide.	T1,T2			…. do …	
2	L4			Asymmetrical planar waveguide	T1,T2			…. do …	
	L5			Ideal slave waveguide	T1,T2			…. do …	
	L6			3D optical waveguide	T1,T2			…. do …	
3	L7			Analysis of guided modes	T1,T2			…. do …	
	L8			Loss mechanisms in waveguides	T1,T2			…. do …	
	L9			Coupling to optical circuit	T1,T2			…. do …	
4	L10			Waveguide devices	T1,T2			…. do …	
	L11			Directional couplers, Phase-matched and non-phase-matched couplers	T1,T2			…. do …	
	L12			Distributed Bragg reflectors	T1,T2			…. do …	
5	L13			Mach-Zender Interferometers	T1,T2			…. do …	
	L14			Optical phase modulator	T1,T2			…. do …	

	L15			Variable optical attenuators	T1,T2			…. do …	
6	L16			Arrayed Waveguide Gratting (AWG)	T1,T2			…. do …	
	L17			PHASER-based devices and Silicon-on-Insulator (SOI)	T1,T2			…. do …	
	L18			Fabrication of silicon waveguide devices, SOI substrate design	T1,T2			…. do …	
7	L19			Waveguide integration	T1,T2			…. do …	
	L20			Photolithography and Oxidation	T1,T2			…. do …	
	L21			Formation of submicrone waveguides and Silicon doping	T1,T2			…. do …	
8	L22			Metalization, Design verification and device models	T1,T2			…. do …	
	L23			Design and testing infrastructure.	T1,T2			…. do …	
	L24			System on-chip perspective On-chip communication	T1,T2			…. do …	
9	L25			SoC Integration Issues	T1,T2			…. do …	
	L26			On-chip optical interconnect	T1,T2			…. do …	
	L27			PICMOS	T1,T2			…. do …	
10	L28			WADIMOS	T1,T2			…. do …	
	L29			High speed performance of Stand-Alone-Silicon MZM	T1,T2			…. do …	
	L30			Performance of standalone MUX/DEMUX	T1,T2			…. do …	
11	L31			High speed performance of silicon PIC	T1,T2			…. do …	
	L32			Green Integrated Photonics	T1,T2 ,R1			…. do …	
	L33			Non-linear optical losses in integrated Photonics	T1,T2 ,R1			…. do …	
12	L34			Two-Photon Photovoltaic effect	T1,T2 ,R1			…. do …	
	L35			Non-linear Photovoltaic effect	T1,T2 ,R1			…. do …	
	L36			Silicon photonic in Biosensing	T1,T2 ,R1			…. do …	
13	L37			Bioreceptors	T1,T2 ,R1			…. do …	
	L38			Surface chemistry and passivation for biosensing	T1,T2 ,R1			…. do …	
	L39			Optical reflectors Transducers in Porous Silicon	T1,T2 ,R1			…. do …	

14	L40			Photoluminescence Transducers	T1,T2 ,R1			…. do …	
	L41			MOEMS	T1,T2 ,R1			…. do …	
	L42			Photonic bandgap structures	T1,T2 ,R1			…. do …	

COURSE INFORMATION SHEET

Name of the Subject: CMOS Analog VLSI Design
Course code: EC578
Course title: CMOS Analog VLSI Design
Pre-requisite(s): EC209 Analog Circuits (AC)
Co- requisite(s):
Credits: L: 3 T: 0 P: 0 C: **3**
Class period per week: 03
Class: M. Tech.
Semester / Level: 02/01
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	To comprehend CMOS amplifiers.
B.	To grasp Analog CMOS Subcircuits.
C.	To apprehend Frequency Response of CMOS Amplifiers.
D.	To perceive CMOS Differential Amplifier and understand CMOS Operational-Transconductance Amplifier.

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

CO1	Apply different biasing styles to CMOS amplifier circuits.
CO2	Design basic building blocks like current sources, current sinks, current mirrors, voltage references up to layout level.
CO3	Appraise Frequency Response of CMOS Amplifiers.
CO4	Design and aanalyze CMOS differential amplifier and op amp.

SYLLABUS

Module -1:
Design and Analysis of CMOS 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.

Module -2:
Design and Analysis of Analog CMOS 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;

Module -3:
Frequency Response of CMOS 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.

Module -4:
Design and Analysis of CMOS 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.

Module -5:
Design and Analysis of CMOS 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.

Text Books:

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

Reference Book:

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): N/A

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

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

CD #	Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes
CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End SEM Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	**3**	**3**	**3**	
Assignment Marks			**3**	
End Sem Examination Marks	**3**	**3**	**3**	**3**

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	3	3		3	3	3		3	3
CO2	3	1	3	3		3	3	2	1	3	3
CO3	3	1	3	3		3	3	3	1	3	3
CO4	3	1	3	3		3	3	3	1	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		

CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		6	Review of MOS Large-Signal Model, Small-Signal Model	T1	1		PPT Digi Class/Chock -Board	
	L2		6	MOS Transconductance, Determination of the small-signal resistances of diode-connected NMOS and PMOS	T1	1		…. do …	
	L3		6	MOS Amplifier Topologies, Biasing, Realization of Current Sources	T1	1		…. do …	
2	L4		7	Common-Source Stage: CS Core, CS stage With Current-Source Load	T1	1		…. do …	
	L5		7	CS stage with Diode-Connected Load	T1	1		…. do …	
	L6		7	CS Stage with Degeneration, CS Core with Biasing	T1	1		…. do …	
3	L7		7	Common-Gate Stage: CG Stage with Biasing	T1	1		…. do …	
	L8		7	Source Follower: Source Follower Core	T1	1		…. do …	
	L9		7	Source Follower with Biasing	T1	1		…. do …	
4	L10		4	Analog CMOS subcircuits: MOS Diode/ Active resistor	T1, T2	2		…. do …	
	L11		4	Current Sink and Sources	T1, T2	2		…. do …	
	L12		4	Impractical biasing of MOS current sources, Current Mirrors	T1, T2	2		…. do …	
5	L13		4	Application of Current Mirror as Current Steering Circuit	T1, T2	2		…. do …	

	L14		9	illustration of NMOS and PMOS current mirrors in a typical circuit	T1, T2	2		…. do …	
	L15		9	Current and Voltage Reference	T1, T2	2		…. do …	
6	L16		9	Bandgap Reference	T1, T2	2		…. do …	
	L17		9	NMOS cascode current source and its equivalent circuit, PMOS cascode current source	T1, T2	2		…. do …	
	L18		9	Cascode Stage as an Amplifier, CMOS Cascode Amplifier	T1, T2	2		…. do …	
7	L19		11	General Considerations: Relationship Between Transfer Function and Frequency Response	T1	3		…. do …	
	L20		11	Bode Rules, Association of Poles with Nodes, Miller’s Theorem	T1	3		…. do …	
	L21		11	High-Frequency Model of Transistor: High-Frequency Model of MOSFET	T1	3		…. do …	
8	L22		11	Transit Frequency	T1	3		…. do …	
	L23		11	Frequency Response of Common Source Stage: Use of Miller’s Theorem	T1	3		…. do …	
	L24		11	Direct Analysis, Input Impedance	T1	3		…. do …	
9	L25		11	Frequency Response of Common Gate Stage	T1	3		…. do …	
	L26		11	Frequency Response of Source Follower: Input and Output Impedances	T1	3		…. do …	
	L27		11	Frequency Response of Cascode Stage: Input and Output Impedances	T1	3		…. do …	
10	L28		10	General Considerations:	T1	4		…. do …	

