Department of Electronics & Telecommunication Engineering

Lists of Open Electives Courses

Course Code	Course	Semester
ET3031	Introduction to Image Processing 3-0-0	Even
ET3032	Multimedia Forensic 3-0-0	Even
ET3033	Consumer Electronics 3-0-0	Odd
ET3034	Microcontroller Applications 3-0-0	Odd
ET3035	Industrial Automation Applications 3-0-0	Odd
ET3036	Introduction to Signals and Systems 3-0-0	Even
ET3037	Introduction to MEMS 3-0-0	Even

List of Humanity Courses

Course Code	Course	Semester
HS 2002	Foreign Language	Even

ET3031 : Introduction to Image Processing (Open Elective)	
Teaching Scheme **Lectures: 3 Hrs/Week** **Credits: 03**	**Examination Scheme** **Test I : 15 Marks** **Test II : 15 Marks** **Teachers Assessment: 10 Marks** **End Semester Exam : 60 Marks**

Prerequisites: Nil

Course description: This course covers fundamentals of image processing, representation of image in matrix form, image enhancement and filtering in spatial domain, introduction to enhancement in frequency domain, morphological image processing, image segmentation and representation of image.

Course Objectives:

- To explain fundamentals of image processing.
- To communicate image enhancement in spatial and frequency domain.
- To represent the morphological image processing and image segmentation.
- To explore the image representation and description techniques

Course Outcomes:

After completing the course, students will able to:

CO1	Discuss fundamental operations of digital image processing.
CO2	Illustrate the methods for image enhancement and morphological image processing.
CO3	Demonstrate the image segmentation, representation and description.
CO4	Solve the given problems using image processing techniques.

Detailed Syllabus:

Unit 1	Digital Image Fundamentals Light, brightness adaption and discrimination, Human visual system, Image as a 2D data, image representation gray scale and colour images, Image sampling and quantization, arithmetic and logical operations on an image, geometric transformation of image.
Unit 2	Image enhancement and filtering in spatial domain: Intensity transformation functions: Contrast stretching, thresholding, image negative, Log transformation, Power-low transformation, Intensity level slicing and Bit-plane slicing. Image histogram, Histogram equalization process. Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing) and high pass filtering (sharpening), introduction to image enhancement in frequency domain.
Unit 3	Morphological Image Processing: Basic morphological operations, Erosion, dilation, opening, closing, Structuring elements, Hit-or-Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons, Reconstruction by erosion and dilation
Unit 4	Image Segmentation: Edge based segmentation, Region based segmentation, Region split and merge techniques, Region growing by pixel aggregation, optimal thresholding.
Unit 5	Image representation and description: Boundary descriptor; Chaincode; Fourier descriptor; Skeletonizing; Texture descriptor; Moments.

Text and Reference Books

1. Rafel Gonzales and Richard Woods,Digital Image Processing, Third Edition, Pearson Education
2. A. K. Jain ,Fundamentals of Digital Image Processing,PHI
3. Aurthr Weeks,Fundamentals of Electronic Image Processing,PHI
4. Rafel Gonzales and Richard Woods, Digital Image Processing with MATLAB, Pearson Education

Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		2	2									
CO3			2							1	1	1
CO4		3	2								1	1

1 – High2 – Medium3 - Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following

1) Simulation
2) Application development
3) Case study on role of Image Processing in Industry processes, medical application etc.

Assessment Pattern

Assessment Pattern Level No.	**Knowledge Level**	**Test I**	**Test II**	**Teachers Assessment/ Assignment**	**End Semester Examination**
K1	Remember	05	05	00	12
K2	Understand	05	05	00	30
K3	Apply	05	05	05	12
K4	Analyze	00	00	05	06
K5	Evaluate	00	00	00	00
K6	Create	00	00	00	00
Total Marks 100		15	15	10	60

Assessment table

Assessment Tool	**K2**	**K2**	**K2**	**K3**
	CO1	**CO2**	**CO3**	**CO4**
Class Test I (15 Marks)	05	05	05	00
Class Test II (15 Marks)	05	05	05	00
Teachers Assessment (10 Marks)	00	00	05	05
ESE Assessment (60 Marks)	20	16	18	06

Special Instructions if any: Nil

ET3032: Multimedia Forensics (Open Elective)	
Teaching Scheme Lectures : 3 Hrs/week Total credits : 03	**Examination Scheme** Test 1 : 15 Marks Test 2 : 15 Marks Teachers' Assessments : 10 Marks End Semester Exam : 60 Marks

Prerequisites: Nil

Course description: The course is designed to give the basic concepts of Multimedia Forensics. Forensics as understood is application of science and technology for investigation of crime. During the course, students will explore an interesting application of engineering. The course will make the students understand the possible ways of tampering of multimedia files, such as image, video and audio and systematic approach for their detection.

