Marathwada Shikshan Prasarak Mandal's

DEOGIRI INSTITUTE OF ENGINEERING AND MANAGEMENT STUDIES

(An Autonomous Institute)

Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, Raigad │B.Tech.│M.Tech.

Affiliated to Dr. Babasaheb Ambedkar Marathwada University, CSN │MBA

Approved by AICTE/UGC-Govt. of India & DTE-Govt. of Maharashtra

Deogiri College Campus, Railway Station Road, Chhatrapati Sambhajinagar- 431 005 (M.S.)

DTE CODE : 2114   ☎ 0240-2367567, 2367577   🌐 **www.dietms.org**   ✉   **director@dietms.org**

Department of Electronics & Telecommunication Engineering
## MTech Electronics and Telecommunication Program Structure
(2025-27)

Course Category			I	II	III	IV	Total Credits
Program Courses	Program Core Course (PCC)	-	12	04	04		24
		MOOC	-	04	-		
	Program Elective Course (PEC)		06	06	-	-	12
Vocational and Skill Education Courses (VSE)	Seminar		01	-	-	-	02
	PG Lab		01	-	-	-	
Humanities, Social Science and Management (HSSM)	Indian Knowledge System (IKS)		-	02	-	-	02
Experiential Learning Courses (EL)	Research Methodology		-	03	-	-	34
	Mini Project		-	01	-	-	
	Project		-	-	10	20	
Open Elective Courses (OE)	Open Elective (OE)		-	-	03	-	03
Multi-Disciplinary Minor Courses (MDM)	Multi-Disciplinary Minor (MDM)		-	-	03	-	03
Total Credits			**20**	**20**	**20**	**20**	**80**
Liberal Learning Courses (LLC)	Co-Curricular Courses (CC)		-	-	-	P	Audit

MTech in Electronics & Telecommunication Engineering		
Course Category	**Credits**	**% Credits**
Program Core Courses **(PCC)**	24	30
Program Elective Courses **(PEC)**	12	15
Vocational & Skill Enhancement **(VSE)**	02	2
Humanity, Social Science & Management (AEC, EM, IKS, VEC) **HSSM**	02	2
Experiential Learning **(EL)**	34	43
Open Electives **(OE)**	03	4
Multi-Disciplinary Minor (MDM)	03	4
Total Credits	**80**	**100%**

COURSE CATERGOTY WISE % DISTRIBUTION

OE 4% 4%
PCC 30%
EL 43%
PEC 15%
HSSM 2% VSE 2%
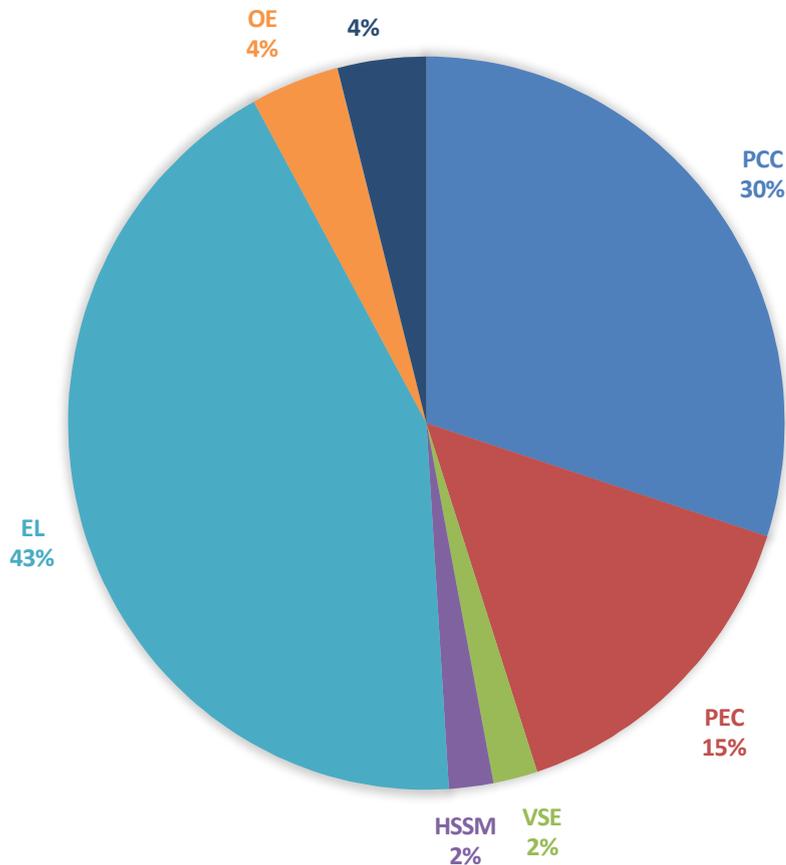
SEMESTER I