				Initial Thoughts, Differential Signals, Differential Pair					
	L29		10	MOS Differential Pair: Qualitative Analysis, Large-Signal Analysis	T1	4		…. do …	
	L30		10	Small-Signal Analysis	T1	4		…. do …	
11	L31		10	Cascode Differential Amplifiers, Common-Mode Rejection	T1	4		…. do …	
	L32		2	Differential Pair with Active Load: Qualitative Analysis, Quantitative Analysis	R1	4		…. do …	
	L33		2	Frequency Response of Differential Pairs	R1	4		…. do …	
12	L34		2	Variability and Mismatch: Systematic Variations Including Proximity Effects	R1	4		…. do …	
	L35		2	Process Variations, Random Variations and Mismatch	R1	4		…. do …	
	L36		2	Analog Layout Considerations: Transistor Layouts, Capacitor Matching, Resistor Layout, Noise Considerations	R1	4		…. do …	
13	L37		6	Performance Analysis of Current-sink CMOS inverting Amplifier, building blocks an CMOS operational-transconductance amplifier and Voltage Operational Amplifier	T2	5		…. do …	

	L38		6	block diagram a general CMOS Operational-Transconductance Amplifier and Voltage Operational Amplifier	T2	5		…. do …	
	L39		6	General Characteristics of the ideal CMOS Operational-Transconductance Amplifier	T2	5		…. do …	
14	L40		6	Division of a two-stage uncompensated CMOS Operational-Transconductance Amplifier into voltage-to-current and current-to-voltage stages	T2	5		…. do …	
	L41		6	Functions of different stages, Characterization of two-stage CMOS Operational-Transconductance Amplifier	T2	5		…. do …	
	L42		6	Slew Rate, CMRR	T2	5		…. do …	
15	L43		6	Design guidelines of two-stage CMOS Operational-Trans conductance Amplifier based on given boundary conditions	T2	5		…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Instrumentation Lab-II
Course Code: **EC583**
Course Title: Instrumentation Lab-II
Pre-requisite(s):
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objective: This course enables the students:

A.	To understand the basics of process control.
B.	To develop basic and advanced pneumatic circuits.
C.	To implement complex control scheme using labview.
D.	To use automation studio for pneumatic devices

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

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	3	2	1	2	2	3	1	2
CO2	2	3	3	2	2	1	2	2	1	2	1
CO3	2	3	3	2	1	2	3	2	1	1	1
CO4	2	3	3	2	1	1	2	1	2	2	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

List of experiments

1. Flow-measurement and control using flow-loop control trainer.
2. Liquid-level measurement and control using level loop control trainer.
3. Presssure control loop using Pressure loop trainer
4. Operation of Cyliners using Advanced Pneumatic setup.
5. Opeartion 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

Text Books:

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):

POs met through Gaps in the SYLLABUS:

Topics beyond SYLLABUS/Advanced topics/Design:

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

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note:* 1** *for fulfilling less than 40%,* **2** *for fulfilling less than 70% and* **3** *for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	3	2	1	2	2	3	1	2
CO2	2	3	3	2	2	1	2	2	1	2	1
CO3	2	3	3	2	1	2	3	2	1	1	1
CO4	2	3	3	2	1	1	2	1	2	2	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		5,6	Demonstration of Experiments	T1, R1, R2	1, 2		PPT Digi Class/Chock-Board	
	L2		9,10	Demonstration of Experiments	T1, R1, R2	1, 2		-do-	
	L3		14, 15	Demonstration of Experiments	T1, R1, R2	1, 2		-do-	
2	L4		5	Experiment 1	T1, R1, R2	1, 2		-do-	
	L5		5	Experiment 1	T1, R1, R2	1, 2		-do-	
	L6		5	Experiment 1	T1, R1, R2	1, 2		-do-	
3	L7		5	Experiment 2	T1, R1, R2	1, 2		-do-	
	L8		5	Experiment 2	T1, R1, R2	1, 2		-do-	
	L9		5	Experiment 2	T1, R1, R2	1, 2		-do-	
4	L10		6	Experiment 3	T1, R1, R2	1, 2		-do-	
	L11		6	Experiment 3	T1, R1, R2	1, 2		-do-	
	L12		6	Experiment 3	T1, R1, R2	1, 2		-do-	
5	L13		6	Experiment 4	T1, R1, R2	1, 2		-do-	
	L14		6	Experiment 4	T1, R1, R2	2, 3		-do-	
	L15		6	Experiment 4	T1, R1, R2	2, 3		-do-	
6	L16		6	Experiment 5	T1, R1, R2	2, 3		-do-	
	L17		6	Experiment 5	T1, R1, R2	2, 3		-do-	
	L18		6	Experiment 5	T1, R1, R2	2, 3		-do-	
7	L19		9	Experiment 6	T1, R1, R2	2, 3		-do-	
	L20		9	Experiment 6	T1, R1, R2	2, 3		-do-	
	L21		9	Experiment 6	T1, R1, R2	2, 3		-do-	
8	L22		9	Experiment 7	T1, R1, R2	2, 3		-do-	
	L23		9	Experiment 7	T1, R1, R2	2, 3		-do-	
	L24		9	Experiment 7	T1, R1, R2	2, 3		-do-	
9	L25		13	Experiment 8	T1, R1, R2	2, 3		-do-	

	L26		13	Experiment 8	T1, R1, R2	2, 3		-do-	
	L27		13	Experiment 8	T1, R1, R2	2, 3		-do-	
10	L28		13	Experiment 9	T1, R1, R2	2, 3		-do-	
	L29		13	Experiment 9	T1, R1, R2	2, 3		-do-	
	L30		13	Experiment 9	T1, R1, R2	2, 3		-do-	
11	L31		14	Experiment 10	T1, R1, R2	3, 4		-do-	
	L32		14	Experiment 10	T1, R1, R2	3, 4		-do-	
	L33		14	Experiment 10	T1, R1, R2	3, 4		-do-	
12	L34		15	Experiment 11	T1, R1, R2	3, 4		-do-	
	L35		15	Experiment 11	T1, R1, R2	3, 4		-do-	
	L36		15	Experiment 11	T1, R1, R2	3, 4		-do-	
13	L37		15	Experiment 12	T1, R1, R2	4		-do-	
	L38		15	Experiment 12	T1, R1, R2	4		-do-	
	L39		15	Experiment 12	T1, R1, R2	4		-do-	
14	L40		10	Examination	T1, R1, R2	4		-do-	

COURSE INFORMATION SHEET

Name of the Subject: Embedded System Lab
Course Code: **EC571**
Course Title: Embedded System Lab
Pre-requisite(s): Fundamental knowledge of VLSI Design, Digital Electronics, signals processing, signal conditioning, microcontroller & microprocessor, I/O Interfacing.
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

A.	Recognize the programmable hardware and its programming.
B.	Develop an ability to write 8051based assembly language/ C programs.
C.	Write the program for different-2 on-chip peripherals to work with Microcontroller.

D.	Develop industrial potentials to develop product in prototype as per demand of market and program for complex chip debugging

Course Outcomes

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

1.	Recognize the concept of programmable hardware and its programming.
2.	Recognize to write 8051based assembly language/ C programs.
3.	Write the efficient program for various on-chip peripherals to work with Microcontroller.
4.	Develop industrial competency to develop product in prototype as per demand of market and capability to debug the complex chip problems.