Course objectives: The course has the following objectives:

- To introduce an interesting application of engineering, i.e., multimedia forensics.
- To give basic ideas of multimedia evidences, such as image, video and audio.
- To make the students understand the basic concepts of forensic techniques.
- To give basic ideas about how multimedia evidences are useful in crime investigation.

Course Outcomes: After completing the course, the students will able to:

CO1	Explain various data capturing devices and processing of data	K2
CO2	Understand types of Forensics	K2
CO3	Know the standards involved in Forensics	K1

Detailed Syllabus:

Unit	Content
Unit-I	**Foundation to Multimedia Forensics** Introduction to digital signals: audio, image and video, Digitization process: sampling and quantization, Image Enhancement Techniques: Spatial and frequency domain, Image Compression Techniques: Introduction and techniques, Image description and representation techniques, Pattern clustering and classification
Unit-II	**Introduction to Multimedia Forensics** Introduction and scope of Multimedia Forensics, Basics of Multimedia, Devices for capturing image and video, Devices for capturing audio, Standard and best practices in Multimedia Forensics, Photo-grammetry in Multimedia Forensics
Unit-III	**Image Forensics** Image Forensics: Introduction and scope, Active and passive image forensics, Blind and non-blind image forensics, Methods of source camera identification, Methods for tampering of digital image, Forensic authentication of digital image
Unit-IV	**Video Forensics** Video forensics: Introduction and scope, Standards for video transmission, Methods of tampering for digital video, Forensic authentication of digital video, Source camera identification from video, Enhancement of digital video
Unit-V	**Audio Forensics** Audio Forensics: Introduction and scope, Methods of tampering for digital audio, Forensic authentication of digital audio, Microphone Forensics Enhancement of digital audio, Counter Forensics

Text and Reference Books

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Prentice-Hall, Inc. Upper Saddle River, NJ, USA, 2006
2. Alan Bovik, Handbook of Image and Video Processing, Academic Press, USA, 2000
3. Husrev Taha Sencar and Nasir Memon, Digital Image Forensics: There is More to a Picture than Meets the Eye, Springer Science and Business Media, New York, 2013
4. Anthony T.S. Ho and Shujun Li, Handbook of digital forensics of multimedia data and devices, John Wiley & Sons, Ltd., UK, 2015.
5. Hany Farid, Photo Forensics, The MIT Press, Cambridge, First Edition, 2016

Mapping of course outcome with program outcomes:

Program outcome / Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**											
CO2	**2**	**3**									**2**	
CO3	**3**										**3**	

1-High 2-Medium 3-Low

Teachers' Assessment: Teachers Assessments of 20 marks is based on one of the/or combination of few of the following

1. Simulation
2. Power point presentation of case studies
3. Question and Answer/Numerical solution
4. Study of processes in Industry/Forensic Lab and its presentation

Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	Test 1	Test 2	Teachers' Assessment/ Assignment	End Semester Examination
K1	Remember	05	05	00	10
K2	Understand	10	10	10	50
K3	Apply	00	00	00	00
K4	Analyze	00	00	00	00
K5	Evaluate	00	00	00	00
K6	Create	00	00	00	00
Total Marks (100)		15	15	10	60

Assessment Table

Assessment Tool	K1	K2	K2
	CO1	CO2	CO3
Class Test 1 (15 marks)	10	05	00
Class Test 2 (15 marks)	00	10	05
Teachers' Assessment (10 marks)	05	05	00
ESE Assessment (60 marks)	30	25	05

ET3033 : Consumer Electronics (Open elective)	
Teaching Scheme **Lectures : 03Hrs/Week** **Total Credits : 03**	**Examination Scheme** **Class Test I : 15 Marks** **Class Test II : 15 Marks** **Teachers Assessment: 10 Marks** **End Semester Exam : 60 Marks**

Prerequisites: Nil

Course description: After completing this course, students will have a clear and fundamental understanding of Consumer Electronics. Topics in this course will give an overview of different audio, video, telephone systems, office equipment and home appliances. This course will help students to understand working of electronics equipment and gadgets from block diagram point of view.