Category	Course Code	Name of the Course	L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	Credits
PCC	PE251001	Advance Signal Theory	4	-	-	4	10	10	20	60	100	4
PCC	PE251002	Microwave and Radar Techniques	4	-	-	4	10	10	20	60	100	4
PCC	PE251003	Advanced Industrial Automation	4	-	-	4	10	10	20	60	100	4
PEC	PE2511--	PECI	3	-	-	3	10	10	20	60	100	3
PEC	PE2511--	PEC II	3	-	-	3	10	10	20	60	100	3
VSE	PE251401	Seminar	-	-	2	2	15	15	-	20	50	1
VSE	PE251402	PG Lab	-	-	2	2	15	15	-	20	50	1
Total			18		4	22					600	20

SEMESTER II

Category	Course Code	Name of the Course	L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	Credits
PCC	PE252004	Advance Digital Communication Systems	4	-	-	4	10	10	20	60	100	4
PCC	PE252005	MOOC/SWAYAM	4	-	-	4	10	10	20	60	100	4
PEC	PE2521--	PECIII	3	-	-	3	10	10	20	60	100	3
PEC	PE2521--	PECIV	3	-	-	3	10	10	20	60	100	3
EL	PG252601	Research Methodology	3	-	-	3	10	10	20	60	100	3
IKS	PG252501	Interdisciplinary Perspective on Indian Science and Technology	2	-	-	2	10	10	20	60	100	2
EL	PE252602	Mini Project	-	-	2	2	15	15	-	20	50	1
Total			19		2	21					650	20

SEMESTER III

Category	Course Code	Name of the Course	L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	Credits
PCC	PE253006	Robotics	4	-	-	4	10	10	20	60	100	4
OE	PE25334-	Open Elective	3	-	-	3	10	10	20	60	100	3
MDM	PE25320-	Multi-Disciplinary Minor	3	-	-	3	10	10	20	60	100	3
EL	PE253603	Project I	-	-	10	10	25	25	-	50	100	10
Total			10		10	20					400	20

SEMESTER IV

Category	Course Code	Name of the Course	L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	Credits
EL	PE254604	Project II	-	-	20	20	50	50	-	100	200	20
Total			2		20	20					200	20
CC	PE254701	Communication Skills and Technical Writing	2	-	-	2	25	25	-	-	50	P

Program Elective Courses (PEC)

Semester	Course Category	No. of Credits			Communication & IoT	Embedded & VLSI	Signal Processing
SEM I	Program Elective I	3	Course Code		PE251101	PE251102	PE251103
			Course		Wireless Mobile Communication	Artificial Neural Networks and Applications	Signal Processing Algorithms & Applications
	Program Elective II	3	Course Code		PE251104	PE251105	PE251106
			Course		Advance Optical Fiber Communication	Microelectronics	Digital Image Processing & Application
SEM II	Program Elective III	3	Course Code		PE252107	PE252108	PE252109
			Course		Wireless Sensor Network Design	Advanced Embedded System Design	Biomedical Signal Processing
	Program Elective IV	3	Course Code		PE252110	PE252111	PE252112
			Course		IOT and Systems	Analog VLSI Design	Pattern recognition

Open Electives (OE)

Semester	Course Category	No. of Credits	Course Code	Course
SEM III	Open Elective	3	PE253341	Intellectual Property Rights
			PE253342	Business To Business Marketing (B2B)
			PE253343	Quantum Computing

Multi-Disciplinary Minor (MDM)

Semester	Course Category	No. of Credits	Course Code	Course
SEM III	Multi-Disciplinary Minor	3	PE253201	Advanced Computer networking
			PE253202	Satellite Communication
			PE253203	Advance Mobile computing

Title of the Course: Advance Signal Theory

Course Code: PE251001 **Course Category: PCC**

Teaching Scheme	Examination Scheme	
Lectures: 04 hrs / week	CA-I	10 Marks
Tutorial: --	CA-II	10 Marks
Credits: 04	MSE	20 Marks
Semester: First Year (Semester-I)	ESE	60 Marks

Course Prerequisite: Course Prerequisite: Basic knowledge of signals and systems, linear algebra, calculus, probability, and digital signal processing.