List of Experiments

1.(a). Assume that ROM space starting at 250H contains "INDIA"; write a program to transfer the bytes into RAM locations starting at 40H.
(b). Write a program to get the X value from P1and transmit toP2, continuously.

2. Design a counter for counting the pulses of an input signal. The pulses to be counted are fed to pin P3.4. Assume an XTAL frequency of 4MHz.

3. (a) Two numbers are stored in registers R0 and R1. Verify if their sum is greater than FFH.
(b) Write programs to (i). add two l6-bit numbers, the numbers are FC45H and 02ECH, and
(ii). Add two 32-bit numbers stored in RAM locations.

4. (a) In a semester, a student has to take six courses. The marks of the student (out of 25) are stored in RAM locations 47H onwards. Find the average marks, and output it on port l.
(b) Ten hex numbers are stored in RAM locations 50H onwards. Write a program to find the biggest number in the set. The biggest number should finally be saved in 60H.

5. (a) Write the assembly code for Intelligent Traffic Light Controllers QTLC) at Zebra Crossing.
(b) Design an Auto Toll Billing System.

6. (a) Design a system using AT89S5l, ADC0848, LM34135, LM336 & POT l0K for reading the output of temperature sensor.
(b) Write assembly code to control the speed of DC and Stepper motors.

7. Generate a square wave with an ON time of 4ms and an OFF time of 10ms on all pins of Port 0. Assume an XTAL frequency of 4MHz.

8. Design a microcontroller based embedded system for agricultural surveillance.

9. Design a system using AT89S5l, ADC0848, LM34135, LM336 & POT l0K for reading the output of temperature sensor.

10. (a) Design a system using AT89S51, DS 1887 & lC7400 and assemble code to control the buzzer.
(b) Write assembly code to control the speed of DC and Stepper motors.

11. Design a microcontroller based embedded system for smart power grids.

12.Write a assemble program to generate saw tooth wave &triangular wave using DAC.

Reference Books:

1. 8051 Microcontroller and Embedded Systems using Assembly and C, 3/E by Muhammad Ali Mazidi, Pearson Publications.

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars

CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	3	3	3	2	3	3
CO2	2	3	3	2	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		5,6	Demonstration of Experiments	R1	1, 2		PPT Digi Class/Chock -Board	
	L2		9,10	Demonstration of Experiments	R1	1, 2		-do-	
	L3		14, 15	Demonstration of Experiments	R1	1, 2		-do-	
2	L4		5	Experiment 1	R1	1, 2		-do-	
	L5		5	Experiment 1	R1	1, 2		-do-	
	L6		5	Experiment 1	R1	1, 2		-do-	
3	L7		5	Experiment 2	R1	1, 2		-do-	
	L8		5	Experiment 2	R1	1, 2		-do-	
	L9		5	Experiment 2	R1	1, 2		-do-	
4	L10		6	Experiment 3	R1	1, 2		-do-	
	L11		6	Experiment 3	R1	1, 2		-do-	
	L12		6	Experiment 3	R1	1, 2		-do-	
5	L13		6	Experiment 4	R1	1, 2		-do-	
	L14		6	Experiment 4	R1	2, 3		-do-	
	L15		6	Experiment 4	R1	2, 3		-do-	
6	L16		6	Experiment 5	R1	2, 3		-do-	
	L17		6	Experiment 5	R1	2, 3		-do-	
	L18		6	Experiment 5	R1	2, 3		-do-	
7	L19		9	Experiment 6	R1	2, 3		-do-	
	L20		9	Experiment 6	R1	2, 3		-do-	
	L21		9	Experiment 6	R1	2, 3		-do-	
8	L22		9	Experiment 7	R1	2, 3		-do-	
	L23		9	Experiment 7	R1	2, 3		-do-	
	L24		9	Experiment 7	R1	2, 3		-do-	
9	L25		13	Experiment 8	R1	2, 3		-do-	
	L26		13	Experiment 8	R1	2, 3		-do-	
	L27		13	Experiment 8	R1	2, 3		-do-	
10	L28		13	Experiment 9	R1	2, 3		-do-	
	L29		13	Experiment 9	R1	2, 3		-do-	

	L30		13	Experiment 9	R1	2, 3		-do-	
11	L31		14	Experiment 10	R1	3, 4		-do-	
	L32		14	Experiment 10	R1	3, 4		-do-	
	L33		14	Experiment 10	R1	3, 4		-do-	
12	L34		15	Experiment 11	R1	3, 4		-do-	
	L35		15	Experiment 11	R1	3, 4		-do-	
	L36		15	Experiment 11	R1	3, 4		-do-	
13	L37		15	Experiment 12	R1	4		-do-	
	L38		15	Experiment 12	R1	4		-do-	
	L39		15	Experiment 12	R1	4		-do-	
14	L40		10	Examination	R1	4		-do-	

COURSE INFORMATION SHEET

Name of the Subject: Optoelectronic Instrumentation Lab
Course Code: **EC573**
Course Title: Optoelectronic Instrumentation Lab
Pre-requisite(s):
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 01
Branch: ECE
Name of Teacher:

Course Objectives

This course enables the students:

A.	To understand the Losses in optical Fiber
B.	To Characteristics of optical fiber source and detector
C.	To understand the analog, Digital TDM, WDM Mux and DMUX
D.	To understand the various fiber optic sensors

Course Outcomes

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

CO1	Compute the Losses in optical Fiber
CO2	Compute the parameters of optical source and detector
CO3	Demonstrate the analog, Digital TDM, WDM Mux and DMUX
CO4	Demonstrate the various fiber optic sensors

List of Compulsory 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.

Text Books:

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

Reference Book:

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:

Topics beyond SYLLABUS/Advanced topics/Design:

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

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment

Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	3	3	3	2	3	3
CO2	2	3	3	2	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		5,6	Demonstration of Experiments	T1, T2	1, 2		PPT Digi Class/Chock -Board	
	L2		9,10	Demonstration of Experiments	T1, T2	1, 2		-do-	
	L3		14, 15	Demonstration of Experiments	T1, T2	1, 2		-do-	
2	L4		5	Experiment 1	T1, T2	1, 2		-do-	

	L5		5	Experiment 1	T1, T2	1, 2		-do-	
	L6		5	Experiment 1	T1, T2	1, 2		-do-	
3	L7		5	Experiment 2	T1, T2	1, 2		-do-	
	L8		5	Experiment 2	T1, T2	1, 2		-do-	
	L9		5	Experiment 2	T1, T2	1, 2		-do-	
4	L10		6	Experiment 3	T1, T2	1, 2		-do-	
	L11		6	Experiment 3	T1, T2	1, 2		-do-	
	L12		6	Experiment 3	T1, T2	1, 2		-do-	
5	L13		6	Experiment 4	T1, T2	1, 2		-do-	
	L14		6	Experiment 4	T1, T2	2, 3		-do-	
	L15		6	Experiment 4	T1, T2	2, 3		-do-	
6	L16		6	Experiment 5	T1, T2	2, 3		-do-	
	L17		6	Experiment 5	T1, T2	2, 3		-do-	
	L18		6	Experiment 5	T1, T2	2, 3		-do-	
7	L19		9	Experiment 6	T1, T2	2, 3		-do-	
	L20		9	Experiment 6	T1, T2	2, 3		-do-	
	L21		9	Experiment 6	T1, T2	2, 3		-do-	
8	L22		9	Experiment 7	T1, T2	2, 3		-do-	
	L23		9	Experiment 7	T1, T2	2, 3		-do-	
	L24		9	Experiment 7	T1, T2	2, 3		-do-	
9	L25		13	Experiment 8	T1, T2	2, 3		-do-	
	L26		13	Experiment 8	T1, T2	2, 3		-do-	
	L27		13	Experiment 8	T1, T2	2, 3		-do-	
10	L28		13	Experiment 9	T1, T2	2, 3		-do-	
	L29		13	Experiment 9	T1, T2	2, 3		-do-	
	L30		13	Experiment 9	T1, T2	2, 3		-do-	
11	L31		14	Experiment 10	T1, T2	3, 4		-do-	
	L32		14	Experiment 10	T1, T2	3, 4		-do-	
	L33		14	Experiment 10	T1, T2	3, 4		-do-	
12	L34		15	Experiment 11	T1, T2	3, 4		-do-	
	L35		15	Experiment 11	T1, T2	3, 4		-do-	
	L36		15	Experiment 11	T1, T2	3, 4		-do-	
13	L37		15	Experiment 12	T1, T2	4		-do-	