Course Objectives:

- To understand working principles of various electronic gadgets and consumer's products.
- To identify blocks in the consumer products and operations.
- To study the various technical specifications and facilities of the equipments used on day to day bases.
- To learn how to select the product by comparing commercially available products.

Course Outcomes

After completing the course, students will able to:

CO1	Learn blocks of audio, video and telephony systems.	K1
CO2	Know the concepts of Radio, TV transmission and reception	K2
CO3	Discuss the principles , working and operation of mobile , audio , video and telephony systems	K2
CO4	Understand the working of television systems, office equipment and domestic appliances.	K2

Detailed Syllabus:

Unit 1	**Audio Video systems** Microphones, Amplifier, Loudspeakers, Home Theatres, Public address system, Radio Receivers-AM/FM, Dolby Digital systems, DVD Players, Blu-ray Players, MP4 Players, Set Top Box, Dish.
Unit 2	**Television** Introduction, Radio and TV transmission & reception, Block Diagram of TV transmitter, Television studies and Equipment, Antenna for TV transmitter, Block Diagram of TV receiver, Color Television-Standards, HDTV, LCD, Plasma and LED TV, Smart TV, Projectors.
Unit 3	**Mobile and Telephony Devices** Basic landline equipment-CLI, Intercom/EPABX system, Mobile Phones-GPRS & Bluetooth, GPS Navigation system**,** Video Telephone, Video conferencing.
Unit 4	**Office Equipment's** Scanners, Printers, Photocopier, Multifunction units (Print, scan, fax, copy)
Unit 5	**Electronic Gadgets and Domestic Appliances** Digital Clock, Digital camera, Handicam, Home security system, CCTV, Air conditioners, refrigerators, Washing machine, Dish washer, Microwave Oven, Vacuum Cleaners, UPS, Inverter, Decorative lighting, barcodes, RFID, Treadmill's, Smart devices: Fitbit, Smart watches

Text and Reference Books

1. R.P.Bali, Consumer Electronics, Pearson Education (2008)
2. R.G.Gupta, Audio and video System, Tata McGraw Hill(2008)

Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2							3			
CO2		2							3			
CO3		2				2			3			
CO4		2				2			3			

1 – High, 2 – Medium, 3 - Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following

1) Power point presentation of case studies
2) Question & answer
3) Comparative study of electronic products
4) Quiz

Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	Test I	Test II	Teachers Assessment/ Assignment	End Semester Examination
K1	Remember	05	00	00	06
K2	Understand	10	15	10	54
K3	Apply	00	00	00	00
K4	Analyze	00	00	00	00
K5	Evaluate	00	00	00	00
K6	Create	00	00	00	00
Total Marks 100		15	15	10	60

Assessment table

Assessment Tool	**K1**	**K2**	**K2**	**K2**
	CO1	**CO2**	**CO3**	**CO4**
Class Test I (15 Marks)	05	10	00	00
Class Test II (15 Marks)	00	05	10	00
Teachers Assessment (10 Marks)	00	00	00	10
ESE Assessment (60 Marks)	06	12	18	24

ET 3034 : Micro-controller Applications (Open Elective)	
Teaching Scheme **Lectures: 3 Hrs/Week** **Credits: 03**	**Examination Scheme** **Test I : 15 Marks** **Test II :15 Marks** **Teachers Assessment : 10 Marks** **End Semester Exam : 60 Marks**

Prerequisites: Nil

Course description: The objective of this course is to teach students design and interfacing of microcontroller-based systems. High-level languages are used to interface the microcontrollers to various applications.

Course Objectives:

- To acquaint the students with fundamentals of Micro-processor and Micro-controller
- To emphasis on design of interfacing techniques of 8051 Microcontroller.
- To develop capacity to analyze and interpret applications using modern microcontrollers.

Course Outcomes

After completing the course, students will able to:

CO1	Understand the basic concept of Microprocessor, Microcontroller and its Applications
CO2	Programme the Microcontroller using High Level Language
CO3	Design the system using Open source software.

