Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	B. Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech. Sem. VIII
Course Code	6EN492
Course Name	Project-II
Desired Requisites:	Project-I

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	12 Hrs/Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 6			

Course Objectives	
1	Review and finalization of the approach to solve the problem relating to the assigned topic.
2	Finalizing objectives and expected outcomes of the project. Writing the technical specifications and product specifications of completed/ final project.
3	Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Design of Experiments as required for the project-work.
4	Prepare a paper on project work for conference/ journal publication with suggested modifications and future of the project work.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Choose/ Experiment with the method/ methodology finalized/ designed to solve the problem undertaken as project.	Apply
CO2	Model/ Simulate/ Design/ Design the experiments to verify the expected results/ specifications of project.	Analyze Evaluate
CO3	Develop the final product/process, testing, results, conclusions and future direction.	Create
CO4	Write and publish a paper for Conference Presentation/Publication in Journals, if possible. Prepare a Project Report in the standard format for being evaluated by the department committee.	Apply
CO5	Prepare an action plan for conducting the investigation, sharing of activities during completion of project work, including team work.	Apply

List of Experiments / Lab Activities/ Topics

It is expected that in-depth study of the topic assigned in the light of the report prepared under Project-I shall be continued as Project-II. The objective of Project-II is to enable the student to extend further the investigative study taken up under Project-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor from the Industry. It is expected to provide a good training for the student(s) in R&D work and technical leadership.

Assessment: The final product shall be a result of Project-I and Project-II and should be demonstrated at the time of examination. A demonstration and oral examination on the Project-II shall be conducted at the end of the semester.

Text Books	
1	Journal/ Conference papers/ Magazine Articles/ Handbooks with reference to topic selected for the project-work.

References

1	Journal/ Conference papers/ Magazine Articles/ Handbooks with reference to topic selected for the project-work.

Useful Links	
1	https://ieeexplore.ieee.org
2	https://www.sciencedirect.com
3	https://www.elsevier.com

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3		3	3	3	2					2	3	3
CO2		2	3	3	3							2	3	3
CO3			3		2	2	2	2			2	2	3	3
CO4								3	3	3	3	2	2	2
CO5									3		3			
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing (min 40 %). LA1, LA2 together is treated as In-Semester Evaluation, LA1+LA2 should be min 40%.				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information	
Programme	B.Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech., Sem. VIII
Course Code	6EN431
Course Name	Professional Elective VII -Radar and Navigation
Desired Requisites:	Communication

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial		30	20	50	100
		Credits: 3			

Course Objectives	
1	To learn Radar fundamentals and analysis of the radar signals.
2	To understand various technologies involved in the design of radar transmitters and receivers.
3	To learn various radars like MTI, Doppler and tracking radars and their comparison.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Demonstrate an understanding of the factors affecting the radar performance using Radar Range Equation	II
CO2	Analyze the principle of FM-CW radar	IV
CO3	Identify the different types of Radar Displays and their application in real time scenario	III
CO4	Demonstrate an understanding of the importance of Matched Filter Receiversin Radars	II

Module	**Module Contents**	**Hours**
I	**Basics of Radar:** Introduction, Maximum Unambiguous Range, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Prediction of Range Performance, Minimum Detectable Signal, ReceiverNoise, Modified Radar Range Equation, Illustrative Problems. **Radar Equation :** SNR, Envelope Detector — False Alarm Time and Probability, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets – sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.	7
II	**CW and Frequency Modulated Radar:** Doppler Effect, CW Radar — Block Diagram, Isolation between Transmitterand Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. Illustrative Problems FM-CW Radar: Range and Doppler Measurement, Block Diagram and Characteristics, FM-CW altimeter, Multiple Frequency CW Radar	7
III	**MTI and Pulse Doppler Radar:** Introduction, Principle, MTI Radar with – Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancelers — Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar.	6