	L38		15	Experiment 12	T1, T2	4		-do-	
	L39		15	Experiment 12	T1, T2	4		-do-	
14	L40		10	Examination	T1, T2	4		-do-	

III-Semester

COURSE INFORMATION SHEET

Name of the Subject: Industrial Instrumentation
Course Code: **EC609**
Course Title: Industrial Instrumentation
Pre-requisite(s): EC518 Advanced Instrumentation System
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	Explain the role of instrumentation in Industrial Automation and Control
B.	To classify the various control schemes used in industry for process control
C.	To discuss the working of PLC and CNC machines for controlling various Industrial processes
D.	To 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	Explain the role of various instruments used in process industry.
CO2	Analyze 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

SYLLABUS

Module -1:
Industrial Instrumentation:
Introduction to Industrial Automation and Control, Architecture, Sensors for Industrial measurement Measurement of Temperature, Pressure, Force, Displacement, Speed, Flow, Level, Humidity and PH. Signal conditioning and processing, Estimation of Errors and Calibration

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

Module -3:
Programmable Logic 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

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.

Module -5:
Introduction to Field bus Network:
Networking of sensors, Actuators and field bus, Communication protocol, Production control

Text Books:

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 Book:

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.

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
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CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	2	3	3	3	2	3	3
CO2	2	2	2	2	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Explain the syllabus if detail, list course objectives and outcomes.	T1			PPT Digi Class/Chock -Board	
	L2			Introduction to Industrial Automation and Control	T1			…. do …	
	L3			Architecture of Industrial Automation Systems	T1			…. do …	
2	L4			Introduction to sensors and measurement systems, Temperature measurement	T1			…. do …	
	L5			Pressure, Force, and Displacement measurements	T1			…. do …	
	L6			speed measurement, Flow Measurement	T1			…. do …	
3	L7			Measurement of level, humidity, pH	T1			…. do …	

	L8			Signal Conditioning and Processing	T1			…. do …	
	L9			Estimation of errors and Calibration	T1			…. do …	
4	L10			Introduction to Process Control, Control Schemes	T2			…. do …	
	L11			P-- I -- D Control	T2			…. do …	
	L12			Controller Tuning	T2			…. do …	
5	L13			Implementation of PID Controllers	T2			…. do …	
	L14			Feedforward and Ratio Control	T2			…. do …	
	L15			Predictive Control,	T2			…. do …	
6	L16			Control of Systems with Inverse Response	T2			…. do …	
	L17			Cascade Control, Overriding Control,	T2			…. do …	
	L18			Selective Control, Split Range Control	T2			…. do …	
7	L19			Introduction to Sequence Control, PLCs and Relay Ladder Logic,	T2			…. do …	
	L20			PLC Architecture,	T2			…. do …	
	L21			Scan Cycle, RLL Syntax	T2			…. do …	
8	L22			Structured Design Approach	T2			…. do …	
	L23			RLL Programming Examples	T2			…. do …	
	L24			RLL Programming Examples ctd.	T2			…. do …	
9	L25			Introduction to CNC Machines tools	T2			…. do …	
	L26			Analysis of a control loop	T2			…. do …	
	L27			Analysis of a control loop cts	T2			…. do …	
10	L28			Introduction to Actuators	T2			…. do …	
	L29			Flow Control Valves	T2			…. do …	
	L30			Hydraulic Actuator Systems	T2			…. do …	
11	L31			Pumps and Motors	T2			…. do …	
	L32			Proportional and Servo Valves	T2			…. do …	
	L33			Pneumatic Control Systems	T2			…. do …	
12	L34			Electric Drives : Introduction, Energy Saving with Adjustable Speed Drives	T2			…. do …	
	L35			Step motors : Principles, Construction and Drives	T2			…. do …	
	L36			AC Motor Drives and Adjustable speed Drives	T2			…. do …	
13	L37			The Fieldbus System	T3			…. do …	
	L38			Networking of Sensors	T3			…. do …	
	L39			Actuators and Controllers	T3			…. do …	
14	L40			The Fieldbus Communication Protocol	T3			…. do …	
	L41			Introduction to Production control System	T3			…. do …	
	L42			Concluding Lecture	T3			…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Biomedical Signal Processing
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 (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objectives
This course enables the students:

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	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 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.	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

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)

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.

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)

Module-5
Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.

References:

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 and Design Handbook, Volume I", McGraw Hill, 2009._
4. D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005.
5. Katarzyn J. Blinowska, Jaroslaw Zygierewicz, "Practical Biomedical Signal Analysis Using MATLAB", 1st Edition, CRC Press, 2011.

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3	1	1	1	1	1	2	3	3
CO2	3	3	3	1	2	2	2	2	2	3	3
CO3	3	3	3	2	2	2	2	2	2	3	3
CO4	3	3	3	2	2	2	2	2	2	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

Lecture Wise Lesson Planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1		1	Acquisition, Generation of Bio-signals,		1		PPT Digi Class/Chock -Board	
	L2		1	Origin of bio-signals, Types of bio-signals,		1		…. do …	
	L3		1	Study of diagnostically significant bio-signal parameters,		1		…. do …	
2	L4		1	Electrodes for bio-physiological		1		…. do …	

				sensing and conditioning,					
	L5		1	Electrode-electrolyte interface, polarization,		1		…. do …	
	L6		1	electrode skin interface and motion artefact,		1		…. do …	
3	L7		1	biomaterial used for electrode,		1		…. do …	
	L8		1	Types of electrodes (body surface, internal, array of electrodes, microelectrodes),		1		…. do …	
	L9		1	Practical aspects of using electrodes,		1		…. do …	
4	L10		1	Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing,		1		…. do …	
	L11		1	Digital filtering		2		…. do …	
	L12		2	Biomedical signal processing by Fourier analysis,		2		…. do …	
5	L13		2	Biomedical signal processing by Fourier analysis,		2		…. do …	
	L14		2	Biomedical signal processing by wavelet (time frequency) analysis,		2		…. do …	
	L15		2	Biomedical signal processing by wavelet (time frequency) analysis,		2		…. do …	
6	L16		2	Biomedical signal processing by wavelet (time frequency) analysis,		2		…. do …	
	L17		2	Analysis (Computation of signal parameters that are diagnostically significant)		2		…. do …	
	L18		2	Analysis (Computation of signal parameters that are		2		…. do …	

				diagnostically significant)					
7	L19		2	Analysis (Computation of signal parameters that are diagnostically significant)		2		…. do …	
	L20		3	Classification of signals and noise,		2		…. do …	
	L21		3	Spectral analysis of deterministic, stationary random signals and non-stationary signals,		2		…. do …	
8	L22		3	Spectral analysis of deterministic, stationary random signals and non-stationary signals,		2		…. do …	
	L23		3	Coherent treatment of various biomedical signal processing methods and applications.		2		…. do …	
	L24		3	Coherent treatment of various biomedical signal processing methods and applications.		2		…. do …	
9	L25		4	Principal component analysis, Correlation and regression,		3		…. do …	
	L26		4	Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis (MRA) and wavelets,		3		…. do …	
	L27		4	Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis (MRA) and wavelets,		3		…. do …	
10	L28		4	Principal component analysis (PCA),		3		…. do …	