Detailed Syllabus:

Unit 1	**Introduction.** Overview of Microprocessor and Microcontroller, Architecture, Interfacing and Programming of 8051 microcontroller.
Unit 2	**8051 Microcontroller Applications** Development of industrial/commercial applications using 8051 and its programming using Integrated Development Environment
Unit 3	**Arduino Technology** Architecture, Arduino open source prototyping platform, various boards (USB, Bluetooth, Serial Communication, etc.), open source interfacing boards
Unit 4	**Arduino Applications** Arduino board programming using IDE, Industrial automation applications (RF transmitter module, Relay control, Real time Clock, Mind control Robot etc), Robotics

Text and Reference Books

1. Muhammad Ali Mazidi and Janice Gillispe, The 8051 Microcontroller and embedded systems, Pearson Education Asia, Indian reprint 2002
2. Kenneth J. Ayala, The 8051 Micro-controller– Architecture, Programming & Applications, Third Edition, Cengage Learning, India, 2007.
3. Ajay V Deshmukh, Microcontrollers (Theory and Applications) The McGraw- Hill Companies, 2005.

4. The 8051 Microcontroller & Embedded Systems Using Assembly and C, 1st Edition, Cengage Learning, India, 2010.

Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	2	2										
CO3		2			3							

1 – High2 – Medium3 - Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following

1. Simulation
2. Application development
3. Power point presentation
4. Question & answer / Numerical solution
5. Mini projects

Assessment Pattern

Assessment Pattern Level No.	**Knowledge Level**	**Test I**	**Test II**	**Teachers Assessment/ Assignment**	**End Semester Examination**
K1	Remember	05	05	00	10
K2	Understand	05	05	05	25
K3	Apply	05	05	05	25
K4	Analyze	00	00	00	00
K5	Evaluate	00	00	00	00
K6	Create	00	00	00	00
Total Marks 100		15	15	10	60

Assessment table

Assessment Tool	**K1**	**K2**	**K3**
	C01	**C02**	**C03**
Class Test I (15 Marks)	05	05	05
Class Test II (15 Marks)	05	05	05
Teachers Assessment (10 Marks)	00	05	05
ESE Assessment (60 Marks)	10	25	25

ET 3035 : Industrial Automation Applications (Open Elective)	
Teaching Scheme **Lectures: 3 Hrs/Week** **Credits: 03**	**Examination Scheme** **Test I : 15 Marks** **Test II :15 Marks** **Teachers Assessment : 10 Marks** **End Semester Exam : 60 Marks**

Prerequisites: Nil

Course Outcomes

As an outcome of completing the course, students will able to:

CO1	Identify the issues and challenges in the development of automation systems.
CO2	Understand Automated Material handling, Manufacturing & Quality control
CO3	Analyze the requirements for manufacturing setup and select the most appropriate architecture and technologies including industrial sensors and robotics.
CO4	Develop Computer and Artificial intelligence based Industrial Automation systems

Detailed Syllabus:

Unit 1	Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations
Unit 2	Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods
Unit 3	Automated Manufacturing Systems: Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, Group Technology and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Modern Quality Control Methods
Unit 4	Technologies in Automation: Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries. Explain Robotics, Identify Types of Robot, Distinguish Uses and Applications of Robot Sensors, Actuators and other Control System Components
Unit 5	Computer and Artificial intelligence based Industrial Automation, Analog & Digital I/O Modules, and SCADA Systems. Distributed Control System. Case studies

Recommended Books:

1. Industrial Control Electronics Devices, Systems, & Applications 3D Edition Author: Terry Bartlet Publisher: Delmar
2. Industrial Automation and Robotics 2013 by A.K. Gupta, S.K. Arora 3rd Edition Amazon Books.
3. Industrial Automation: Hands On By Frank Lamb Google Books

List of Reference Sources for Classes and Assignments:

Resources available on e-learninggecaect.com site http://www.

Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2			3	1			
CO2		3										
CO3										1		
CO4			2		3							1

1 – High 2 – Medium 3 – Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following

1) Simulation
2) Application development
3) Power point presentation of case studies
4) Question & answer / Numerical solution
5) Study of Industry processes and its presentation
6) Mini projects

Recommended Assessment Pattern

Assessment Pattern Level No.	**Knowledge Level**	**Test**-I	**Test**-II	**Teachers Assessment/ Assignment**	**End Semester Examination**
K1	Remember	05	05	00	10
K2	Understand	10	10	05	20
K3	Apply	00	00	05	25
K4	Analyze	00	00	00	05
K5	Evaluate	00	00	00	00
K6	Create	00	00	00	00
Total Marks 100		15	15	10	60

Assessment table

Assessment Tool	K1	K2	K2	K3
	CO1	CO1,CO2	CO3	CO4
Class Test – I (15 Marks)	05	10	00	00
Class Test – II (15 Marks)	00	00	10	05
Teachers Assessment (10 Marks)	00	00	05	05
ESE Assessment (60 Marks)	10	20	15	15

Special Instructions if any: Nil

ET3036 : Introduction to Signals and Systems (Open Elective)	
Teaching Scheme **Lectures : 3Hrs/week** **Total credits : 03**	**Examination Scheme** **Test 1 : 15 Marks** **Test 2 : 15 Marks** **Teachers' Assessments : 10 Marks** **End Semester Exam : 60 Marks**

Prerequisites: Nil

Course Objectives:

- To explain the fundamental properties of linear systems.
- To know CT & DT Signals and Systems and their mathematical representation
- To use FT, LT and ZT to understand signal in frequency domain
- To Develop mathematical skill for solving problem

Course Outcomes: After completing the course, students will able to:

CO1	Classify various types of signals, their properties, & perform various operations on them. Understand about various types of systems, classify them & understand their response.
CO2	Understand the fundamentals of LTI systems
CO3	Do Fourier Analysis of a periodic and non-periodic signals
CO4	To apply Laplace transform & Z transform for understanding signals and systems.

Detailed Syllabus

Unit-I	**Introduction :** Types and Classification of Signals (Continuous time Discrete time), sampling theorem, types of sampling , Elementary operations on Signals ,types of Systems, Basic Properties of the systems
Unit-2	**Linear time invariant systems:** Time Domain Representations of Linear Time Invariant (LTI) Systems, Impulse Response, Convolution, Differential and Difference Equation Representation properties of convolution block diagram representations of LTI systems, properties of linear time-invariant systems.
Unit-3	Fourier analysis of Continuous Time Signals and , Fourier series, Fourier Transform and properties, Fourier Analysis of Discrete Time Signals, Introduction to DTFT & DFT.
Unit-4	Laplace Transform and its properties, Inverse Laplace Transform Application of Laplace transform
Unit-5	Z-Transform, Convergence of z-Transform, Properties of z- Transform, Inverse z-Transform

TEXT AND REFERENCE BOOKS

1. Simon Haykins and Barry Van Veen, Signals and Systems, 2nd Edition, Wiley India.
2. Ravikumar, Introduction to signals and systems, PHI.
3. B.P. Lathi, Linear Systems and Signals, 2nd Edition, Oxford University Press, 2004.
4. Peyton Peebles, Probability, Random Variable, Random Processes, 4th Edition, Tata McGraw Hill.
5. A.V. Oppenheim, A.S. Willsky and I.T. Young, Signals and Systems, Prentice Hall, 1983.
6. M. J. Roberts, Signals and Systems - Analysis using Transform methods and MATLAB, Tata McGraw Hill Edition, 2003.

Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	3									
CO2		2	3									
CO3		2	3									
CO4		2	3									

1 – High 2 – Medium 3 - Low

Teacher's Assessment: Teachers Assessment of 20 marks is based on one of the / or combination of few of following
1) Simulation
2) Power point presentation of case studies
3) Question & answer / Numerical solution

Assessment Pattern

Assessment Pattern Level No.	**Knowledge Level**	**Class Test 1**	**Class Test 2**	**End Semester Examination**
K1	Remember	05	05	10
K2	Understand	10	10	50
K3	Apply	00	00	00
K4	Analyze	00	00	00
K5	Evaluate	00	00	00
K6	Create	00	00	00
Total Marks 80				

Assessment table

Assessment Tool	K1	K2	K2	K1
	C01	C02	C03	CO4
Class Test 1 (15 Marks)	05	10	00	00
Class Test 2 (15 Marks)	00	05	10	00
Teachers Assessment (10 Marks)	00	00	05	05
ESE Assessment (60 Marks)	15	20	10	15

ET3037 : Introduction to MEMS (Micro Electro Mechanical Systems) (Open Elective)	
Teaching Scheme **Lectures: 3 Hrs/Week**	**Examination Scheme** **Test I :15 Marks** **Test II : 15 Marks** **Teachers Assessment : 10 Marks** **End Semester Exam : 60 Marks**

Prerequisites: Nil

Course description: This interdisciplinary course not only gives an overview of the micro and smart systems technologies but also gives an in-depth understanding of the issues involved. It then presents a comprehensive description of microfabrication. Here, the basics and advanced topics are interleaved to provide a thorough understanding of the finite element method. After this, electronics circuits, control, and packaging are also presented.