IV	**Tracking Radar:** Tracking with Radar, Sequential Lobing, Conical Scan, Monopulse Tracking Radar — Amplitude Comparison Monopulse (one- and two- coordinates), Phase Comparison Monopulse, Tracking in Range. Acquisition and Scanning Patterns. Comparison of Trackers.	6
V	**Detection of Radar Signals in Noise :** Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation Function and Cross- correlation Receiver, Efficiencyof Non-matched Filters, Matched Fitter with Nonwhite Noise. Radar Receivers – Noise Figure and Noise Temperature. Displays — types. Duplexers — Branch type and Balanced type. Circulators as Duptexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Applications. Advantages and Limitations.	6
VI	**Radar Clutter And Basic Navigational Radar System 9:** Introduction to Radar Clutter - Types, Surface clutter radar equation, Fundamentals of Navigation aids: Types of Navigation aids, ILS, DME, VOR, TACAN, MLS, LORAN, DECCA, OMEGA,	7
Textbooks		
1	Skolnik, Merrill Ivan. Introduction to Radar Systems , TMH Special Indian Edition, 2nd Ed.. 2007. ISBN: 9780072881387	
2	Raju, G. S. N.. Radar engineering. India, I.K. International Publishing House Pvt. Limited, 2008., ISBN: 9788190694216	
References		
1	Mark A. Rkhards, James A. Scheer, William A. HoIm. Yesdee , Principles of ModemRadar: Basic Principles –, Scitech Publication, 2013, ISBN: 9781613532010	
2	Radar Principles. India, Wiley India Pvt. Limited, 2007., ISBN: 9788126515271	
Useful Links		
1	https://archive.nptel.ac.in/courses/108/105/108105154/	

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2				3										
CO3				3										
CO4	3													
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2024-25

Course Information	
Programme	B.Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech., Sem. VIII
Course Code	6EN432
Course Name	Professional Elective VII - Advanced Embedded Programming
Desired Requisites:	Embedded System Design, Python programming

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To understand the recent advancements in Embedded System Design .
2	To motivate students to learn implementation of Linux based Embedded System Design.
3	To motivate students to learn implementation of solutions for Autonomous Vehicles using Intelligent Embedded System.
4	To teach students to develop AI based Embedded System Design.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**understand** the need of python programming language in Embedded System Design.	Understand
CO2	**write** code / scripts to configure and use Embedded Web Server using Embedded Linux.	Apply
CO3	**design** AI based applications for Automotive using Embedded System Design.	Apply
CO4	**analyze** different object detection Embedded Automotive algorithms required by autonomous vehicles for decision making.	Analyze

Module	**Module Contents**	**Hours**
I	**Python for Embedded System Design** Benefits of Using Python, Memory Management in Embedded Systems, Disadvantages of Using Python, Hardware Options for Running Embedded Python, Software Options for Writing Embedded Python, Micro Python and Circuit Python, Setting Up Environment and Running Code.	6
II	**Embedded Web Server** Fundamentals of Web technology, Web server, Web Client, Server and client side scripting, Front End Design using HTML, CSS and Responsive web design, Configuration of web server on Embedded System Design, Handling hardware through python, Fundamentals of database.	7
III	**Embedded Web Server with Flask and Raspberry Pi** Installing FLASK and Setting RPi Web Server, Design and Implementation of web based application using Python and Raspberry Pi like controlling GPIO pins, reading status of GPIO, Integrating Sensors and Actuators in Web based Embedded System.	7
IV	**Intelligent Embedded Systems for Automotive** Applications of Embedded Systems in Automotive, Challenges and Limitations of Embedded Systems in Automotive, intelligent embedded software, AI in Embedded Systems.	6
V	**Object Detection for Electric / Autonomous Vehicles** Case study Advanced Driver Assistance Systems (ADAS) driven by AI, case study of object detection, object categorization and decision making for vehicles using different algorithms and Embedded C / Embedded Linux platform.	7

VI	**Protocols for Embedded Automotive** Controller area network (CAN) protocol, Need of CAN in Automobiles, CAN Protocol Stack and its Layered Architecture, programming Example for CAN, overview of LoRa Technology in Vehicle Communication.	6