	L29		4	Principal component analysis (PCA),		3		…. do …	
	L30		4	Principal component analysis (PCA),		3		…. do …	
11	L31		4	Independent component analysis (ICA)		3		…. do …	
	L32		4	Independent component analysis (ICA)		3		…. do …	
	L33		4	Independent component analysis (ICA)		3		…. do …	
12	L34		5	Pattern classification– supervised and unsupervised classification,		4		…. do …	
	L35		5	Pattern classification– supervised and unsupervised classification,		4		…. do …	
	L36		5	Neural networks,		4		…. do …	
13	L37		5	Neural networks,		4		…. do …	
	L38		5	Neural networks,		4		…. do …	
	L39		5	Support vector Machines,		4		…. do …	
14	L40		5	Support vector Machines,		4		…. do …	
	L41		5	Support vector Machines,		4		…. do …	
	L42		5	Hidden Markov models.		4		…. do …	
15	L43		5	Hidden Markov models.		4		…. do …	
	L44		5	Hidden Markov models.		4		…. do …	
	L45		5	Examples of biomedical signal classification examples.		4		…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Virtual Instrumentation
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 (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objective

This course enables the students to:

A.	Define the concept of the virtual instruments
B.	Analyse the analogue and digital measurement principles
C.	Show the data acquisition operations using LabVIEW
D.	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:

1.	Explain the concept of virtual instrument and components
2.	Recognize the dataflow in the graphical programming environment
3.	Determine the device driver and interface buses to interface an instrument
4.	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.

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.

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

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.

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

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

Note:* *1* *for fulfilling less than 40%,* *2* *for fulfilling less than 70% and* *3* *for fulfilling above 70 %

Indirect Assessment

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	1	2	2	1	1	2
CO2	3	3	3	3	3	1	1	1	1	1	2
CO3	3	3	2	2	3	2	2	2	1	2	2
CO4	3	3	2	2	3	1	2	1	2	2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, CO2, CO3	CD1
CD2	Tutorials/Assignments		CO3, CO4	CD1
CD3	Seminars		CO4	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets		CO4	
CD9	Simulation			

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus				PPT Digi Class/Chock -Board	
	L2		1,2	Introduction and Historical perspective, Need of VI,	T1	1, 2		-do-	
	L3		1,2	Define VI, Advantages of VI	T1	1, 2		-do-	
2	L4		1,3	Block diagram & architecture of VI,	T1	1, 2		-do-	
	L5		1,3	Data flow techniques, Graphical programming in data flow,	T1	1, 2		-do-	

	L6		1	Comparison with conventional programming.	T1	1, 2		-do-	
3	L7		3,4	VIS and sub-VIS,	T1	1, 2		-do-	
	L8		5	Creating sub-VI	T1	1, 2		-do-	
	L9		6	Loops, Case structure	T1	1, 2		-do-	
4	L10		6	sequence structures, formula nodes	T1	1, 2		-do-	
	L11		7	Arrays, Clusters	T1	1, 2		-do-	
	L12		7	Arrays, Clusters	T1	2, 3		-do-	
5	L13		8	charts, graphs	T1	2, 3		-do-	
	L14		8	charts, graphs	T1	2, 3		-do-	
	L15		9	String & file input and output graphical Programming in data flow.	T1	2, 3		-do-	
6	L16		2, 10	Data Acquisition, ADC, DAC, DIO	T1	2, 3		-do-	
	L17		10, 6	Counters and timers,	T1	2, 3		-do-	
	L18		10, 6	Timing, Interrupts, DMA, MAX, NI-DAQmx, PXI, RTSI	T1	2, 3		-do-	
7	L19		10, 6	SCC, SCXI, SISTA USB, RS232C/ RS485, VISA	T1	2, 3		-do-	
	L20		10	GPIB System buses, Interface buses	T1	2, 3		-do-	
	L21		11	Analog and Digital I/O, NI-DAQmx Tasks,	T1	2, 3		-do-	
8	L22		11	DAQmx Timing and Trigger	T1	2, 3		-do-	
	L23		12	Networking basics, VISA	T1	2, 3		-do-	
	L24		13	Local, Global, and Shared Variables,	T1	2, 3		-do-	
9	L25		13	Property Nodes, Invoke Nodes,	T1	2, 3		-do-	
	L26		13	Event-Driven Programming: The Event Structure,	T1	2, 3		-do-	
	L27		13	Type Definitions,	T1	3, 4		-do-	
10	L28		13	The State Machine and Queued Message Handler,	T1	3, 4		-do-	
	L29		13	Messaging and Synchronization,	T1	3, 4		-do-	
	L30		13	Structures for Disabling Code.	T1	3, 4		-do-	
11	L31		18	Applications of VI.	T2	3, 4		-do-	
	L32		11	Advanced analysis tools,	T2	3, 4		-do-	

	L33		11	Advanced analysis tools,	T2	3, 4		-do-	
12	L34		11	Correlation methods,	T2	3, 4		-do-	
	L35		11, 12	windowing & filtering,	T2	3, 4		-do-	
	L36		11, 12	windowing & filtering,	T2	3, 4		-do-	
13	L37		18	Application in Process Control projects,	T3	3, 4		-do-	
	L38		18	Application in Process Control projects,	T3	3, 4		-do-	
	L39		20	Data Visualization, Imaging, and Sound	T3	3, 4		-do-	
14	L40		20	Data Visualization, Imaging, and Sound	T3	3, 4		-do-	
	L41		22	Embedding LabVIEW for Linux in a Virtual Machine	T3	3, 4		-do-	
	L42		22	Embedding LabVIEW for Linux in a Virtual Machine	T3	3, 4		-do-	

COURSE INFORMATION SHEET

Name of the Subject: Instrumentation System design
Course Code: **EC612**
Course Title: Instrumentation System design
Pre-requisite(s): EC518 Advanced Instrumentation System (AIS)
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	Explain the concept and need of Signal Conditioning and impart knowledge on the designing of signal conditioning circuit for different application.
B.	To state the design of signal conditioners for different applications
C.	To framework the design of DAS, DATA Loggers and transmitters
D.	To 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 the working of instrumentation systems for the measurement and control of any process variable.
CO2	Able to design the signal conditioning circuit for given application.

CO3	Architect and design DAS, DATA Loggers and transmitter
CO4	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.

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.
.