Course Description: This course provides a comprehensive understanding of advanced concepts and analytical techniques in signal theory. It focuses on the mathematical foundations of probability, random variables, and stochastic processes, emphasizing their application in modern signal representation, transformation, and processing. The course will cover the theoretical underpinnings necessary for advanced research and practical applications in fields such as communication systems, estimation theory, and statistical signal processing.

Course Objectives:
1. To equip students with a solid foundation in probability theory relevant to signal processing.
2. To enable students to analyze and characterize random variables and their statistical properties.
3. To develop the ability to apply joint distributions and conditional expectations for multiple random variables.
4. To introduce the concepts of stochastic processes and their applications in communication and signal estimation.
5. To prepare students for advanced study and research in signal processing by developing strong analytical skills.

Course Outcomes:		
CO	**After the completion of the course the student should be able to**	**Bloom's Level**
CO1	Apply the fundamental principles of probability to analyze and solve problems in signal theory.	L3 Apply
CO2	Analyze and characterize random variables by evaluating their distributions, density functions, and statistical properties.	L4 Analyze
CO3	Evaluate functions of random variables to determine moments, variances, and characteristic functions.	L5 Evaluate
CO4	Apply joint distributions and conditional expectations to analyze systems with multiple random inputs.	L3 Apply

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	-	-	-	-	2	-	2	3	2	2	1
CO2	3	3	2	2	2	-	-	-	-	2	-	2	3	2	2	1
CO3	3	3	2	2	2	-	-	-	-	2	-	2	3	3	2	1
CO4	3	3	2	2	3	-	-	-	-	2	-	2	3	3	2	1

Assessment:

CA-I (a) (10M)	Subjective Test / Open book test
CA-II (b) (10M)	Assignment / Presentation / Case Study
MSE (c) (20M)	Descriptive Test

Course Contents:

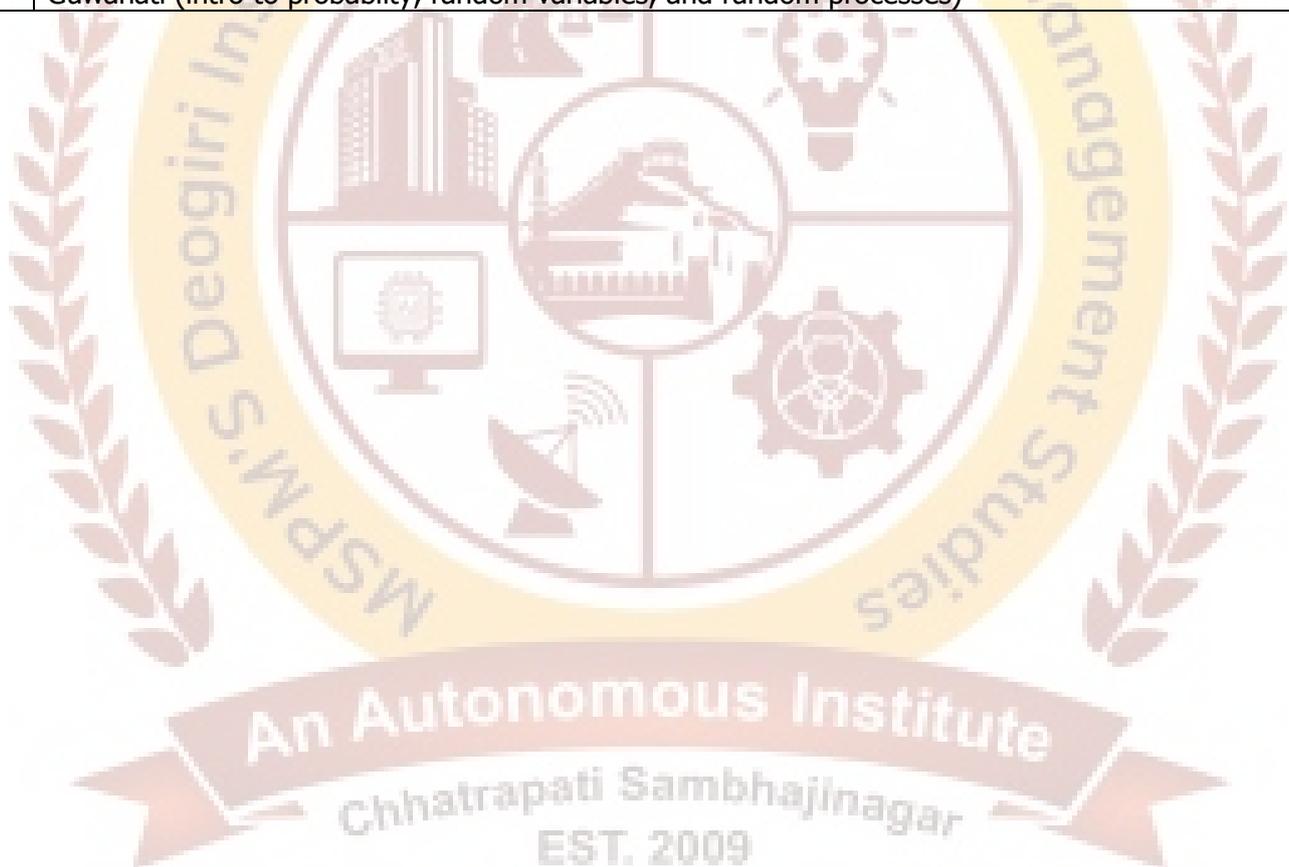|		
Unit 1	**Probability Theory** Introduction to probability: The meaning and axioms of probability, Repeated trials and sequences of events, Conditional probability and independence of events, Bayes' theorem, and its applications.	Hrs.
Unit2	**Random Variables** Introduction to the concept of a random variable, Distribution and density functions (PDF and CDF), Specific random variables (e.g., Gaussian, Uniform, Exponential), Conditional distributions and asymptotic approximations for Binomial random variables.	6 Hrs.
Unit3	**Functions of One Random Variable** The random variable and its distribution, Calculating mean and variance of Moments and characteristic functions, Application of characteristic functions in statistical analysis.	6 Hrs.
Unit 4	**Multiple Random Variables** Joint and marginal distributions, Functions of multiple random variables, Joint moments and joint characteristic functions, Conditional distributions and conditional expected values, Statistical independence of multiple random variables.	6 Hrs..
Unit 5	**Sequences of Random Variables** General concepts and properties of sequences of random variables, Mean square estimation, Stochastic convergence and limit theorems, Random Number Generation: Methods and importance.	6 Hrs.
Unit 6	**Random Processes and Applications** Introduction to random processes: Characterization and classification, Stationary and non-stationary processes, Autocorrelation and power spectral density, Cross-correlation and cross-spectral density, Analysis of linear systems with random inputs, Gaussian and Markov processes, White noise and colored noise models, Applications in communication systems and statistical signal estimation.	6 Hrs.

Textbooks	
1.	Papoulis, A., & Pillai, S. U. (2002). Probability, Random Variables and Stochastic Processes (4th ed.). McGraw Hill.
2.	Stark, H., & Woods, J. W. (2011). Probability and Random Processes with Applications to Signal Processing (4th ed.). Pearson Education.
3.	Peebles, P. Z. (2001). Probability, Random Variables and Random Signal Principles (4th ed.). McGraw Hill.
Reference Books	
1.	Gallager, R. G. (2013). Stochastic Processes: Theory for Applications. Cambridge University Press.
2.	Grimmett, G., & Stirzaker, D. (2001). Probability and Random Processes (3rd ed.). Oxford University Press.
Web Resources	
1.	https://nptel.ac.in/courses/117104117 — NOC: Probability and Random Variables/Processes for Wireless Communications (covers probability, random variables, distributions, etc.)
2.	https://onlinecourses.nptel.ac.in/noc22_ee123/preview — Probability and Random Processes by IIT Guwahati (intro to probabilty, random variables, and random processes)