Textbooks	
1	"Programming Microcontrollers with Python" first edition, Apress, 2021.
2	Cem Unsalan; Duygun E. Barkana; H. Deniz Gurhan, "Embedded Digital Control with Microcontrollers: Implementation with C and Python", Wiley-IEEE Press, 2021.
3	Ovidiu Vermesan, Mario Diaz Nava, Björn Debaillie, "Embedded Artificial Intelligence Devices, Embedded Systems, and Industrial Applications", River Publishers, 2023.
4	"Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", Wiley, 2016
References	
1	https://www.w3schools.com/nodejs/nodejs_raspberrypi.asp
2	Raj Ponnaluri and Priyanka Alluri, "Connected and Automated Vehicles", 2021
3	"Building Embedded Linux Systems",
4	Sumit Ranjan, Dr. S. Senthamilarasu, "Applied Deep Learning and Computer Vision for Self-Driving Cars", Packt Publishing, 14 August 2020.
Useful Links	
1	https://www.edx.org/
2	https://www.udacity.com/
3	https://www.coursera.org/
4	https://www.kernel.org/

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2													
CO2		2												
CO3			2		2									
CO4				2										2
1: Low, 2: Medium, 3: High														

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment canbe field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech., Sem. VIII
Course Code	6EN433
Course Name	Professional Elective VII - System on Chip
Desired Requisites:	Embedded System Design, FPGA Based System Design

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To understand the concepts of System on Chip Design methodology for Logic and Analog Cores.
2	To differentiate embedded system design and system on chip architectures.
3	To motivate students to learn implementation of SOC using MicroBlaze.
4	To teach students to develop IP based system design

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**understand** about SOC design methodology	Understand
CO2	**discuss** the functional and non-functional performance of the system early in the design process to support design decisions	Understand
CO3	**apply** concepts of System on Chip Design methodology for Logic and Analog Cores	Apply
CO4	**analyze** hardware/software trade-offs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction to the System Approach** Concept of system, importance of system architectures, introduction to SIMD, SSID, MIMD and MISD architectures, concept of pipelining and parallelism. Designing microprocessor /Microcontroller based system and embedded system	5
II	**Introduction to SOC** Components of SOC, Design flow of SOC, Hardware/Software nature of SOC, Design Trade-offs, SOC Applications, Differences between Embedded systems and SOCs. System design issues in SOCs.	7
III	**Interconnection** On-chip Buses: basic architecture, topologies, arbitration and protocols, Introduction to AMBA bus, IBM's core connect bus, concept of PLB-processor local bus and on chip peripheral bus (OPB), implementing arbiters in design.	7
IV	**Processors** Concept of Soft embedded processors, Hard vs. Soft embedded processors, Study of Microblaze RISC processor, Programming steps in MicroBlaze Processor.	7
V	**IP based system design** Introduction to IP Based design, Types of IP, IP across design hierarchy, IP life cycle, Creating and using IP, Technical concerns on IP reuse, IP integration, IP evaluation on FPGA prototypes.	7
VI	**Application Studies/ Case Studies** SOC system design example with Peripherals like USB, UART, Ethernet Etc. using latest FPGA. (Xilinx/ Altera tools) Eclipse IDE development tool for a full SOC system design with embedded C/C++ applications (Xilinx / Altera tools)	6

Textbooks	
1	René Beuchat, Florian Depraz, Andrea Guerrieri, Sahand Kashani, “Fundamentals of System-on-Chip Design on Arm Cortex-M Microcontrollers”, ARM Education Media.
2	Michael J. Flynn and Wayne Luk, “Computer System Design System-on-Chip”, Wiley India Pvt. Ltd.
3	Steve Furber, “ARM System on Chip Architecture “, 2nd Edition, 2000, Addison Wesley Professional.
4	“A Hands-On Guide to Effective Embedded System Design”, XILINX
References	
1	Ricardo Reis, “Design of System on a Chip: Devices and Components”, 1st Edition, 2004, Springer
2	Jason Andrews, “Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology)”, Newnes, BK and CDROM.
3	Prakash Rashinkar, Peter Paterson and Leena Singh L, “System on Chip Verification – Methodologies and Techniques”, 2001, Kluwer Academic Publishers.
4	“Embedded Processor Hardware Design” UG940 (v 2013.2) February 7, 2014
Useful Links	
1	https://www.arm.com/resources/education
2	https://www.xilinx.com/
3	https://swayam.gov.in/nc_details/NPTEL
4	https://www.coursera.org/