Module -3:
Design of Data Acquisition system and 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**.**

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

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,

Text Books:
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 Book:
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:

S. No.	Course Delivery Methods

CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	1	2	2	1	1	2
CO2	3	2	3	3	3	1	1	1	1	1	2
CO3	3	2	2	2	3	2	2	2	1	2	2
CO4	3	3	2	2	3	1	2	1	2	2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Discuss the syllabus, list the various course objectives and outcomes	T1			PPT Digi Class/Chock -Board	
	L2			Review of Instrumentation System, Sensing Elements	T1			…. do …	
	L3			Signal Conditioners	T1			…. do …	
2	L4			Transmitters, and Data presentation,	T1			…. do …	
	L5			Controllers, Actuators and Final Control Elements.	T1			…. do …	
	L6			Controllers, Actuators and Final Control Elements.	T1			…. do …	
3	L7			Instrumentation system for measuring Temperature,	T1			…. do …	
	L8			Instrumentation system for measuring Level and Pressure	T1			…. do …	
	L9			Instrumentation system for measuring flow	T1			…. do …	
4	L10			Principles of signal conditioning, signal level and bias change,	T1			…. do …	
	L11			linearization, conversion,	T1			…. do …	
	L12			filtering and impedance matching, loading,	T1			…. do …	

5	L13			Design of passive signal conditioners, Bridge circuits, RC filters,	T1			…. do …	
	L14			Design of active signal conditioners, OPAMPS circuits,	T1			…. do …	
	L15			Design of digital signal conditioners, ,	T1			…. do …	
6	L16			Comparator, Implementation of Boolean functions	T1			…. do …	
	L17			Design of Bipolar DAC	T1			…. do …	
	L18			ADC, S/H for different applications	T1			…. do …	
7	L19			Microprocessor/microcontroller based DAS				…. do …	
	L20			Design of Microprocessor/microcontroller based DAS and DATA logger,				…. do …	
	L21			Design of Microprocessor/microcontroller based DAS and DATA logger contd.				…. do …	
8	L22			Two wire and 4 wire transmitters				…. do …	
	L23			temperature transmitters,				…. do …	
	L24			Level transmitters,				…. do …	
9	L25			pressure transmitters,				…. do …	
	L26			flow transmitters,				…. do …	
	L27			Design of Smart transmitters				…. do …	
10	L28			Design of on/off controller using OPAMP,				…. do …	
	L29			design of Microprocessor/Microcontroller based PID controller				…. do …	
	L30			design of Microprocessor/Microcontroller based PID controller contd.				…. do …	
11	L31			Design of Alarm and Annunciation circuits,				…. do …	
	L32			Design of PLC				…. do …	

	L33			Design of PLC contd.				…. do …	
12	L34			Design of PLC contd.				…. do …	
	L35			Design of configurable sequential controller using PLDs				…. do …	
	L36			Design of configurable sequential controller using PLDs contd.				…. do …	
13	L37			Comparison of Pneumatic, Hydraulic and Electrical/Electronic instrumentation systems and their selection for present process industry requirement,				…. do …	
	L38			Pneumatic Cylinders				…. do	
	L39			Relays and Solenoids				…. do	
14	L40			Control Valve and their Selection,				…. do	
	L41			Pumps,				…. do	
	L42			Motors				…. do	

COURSE INFORMATION SHEET

Name of the Subject: Applied Industrial Instrumentation
Course Code: **EC613**
Course Title: Applied Industrial Instrumentation
Pre-requisite(s): EC313 Electronic Measurement, EC377 sensor and Transducer
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:
Course Objectives:
This course enables the students:

A.	Explain the role of instrumentation in Industrial Automation and Control
B.	To classify the various control schemes used in industry for process control
C.	To discuss the working of PLC and CNC machines for controlling various Industrial processes
D.	To outline the construction and working of commonly used Actuators and Final Control Elements in industry.
E.	To state and outline the networking of sensors and actuators.

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

CO1	Explain the role of various instruments used in process industry.
CO2	Analyze 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.
CO5	Architect and design networking of sensors and actuators on field bus

SYLLABUS

Module -1:

Industrial Instrumentation:

Introduction to Industrial Automation and Control, Architecture, Sensors for Industrial measurement, Measurement of Temperature, Pressure, Force, Displacement, Speed, Flow, Level, Humidity and PH. Signal conditioning and processing, Estimation of Errors and Calibration.

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

Module -3:

Programmable Logic 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

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.

Module -5:

Introduction to Field bus Network:

Networking of sensors, Actuators and field bus, Communication protocol, Production control

Text Books:

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 Book:

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.

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars

CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1		1	1	1	1	1	1
CO2	3	3	1	2		1	2	2	1	1	1
CO3	3	3	2	2		1	2	2	2	1	1
CO4	3	3	2	2	1	2	2	2	2	2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1

CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Lecture Wise Lesson Planning Details:

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1				T1			PPT Digi Class/Chock -Board	
	L2			Introduction to Industrial Instrumentation	T1			…. do …	
	L3			Measurement of Force.	T1			…. do …	
2	L4			Measurement of Torque	T1			…. do …	
	L5			Measurement of Velocity, Acceleration,	T1			…. do …	
	L6			Measurement of Pressure	T1			…. do …	
3	L7			Measurement of, Temperature	T1			…. do …	
	L8			Measurement of Flow, Level,	T1			…. do …	
	L9			Measurement of Viscosity, Humidity & Moisture	T1			…. do …	
4	L10			Measurements in thermal power plant	T2			…. do …	
	L11			Installation and maintenance of Instruments used for the measurement of fuel flow, Air flow, Drum level in thermal power plant.	T2			…. do …	
	L12			Installation and maintenance of Instruments used for the measurement of Steam pressure,	T2			…. do …	

				Steam temperature and other parameters in thermal power plant					
5	L13			Analyzers, Dissolved Oxygen Analyzers	T2			…. do …	
	L14			Flue gas Oxygen Analyzers	T2			…. do …	
	L15			pH measurement-	T2			…. do …	
6	L16			Coal/Oil Analyzer –	T2			…. do …	
	L17			Pollution Controlling Instruments	T2			…. do …	
	L18			Pollution Controlling Instruments	T2			…. do …	
7	L19			Signal conditioning and processing	T2			…. do …	
	L20			Estimation of Errors and Calibration	T2			…. do …	
	L21			On /off control, PID control	T2			…. do …	
8	L22			Controller Tuning	T2			…. do …	
	L23			Implementation of PID Controllers	T2			…. do …	
	L24			feed forward control	T2			…. do …	
9	L25			ratio control, Predictive Control	T2			…. do …	
	L26			Control of Systems with Inverse Response	T2			…. do …	
	L27			Cascade Control	T2			…. do …	
10	L28			Overriding Control	T2			…. do …	
	L29			Selective Control, Split Range Control	T2			…. do …	
	L30			Flow control valves	T2			…. do …	
11	L31			Hydraulic actuators	T2			…. do …	
	L32			Pumps and Motors, Servo valves	T2			…. do …	
	L33			Pneumatic controllers	T2			…. do …	

12	L34			Electric drives	T2			…. do …	
	L35			DC motor drives	T2			…. do …	
	L36			Induction motor drives	T2			…. do …	
13	L37			adjustable speed and servo drives	T3			…. do …	
	L38			Networking of sensors	T3			…. do …	
	L39			Actuators and field bus	T3			…. do …	
14	L40			Communication protocol	T3			…. do …	
	L41			Production control	T3			…. do …	
	L42			Concluding Lecture	T3			…. do …	

COURSE INFORMATION SHEET

Name of the Subject: Adaptive System and Signal Processing
Course Code: **EC614**
Course Title: Adaptive Signal Processing
Pre-requisite(s): EC 305 Signal Processing Techniques
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objectives:

This course aims is

1	To help to understand the concept of adaptive systems and its characteristics.
2	To impart knowledge on adaptive algorithms and adaptive filter for optimal control.
3	To help to 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	To help to design and apply adaptive filters for real- time applications.