Course Title: Microwave and Radar Techniques		
Course Code: PE251002		**Course Category: PCC**
Teaching Scheme	**Examination Scheme**	
Lectures: 04hrs/week	CA-1	10 Marks
Tutorial:-----	CA-2	10 Marks
Credits:04	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Basic knowledge electromagnetic theory, transmission lines, and Communication systems.		
Course Description: This course includes the study of microwave principles, components, and radar techniques for high-frequency communication and detection systems.		
Course Objectives: To equip students with fundamental concepts and practical skills in microwave engineering and radar system design and analysis.		

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Understand microwave frequency spectrum, waveguide modes, and matching techniques.	L2 Understand
CO2	Analyze microwave components, devices, and solid-state sources.	L3 Apply
CO3	Perform microwave measurements using modern instruments.	L2 Understand
CO4	Explain radar fundamentals, range equation, and basic radar types.	L2 Understand

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	-	-	-	-	-	-	-	-	3	2	3	2
CO2	3	3	3	2	-	-	2	-	-	-	-	-	3	2	3	2
CO3	2	2	2	3	-	-	-	-	-	-	-	-	2	2	2	2
CO4	3	3	2	2	-	-	-	-	-	3	-	-	2	2	2	2

Assessment:	
CA-I (a) (10M)	Subjective Test / Open book test
CA-II (b) (10M)	Assignment / Presentation / Case Study
MSE (c) (20M)	Descriptive Test

Course Contents		
Unit 1	**Microwave Fundamentals** Microwave frequency spectrum and applications, Guided wave concepts: mode design rectangular and circular waveguides, Scattering matrix and impedance transformation, Microwave matching techniques, transmission lines, and Smith chart basics.	6 Hrs.
Unit 2	**Microwave Components and Devices** Directional couplers, power dividers, hybrid junctions, circulators, isolators, Microwave filters and resonators, Microwave sources: Klystron, Reflex Klystron, Magnetron, TWT, Gunn diode, Solid-state Microwave devices: IMPATT, PIN diodes witches, mixers, detectors.	6 Hrs.
Unit 3	**Microwave Measurement Techniques** Measurement of power, frequency, impedance, VSWR, Q-factor, S-parameter measurements using network analyzers, High-power measurement methods and error analysis principles.	6 Hrs.
Unit 4	**Radar Basics** Radar block diagram and operating principles, Radar range equation, PRF, duty cycle, and system losses, CW, FM-CW radar and Doppler Effect, basics MTI radar, pulse radar, radar cross-section,	6 Hrs.
Unit 5	**Advanced Radar Systems** Tracking radars: mono pulse, conical scan, sequential lobing, Phased array radars and electronically steered arrays, Synthetic Aperture Radar (SAR)and Inverse SAR(ISAR), Low probability of intercept (LPI), Radars and stealth techniques.	6 Hrs.
Unit 6	**Applications and Emerging Trends** Microwave links and line-of-sight systems, Airborne and space borne radar applications, Automotive radar and collision avoidance systems, Millimeter-wave radar and microwave imaging.	6 Hrs.

Textbooks	
1.	R.E.Collin – Foundations for Microwave Engineering
2.	S.Y.Liao – Microwave Devices and Circuits
3.	M.I.Skolnik – Introduction to Radar Systems
Reference Books	
1.	D.M.Pozar – Microwave Engineering
2.	KaiChang – RF and Microwave Wireless Systems
3.	Dr. M. Kulkarni – Microwave and Radar Engineering

Web Resources	
1.	NPTEL Microwave Engineering Course: https://nptel.ac.in/courses/108/106/108106119/
2.	Electronics Stack Exchange: https://electronics.stackexchange.com
3.	MIT OpenCourseWare - Radar Systems: https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-650j-digital-radar-signals-and-systems-fall-2008

Course Title: Advanced Industrial Automation	
Course Code: PE251003	Course Category: PCC

Teaching Scheme	Examination Scheme	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: First Year (Semester -I)	ESE	60 Marks

Course Prerequisite: Fundamentals of control systems, process instrumentation, and basic industrial automation concepts.