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2													
CO2	2													
CO3		2			2									2
CO4			2										2	
1: Low, 2: Medium, 3: High														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be quiz, seminar, assignments or any interactive activity etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech., Sem. VIII
Course Code	6EN434
Course Name	Professional Elective VIII-Satellite Communication
Desired Requisites:	Communication

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial		30	20	50	100
		Credits: 3			

Course Objectives

1	To prepare students to excel in basic knowledge of satellite communication principles
2	To provide students with solid foundation in orbital mechanics and launches for the satellite communication.
3	To train the students with a basic knowledge of link design of satellite with a design example
4	To provide better understanding of multiple access systems and earth station technology and prepare students with knowledge in satellite navigation and GPS & and satellite packet communications

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	Analyze satellite orbit mechanics and subsystem components	Apply
CO2	Analyze the earth segment and space segment with multiple access technology	Apply
CO3	Design various satellite link for various applications	Remember

Module	**Module Contents**	**Hours**
I	**Communication Satellite:** Orbit and Description: A Brief history of satellite Communication, Satellite Frequency Bands, Satellite Systems, Applications, Orbital Period and Velocity, effects of Orbital Inclination, Azimuth and Elevation, Coverage angle and slant Range, Eclipse, Orbital Perturbations, Placement of a Satellite in a Geo-Stationary orbit	7
II	**Satellite Sub-Systems:** Attitude and Orbit Control system, TT &C subsystem, Attitude Control subsystem, Power systems, Communication subsystems, Satellite Antenna Equipment. **Satellite Link**: Basic Transmission Theory, System Noise Temperature and G/T ratio, Basic Link Analysis, Interference Analysis, Design of satellite Links for a specified C/N, (With and without frequency Re-use), Link Budget	7
III	**Propagation effects:** Introduction, Atmospheric Absorption, Cloud Attenuation, Tropospheric and lonospeheric Scintillation and Low angle fading, Rain induced attenuation, rain induced cross polarization interference	6
IV	**Multiple Access:** Frequency DivisIon Multiple Access (FDMA) – Intermodujation Calculation of C/N, Time Division Multiple Access (TDMA) – Frame Structure, Burst Structure, Satellite Switched TDMA, On-board Processing, Demand Assignment Multiple Access (DAMA) — Types of Demand Assignment, Characteristics, CDMA Spread Spectrum Transmission and Reception	7
V	**Earth Station Technology:** Transmitters, Receivers, Antennas, Tracking Systems, Terrestrial Interface, Power Test Methods, Lower Orbit Considerations	6

VI	**Satellite Navigation and GPS System**s: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers, GPS C/A Code Accuracy, Differential GPS.	6

Textbooks	
1	Satellite Communications Dennjs Roddy, 2nd Edition, 1996, McGraw Hill.
2	Satellite Communications —Timothy Pratt, Charles Bostian, Jeremy Allnutt, 2nd Edition, 2003, John Wiley & Sons
References	
1	Satellite Communications: Design Principles — M. Richcharia, 2nd Ed., BSP, 2003.
2	Fundamentals of Satellite Communications — K. N. Raja Rao, PHI, 2004.
Useful Links	
1	-

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				3										
CO2				3										
CO3				3										
CO4														

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	B.Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	6EN435
Course Name	Professional Elective VIII-Medical Image Analysis
Desired Requisites:	Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial		30	20	50	100
		Credits: 3			

Course Objectives	
1	To learn facts about medical imaging sources and study various formats.
2	To study various segmentation and filtering technique of medical image.
3	To learn spatial transformation of medical image

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Demonstrate various image sources, there representation and various formatsof image.	II
CO2	Apply segmentation, filtering and transformation on medical image.	IV
CO3	Analyse various facts of image registration and CT reconstructed image.	IV