Course Objectives:

- To impart in students detailed knowledge about Principle and working of Micro electro mechanical system (MEMS)
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators.
- To introduce different materials used for MEMS.
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical Engineering.

Course Outcomes

After completing the course, students will able to:

CO1	Ability to understand and apply basic science, circuit theory, and Electro-magnetic field theory, MEMS technology and apply them to engineering problems.
CO2	Ability to understand and learn fabrication process of Micro Electro mechanical system.
CO3	Ability to understand the Modeling MEMS sensors and actuators
CO4	Ability to design a microsystem based applications in multi discipline area

Detailed Syllabus:

Unit 1	**INTRODUCTION TO MICROELECTROMECHANICAL (MEMS)** Glimpses of Microsystems; scaling effects, Smart materials and systems: an overview, Micro-sensors, Micro-actuators Microsystems, Examples of smart systems: structural health monitoring and vibration control, Integration of microsystems and microelectronics, MEMS materials, Electronics and packaging.
Unit 2	**SENSORS AND ACTUATORS** Electrostatic sensors: Parallel plate capacitor, Interdigitated Finger capacitor, Comb drive devices , Micro Grippers, Micro Motors, Thermal Sensing and Actuation, Magnetic Actuators — Case studies of MEMS in magnetic actuators, Piezo-resistive sensors , Piezo-resistive sensor materials ,Stress analysis of mechanical elements, Applications to Inertia, Pressure, Tactile and Flow sensors, Piezoelectric sensors and actuators : piezoelectric effects , piezoelectric materials.
Unit 3	**MICROFABRICATION PROCESSES** Structure of silicon and other materials, Silicon wafer processing; Thin-film deposition, Lithography, wet etching and dry etching, Bulk micromachining and Surface micromachining, Wafer-bonding; LIGA and other molding techniques, Soft lithography and polymer processing, Thick-film processing; Low temperature co-fired ceramic

	processing, Smart material processing
Unit 4	**APPLICATION OF MEMS** Case-study 1 (Pressure sensor), Case-study 2 (Accelerometer), Applications to Inertia , Acoustic, Tactile and Flow sensors, Gyroscope, MEMS biosensors, Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actuation Systems, Applications of MEMS in various industries, Mirco-pumps and Micro-valve, Micro thruster design , MEMS application used in industrial as well as space application.

Text and Reference Books

1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre" Micro And Smart Systems ",John Wiley,
2. V.K. Varadan, K.J. Vinoy, and S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, Wiley, 2006.
3. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.
4. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
5. Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, McGraw Hill, 2002.
6. V.K. Varadan, K.J. Vinoy, and S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, Wiley, 2006.
7. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
8. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2000
9. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002.
10. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010.

Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3						1	3		
CO2	2	2							1	3		
CO3		2	1						1	3		
CO4	3	2	2						1	3		

1 – High 2 – Medium 3 - Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following

1) Simulation
2) Application development
3) Power point presentation of case studies

4) Question & answer / Numerical solution
5) Mini projects

Assessment Pattern

Assessment Pattern Level No.	**Knowledge Level**	**Test I**	**Test** II	**Teachers Assessment/ Assignment**	**End Semester Examination**
K1	Remember	05	05	00	15
K2	Understand	05	05	05	30
K3	Apply	05	05	05	15
K4	Analyze	00	00	00	00
K5	Evaluate	00	00	00	00
K6	Create	00	00	00	00
Total Marks 100		15	15	10	60

Assessment table

Assessment Tool	**K1**	**K2**	**K2**	**K3**
	C01	**C02**	**C03**	**C04**
Class Test I (15 Marks)	05	05	05	00
Class Test II (15 Marks)	00	05	05	05
Teachers Assessment (10 Marks)	00	03	02	05
ESE Assessment (60 Marks)	15	15	15	15