Course Description: This course explores advanced concepts of industrial automation including process control, distributed and supervisory control systems, industrial communication protocols, and intelligent control techniques for modern industrial applications.

Course Objectives: The objective of this course is to provide in-depth knowledge of advanced automation systems, control strategies, and communication technologies for efficient monitoring and control of industrial processes.

Course Outcomes:		
COs	**After completion of the course:** **Student should be able to**	**Bloom's Level**
CO1	Understand fundamental concepts of process control and automation used in industrial systems.	L1 Remember
CO2	Apply knowledge of control strategies and system architectures to analyze and design industrial control solutions.	L2 Understand
CO3	Demonstrate the ability to use industrial communication protocols and control tools for monitoring and supervision of processes.	L3 Apply
CO4	Develop problem-solving skills for real-world industrial applications by integrating conventional and advanced control techniques.	L4 Analyze

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	-	2	-	-	-	-	-	-	2	3	2	2	2
CO2	3	3	3	-	3	-	-	-	-	-	-	3	3	3	2	2
CO3	2	2	3	-	3	-	-	-	-	-	-	3	3	3	2	2
CO4	2	3	3	-	-	-	-	-	-	-	-	3	3	3	2	2

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents			
Unit 1	**Controllers and Basics of DCS** Basic concepts of process control, Mathematical modeling of controllers, ON/OFF, P, PI, PD, PID controllers: characteristics and tuning methods, Distributed Control Systems (DCS): definition, need, architecture overview	6 Hrs
Unit 2	**Distributed Control System Architecture** Local Control Units (LCU): architecture and communication facilities, Configuration of DCS and display features, Case studies of DCS applications in industries.	6 Hrs
Unit 3	**Industrial Control Systems and SCADA** Data loggers and Data Acquisition Systems (DAS), Direct Digital Control (DDC): concept and implementation, Supervisory Control and Data Acquisition Systems (SCADA), Functional block diagram of computer control systems, alarms, interrupts, digital controller modes	6 Hrs
Unit 4	**Industrial Communication Protocols** Fieldbus in industrial plants: functions, performance, and standards, Ethernet networks in process control, Fieldbus design, installation, sensor networks, HART and Foundation Fieldbus networks, Advantages and limitations of open networks	6 Hrs

Unit 5	**Process and Plant Control**
	NC, CNC, and DNC machines: concepts and control, Process simulation and control, Plant/sub-plant study and instrumentation processes used in
	  a) Thermal power stations
	  b) Sugar, cement, paper industries
	  c) Pharmaceutical industries
		6 Hrs

Unit 6	**Fuzzy Logic Control** Fuzzy sets, fuzzy relations, and calculations, Membership functions and indices of fuzziness, Comparison of fuzzy quantities and methods to determine membership functions, Fuzzy logic–based controllers and industrial case studies.	6Hrs

Sr. No.	Text Books
1.	D. N. Considine – Process Instruments and Controls Handbook – McGraw-Hill
2	B. G. Lipták – Process Control: Instrument Engineers' Handbook – CRC Press
3	Wayne W. Bequette – Process Control: Modeling, Design and Simulation – Prentice Hall
4	Gopal M. Nair – Distributed Control Systems: Principles and Applications – I.K. International

	Reference Books	
1.	Stuart A. Boyer – SCADA: Supervisory Control and Data Acquisition – ISA / International Society of Automation	
2.	Jon Stenerson & Debra Swanson – Industrial Automation and Process Control – Pearson	
3.	William Bolton – Programmable Logic Controllers and Industrial Control – Elsevier / Newnes	
4.	D. Driankov, H. Hellendoorn, M. Reinfrank – An Introduction to Fuzzy Control – Springer	
	Web Resources	
1.	Introductory chapter on *New Trends in Industrial Automation* (IntechOpen — open access) https://www.intechopen.com/chapters/66195 (IntechOpen)	
2.	"Advanced Applications of Industrial Robotics: New Trends and Possibilities" (MDPI, open access) https://www.mdpi.com/2076-3417/12/1/135 (MDPI)	

Course Title: Wireless Mobile Communication		
Course Code: PE251101		**Course Category: PEC I**
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks

Course Prerequisite: Basic Knowledge of communication theory, digital modulation, electromagnetic theory, signal processing, networking, probability, and simulation tools (MATLAB, Python).