Module	**Module Contents**	**Hours**
I	**Basics of Medical Image Sources:** Radiology, the electromagnetic spectrum, basic x-ray physics, attenuation and imaging, computed tomography, magnetic resonance tomography, ultrasound, nuclear medicine and molecular imaging, other imaging techniques, radiation protection and dosimetry	7
II	**Image Representation:** Pixels and voxels, gray scale and color representation, image file formats, DICOM, other formats, image quality, and the signal-to-noise ratio, the intensity transform function and the, dynamic range, windowing, histograms and histogram operations, dithering and depth	7
III	**Image segmentation:** Region growing, k-means clustering, snakes, introduction to level sets,speed functions, multi-atlas fusion-based segmentation	7
IV	**Image enhancement:** contrast enhancement, denoising, deblurring, edge detection, derivativesand Fourier theory, anisotropic diffusion;	6

V	**Image registration:** correlation, least squares, transform based registration, joint entropy, mutual information, binning discontinuities, registration optimization, registration by clustering, ensemble registration, gaussian mixture models.	6
VI	**Medical image reconstruction:** Theory of MRI reconstruction, MRI motion, compensation, algebraic CT reconstruction, CT filtered back-projection.	6

Textbooks	
1	Prince J L and Links J M, *Medical Imaging Signals and Systems*, Pearson (2015).
2	Suetens P, *Fundamentals of Medical Imaging*, Cambridge University Press (2009).

References	
1	Birkfellner W, *Applied Medical Image Processing: A Basic Course*, CRC Press (2014).
2	Nishimura D, *Principles of Magnetic Resonance Imaging*, Stanford University Press (2010).

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_ee64/preview

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2	3													
CO3				3										
CO4				3										

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Electronics Engineering)
Class, Semester	Final Year B. Tech., Sem. VIII
Course Code	6EN436
Course Name	Professional Elective VIII - Microelectromechanical Systems (MEMS)
Desired Requisites:	ECAD

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	0 Hrs/week	30	20	50	100
		Credits: 3			

Course Objectives

1	To learn the Material system for MEMS
2	To understand the fabrication process and learn various tools.
3	To learn various applications of MESM in variety of domain.
4	

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	Classify various materials for MEMS system	IV
CO2	Identify the process of fabrication to develop MEMS components.	III
CO3	Interpret various applications in variety of domain using MEMS	V

Module	**Module Contents**	**Hours**
I	**Materials for MEMS**: Silicon-Compatible Material System, Other Materials andSubstrates, Important Material Properties and Physical Effects,	6
II	**Processes for Micromachining**: Basic Process Tools, Advanced Process Tools,Nonlithographic Microfabrication Technologies, Combining the Tools— Examples of Commercial Processes	6
III	**MEM Structures and Systems in Industrial and Automotive Applications**: General Design Methodology, Techniques for Sensing and Actuation, Passive Micromachined Mechanical Structures, Sensors and Analysis Systems, Actuators and Actuated Microsystems, MEM Structures and Systems in Photonic Applications, Imaging and Displays,Fiber-Optic Communication Devices	9
IV	**MEMS Applications in Life Sciences:** Microfluidics for Biological Applications,DNA Analysis, Microelectrode Arrays	6
V	**MEM Structures and Systems in RF Applications:** Signal Integrity in RF MEMS, Microelectromechanical Resonators, Microelectromechanical Switches,	6
VI	**Packaging and Reliability Considerations for MEMS**: Key Design and Packaging, Considerations, Die-Attach Processes, Wiring and Interconnects, Types of Packaging Solutions, Quality Control, Reliability, and Failure Analysis	6

Textbooks

1	Maluf, Nadim., An Introduction to microelectromechanical systems engineering–2nd edition, Artech House, 2004
2	Lyshevski, Sergey Edward., Electromechanical systems and devices, CRC Press, Taylor & Francis Group, 2008

References	
1	MEMS Applications in Electronics and Engineering, AIP Publishing Books,
2	Electromechanical Devices & Components Illustrated Sourcebook, Brian S. Elliott, McGraw-Hill
Useful Links	
1	https://nptel.ac.in/courses/117105082

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				3										
CO2				3										
CO3				3										
CO4														

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)