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 filters through estimation of different parameters of stationary random process clearly considering practical application specifications. Analyse convergence and stability issues associated with adaptive filter design
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.

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.

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

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.

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.

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

Text Books:

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

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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids

CDM 6	Industrial/guest lectures
CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note: 1** for fulfilling less than 40%, **2** for fulfilling less than 70% and **3** for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

	Program Outcomes										
Course Outcome #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	1		1	1	1	1	1	1
CO2	3	2	1	2		1	2	2	1	1	1
CO3	3	3	2	2		1	2	2	2	1	1
CO4	3	3	2	2	1	2	2	2	2	2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Lecture Wise Lesson Plan Details

Week No.	Lect. No.	Tentative Date	Module No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	1		1	Introduction to adaptive systems	1	CO1		PPT and Chock-Board	
	2			adaptive systems - definitions and characteristics	1	CO1		...Do...	
	3			Adaptive linear combiner	1,3	CO1		...Do...	
2	4			input signal and weight vector,	1,3	CO1		...Do...	
	5			the performance function,	1	CO1		...Do...	
	6			gradient andminimum mean square error,	1,3	CO1		...Do...	

3	7		2	LMS,	1,3	CO1		...Do...	
	8			NLMS, sign-error, sign-data LMS	1,3	CO1		...Do...	
	9			FXLMSalgorithms,	1,3	CO1		...Do...	
4	10			Transform domain LMS.	1,3	CO1		...Do...	
	11			Recursive least square algorithm,	1,3	CO1		...Do...	
	12			windowed RLS, computational complexity,	1,3	CO1		...Do...	
5	13			Block adaptive filter(time and DFT domains)	1	CO1		...Do...	
	14			adaptive lattice filters,	1	CO1		...Do...	
	15			Adaptive filters with Orthogonal signals	1	CO1		...Do...	
6	16			Kalman Filter	1	CO1		...Do...	
	17			Kalman Filter	1	CO2		...Do...	
	18		3	Adaptive model control	1	CO2, CO3		...Do...	
7	19			Adaptive inverse control	1	CO2, CO3		...Do...	
	20			model reference controls	1	CO2, CO3		...Do...	
	21			Plant noise and the filtered-X LMS Algorithm	1	CO2, CO3		...Do...	
8	22			Inverse control using Filtered-X LMS algorithm.	1	CO2, CO3		...Do...	
	23		4	Adaptive array,	1,2	CO2		...Do...	
	24			adaptive beam forming	1,2	CO2		...Do...	
9	25			Sidelobe cancellation	1,2	CO2, CO3		...Do...	
	26			Beam forming with a Pilot signal,	1,2	CO2, CO3		...Do...	
	27			Narrowband experiments	1	CO2, CO3			
10	28			Broadband experiments,	1	CO2, CO3		...Do...	
	29			Characteristics of receiving arrays,	1	CO2		...Do...	
	30			Griffiths LMS Beamformer	1	CO2, CO3		...Do...	
11	31			Adaptive beamformer with pole and zeros	1	CO2		...Do...	
	32			signal cancellation and distortion.	1	CO2		...Do...	
	33		5	Adaptive Noise Cancelling,	1	CO3		...Do...	
12	34			Adaptive Line Enhancement	1	CO3		...Do...	
	35			System identification	1	CO3		...Do...	
	36			Channel equalization	1	CO3		...Do...	
13	37			System identification	1	CO4		...Do...	
	38			Channel equalization	1	CO4		...Do...	
	39			Cancelling antenna side lobe Interference	1	CO4		...Do...	
14	40			Adaptive self-tuning filter	1	CO4		...Do...	

COURSE INFORMATION SHEET

Name of the Subject: Modern Instrumentation System
Course Code: **EC549**
Course Title: Modern Instrumentation System
Pre-requisite(s):
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	The knowledge about Silicon Sensors and its application for measurement of pressure, level, flow and Temperature. Biosensors
B.	The knowledge about DAS, Controller and Components involved in implementation of Automation system
C.	The knowledge about Distributed Control Systems and Artificial Intelligent Based Systems
D.	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 and Artificial Intelligent Based Systems
CO4	Gain knowledge of about microcontroller and Telemetry

SYLLABUS

Module – 1 :

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.

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.

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.

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.

Module –6 :

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.

Module –7 :

Introduction to telemetry, telemetry links, signal characterisations in time and frequency domain, analog and digital signals. Data transmission systm,Advantages and disadvantages of digital transmission over analog one. Time division multiplexing ,pulse modulation, Digital modulation ,Pulse code modulation and Modem.

Text Books:

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

Ref. 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:

S. No.	Course Delivery Methods
CDM 1	Lecture by use of boards/LCD projectors/OHP projectors
CDM 2	Quizzes
CDM 3	Assignments/Seminars
CDM 4	Mini projects/Projects
CDM 5	Laboratory experiments/teaching aids
CDM 6	Industrial/guest lectures

CDM 7	Industrial visits/in-plant training
CDM 8	Self- learning such as use of NPTEL materials and internets
CDM 9	Simulation

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	2	2	2	2
Assignment Marks	1	1	1	1
End Sem Examination Marks	3	3	3	3

***Note:* 1** *for fulfilling less than 40%,* **2** *for fulfilling less than 70% and* **3** *for fulfilling above 70 %*

Indirect Assessment

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

Mapping between Course Outcomes and Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3		3	1	3	3	3	3
CO2	3	3	2	3		3	1	3	3	3	3
CO3	2	2	3	3	1	3	1	2	3	3	3
CO4	3	3	2	3	2	3	1	3	3	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, CO2, CO3	CD1
CD2	Tutorials/Assignments		CO3, CO4	CD1

CD3	Seminars		CO4	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets		CO4	
CD9	Simulation			

Lecture wise Lesson planning Details.

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Tentative Date	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Actual Content covered	Methodology used	Remarks by faculty if any
1	L1			Illustration of course objectives and course outcomes, besides detailed introduction of the course syllabus				PPT Digi Class/Chock -Board	
	L2		1,2	Review of Instrumentation System, Sensing Elements, and Signal Conditioners	T1	1, 2		-do-	
	L3		1,2	Transmitters, and Data presentation	T1	1, 2		-do-	
2	L4		1,3	Controllers	T1	1, 2		-do-	
	L5		1,3	Actuators and Final Control Elements	T1	1, 2		-do-	
	L6		1	Instrumentation system for measuring: Temperature	T1	1, 2		-do-	
3	L7		3,4	Instrumentation system for measuring: Level	T1	1, 2		-do-	
	L8		5	Instrumentation system for measuring: Pressure	T1	1, 2		-do-	
	L9		6	Instrumentation system for measuring: flow	T1	1, 2		-do-	
4	L10		6	Principles of signal conditioning	T1	1, 2		-do-	
	L11		7	signal level and bias change,	T1	1, 2		-do-	
	L12		7	linearization, conversion filtering	T1	2, 3		-do-	
5	L13		8	impedance matching, loading	T1	2, 3		-do-	
	L14		8	Design of passive signal conditioners	T1	2, 3		-do-	
	L15		9	Bridge circuits, RC filters	T1	2, 3		-do-	

6	L16		2, 10	Design of active signal conditioners	T1	2, 3		-do-	
	L17		10, 6	OPAMPS circuits,	T1	2, 3		-do-	
	L18		10, 6	Design of digital signal conditioners	T1	2, 3		-do-	
7	L19		10, 6	Comparator	T1	2, 3		-do-	
	L20		10	Bipolar DAC, ADC	T1	2, 3		-do-	
	L21		11	S/H for different applications	T1	2, 3		-do-	
8	L22		11	Design of Microprocessor/microcontroller based DAS	T1	2, 3		-do-	
	L23		12	Design of DATA logger	T1	2, 3		-do-	
	L24		13	Two wire and 4 wire transmitters,	T1	2, 3		-do-	
9	L25		13	temperature transmitters	T1	2, 3		-do-	
	L26		13	Level transmitters, pressure transmitters	T1	2, 3		-do-	
	L27		13	flow transmitters	T1	3, 4		-do-	
10	L28		13	Design of Smart transmitters**.**	T1	3, 4		-do-	
	L29		13	Design of on/off controller using OPAMP	T1	3, 4		-do-	
	L30		13	design of Microprocessor/Microcontroller based PID controller	T1	3, 4		-do-	
11	L31		18	Design of Alarm and Annunciation circuits	T2	3, 4		-do-	
	L32		11	Design of PLC	T2	3, 4		-do-	
	L33		11	Design of configurable sequential controller using PLDs	T2	3, 4		-do-	
12	L34		11	Comparison of Pneumatic	T2	3, 4		-do-	
	L35		11, 12	Hydraulic and Electrical instrumentation systems	T2	3, 4		-do-	
	L36		11, 12	Hydraulic and Electronic instrumentation systems	T2	3, 4		-do-	
13	L37		18	Electrical/Electronic instrumentation systems selection for present process industry requirement	T3	3, 4		-do-	
	L38		18	Control Valve and their Selection	T3	3, 4		-do-	

	L39		20	Pumps and their Selection	T3	3, 4		-do-	
14	L40		20	Motors and their Selection	T3	3, 4		-do-	

COURSE INFORMATION SHEET

Course code: EC617
Course title: Nanoelectronic Devices & Materials
Pre-requisite(s): EC201 Electronic Devices
Co- requisite(s):
Credits: L: 0 T: 0 P: 0 C: **2**
Class period per week: 0
Class: M. Tech.
Semester / Level: 3/6
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	The objective of this course is to present the state of the art in the areas of semiconductor device physics and materials technology to enable the Nanoelectronics.
B.	The fundamentals of classical CMOS technology will be discussed and the issue in scaling MOSFET in the sub-100nm regime will be elaborated.
C.	In this context the need for non-classical transistors with new device structure and nanomaterials will be elucidated.
D.	The issues in realizing Germanium and compound semiconductor MOSFET will be presented.
E.	Extensive materials characterization techniques will also be discussed, which help in engineering high performance transistors.

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

CO1	Infer the semiconductor device physics and materials technology.
CO2	Interpret The fundamentals of classical CMOS technology and the issue in scaling MOSFET in the sub-100nm regime.
CO3	Appraise the theory of non-classical transistors with new device structure and nanomaterials.
CO4	Infer the issues in realizing Germanium and compound semiconductor MOSFET and materials characterization.

SYLLABUS

Module – 1:
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 Non-classical MOS transistor.

Module – 2:
MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO2 vs High-k gate dielectrics. Integration issues of high-k.

Interface states, bulk charge, band offset, stability, possible candidates, CV and IV techniques, Metal gate transistor: Motivation, requirements, Integration Issues., Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot.

Module – 3:

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 – 4:

Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS. Compound semiconductors - material properties, MESFETs Compound semiconductors MOSFETs in the context of channel quantization and strain, Hetero structure MOSFETs exploiting novel materials, strain, quantization, Synthesis of Nanomaterials: CVD, Nucleation and Growth, ALD, Epitaxy, MBE.

Model – 5:

Compound semiconductor hetero-structure 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.

Text Books:

1. Fundamentals of Modern VLSI Devices, Y. Taur and T. Ning, Cambridge University Press.
2. Silicon VLSI Technology, Plummer, Deal, Griffin, Pearson Education India.
3.

Reference Book:

1. 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): N/A

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

Topics beyond syllabus/Advanced topics/Design: Learning from papers

POs met through Topics beyond syllabus/Advanced topics/Design: Learning from papers

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes
CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids

CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Quizzes	**3**	**3**	**3**	
Assignment Marks				**3**
End Sem Examination Marks	**3**	**3**	**3**	**3**

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO 10	PO 11
CO1	1	1	1	1	1				2	1	1
CO2	2	1	2	1	2				2	1	1
CO3	1	1	1						1	1	1
CO4		2	3	3	2			2	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets	CO1, CO2, CO3, CO4	CD8
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EC618
Course title: Boiphotonics
Pre-requisite(s): EC201 Electronic Devices, EC257 Electromagnetic field and waves
Co- requisite(s):
Credits: L: 0 T: 0 P: 0 C: **2**
Class period per week: 0
Class: M. Tech.
Semester / Level: 3/6
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	EM and Quantum Picture of Light
B.	Light-matter interactions
C.	Explain optical imaging
D.	Optical manipulation of biological materials

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	Write down the application of optical imaging
CO4	Manipulate biological material for optical use

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.

Module4: Optical Imaging II

Biomedical (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.

Text Books:

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

Reference Book:

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

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

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

Topics beyond syllabus/Advanced topics/Design: Learning from papers

POs met through Topics beyond syllabus/Advanced topics/Design: Learning from papers

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes

CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	**3**	**3**	**3**	
Assignment Marks				**3**
End Sem Examination Marks	**3**	**3**	**3**	**3**

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Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO 10	PO 11
CO1	1	1	1	1	1				2	1	1
CO2	2	1	2	1	2				2	1	1
CO3	1	1	1						1	1	1
CO4		2	3	3	2			2	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets	CO1, CO2, CO3, CO4	CD8
CD9	Simulation		

COURSE INFORMATION SHEET

Name of the Subject: Neural Networks and Applications
Course Code: **EC619**
Course Title: Neural Networks and Applications
Pre-requisite(s):
Co-requisite(s):
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: M. Tech (Instrumentation)
Semester / Level: 02
Branch: ECE
Name of Teacher:

Course Objectives:
This course enables the students:

A.	Define the fundamental concepts of artificial neuron
B.	Analyze the different neural network algorithms
C.	Show the application of neural network and its functionality
D.	Recognize the constraints and suitable algorithms for classification using ANN

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

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

Text Books:

Simon Haykin , “Neural Networks and Learning Machines”, , Third Edition, Pearson

Reference Book:
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Gaps in the syllabus (to meet Industry/Profession requirements): N/A

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

Topics beyond syllabus/Advanced topics/Design: Learning from papers

POs met through Topics beyond syllabus/Advanced topics/Design: Learning from papers

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Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Assignment Marks	10
Quizzes	30
End Sem Examination Marks	60

Assessment Components	CO1	CO2	CO3	CO4
Quizzes	**3**	**3**	**3**	
Assignment Marks				**3**
End Sem Examination Marks	**3**	**3**	**3**	**3**

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Indirect Assessment –

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Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

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

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Mapping Between COs and Course Delivery (CD) methods			
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CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets	CO1, CO2, CO3, CO4	CD8
CD9	Simulation		