Course Description: Wireless Mobile Communication focuses on mobile communication principles, cellular systems, wireless network design, and protocols. It covers technologies like 4G/5G, handoff, channel allocation, and mobile IP for efficient mobile connectivity and data transfer.

Course Objectives:
1. To Understand mobile communication basics and cellular concepts.
2. To Learn wireless protocols and standards (4G/5G).
3. To Study signal propagation and interference.
4. To Analyze handoff and resource management.
5. To Design efficient mobile communication systems.

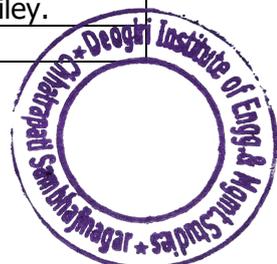| Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Understand the characteristics of wireless channels and broadband fading models.	L1 Remember
CO2	Analyze cellular processes, OFDM, and MIMO systems for performance evaluation.	L2 Understand
CO3	Apply wireless communication concepts to design systems with diversity, multiplexing, and multi-access techniques.	L3 Apply
CO4	Explore advanced wireless technologies and standards for modern communication applications.	L4 Analyze

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	-	2	-	-	-	-	-	-	-	-	3	2	2	2
CO2	2	3	-	2	3	-	-	-	-	-	-	-	3	3	2	2
CO3	-	-	3	-	3	-	-	-	2	-	2	-	2	3	3	2
CO4	-	-	-	-	2	3	2	-	-	3	-	3	2	3	3	3

Assessment	
CA-1 (a) (10M)	Assignment
CA-2 (b) (10M)	Assignment
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Wireless Channels and Diversity** Fast fading wireless channel modelling, Rayleigh and Ricean fading channels, BER performance in fading channels, Diversity techniques for wireless communications (frequency, time, space), BER improvement with diversity methods	6 Hrs
Unit 2	**Broadband Wireless Channel Modeling** WSSUS channel modeling and parameters, RMS delay spread and Doppler fading, Jakes model, autocorrelation, and Jakes spectrum, Impact of Doppler fading on system performance,	6 Hrs
Unit 3	**Cellular Communications** Introduction to cellular systems and frequency reuse, Multiple access technologies (FDMA, TDMA, CDMA, OFDMA), Cellular processes: call setup, handover procedures, roaming, Teletraffic theory fundamentals for wireless networks	6 Hrs
Unit 4	**OFDM Systems** Introduction to OFDM and multicarrier modulation, Cyclic prefix, channel models, and SNR performance, PAPR issues and mitigation techniques, Frequency and timing offset issues in OFDM.	6 Hrs
Unit 5	**MIMO Wireless Systems** MIMO fundamentals and channel capacity, SVD and eigenmodes of MIMO channels, Spatial multiplexing techniques (BLAST) and diversity methods (Alamouti, OSTBC, MRT), MIMO-OFDM concepts and applications.	6 Hrs
Unit 6	**UWB and Wireless Standards** UWB definition, features, and wireless channels, UWB modulation techniques and BER performance, Overview of 3G and 4G standards: GSM, GPRS, WCDMA, LTE, WiMAX, Key differences and applications of modern broadband wireless systems.	6 Hrs

Text Books	
1.	T. S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Pearson.
2.	A. Goldsmith – Wireless Communications, Cambridge University Press, 2005.
3.	David Tse and Pramod Viswanath – Fundamentals of Wireless Communication, Cambridge University Press, 2005.
4.	Andreas F. Molisch – Wireless Communications, Wiley, 2nd Edition, 2011.
5.	A. F. Molisch, Wireless Communications, Wiley.
Reference Books	
1.	Simon Haykin & Michael Moher, Modern Wireless Communications, Pearson.
2.	Andrea Goldsmith, Broadband Wireless Communications, Springer.
3.	William Stallings, Wireless Communications and Networks, Pearson.
4.	M. K. Simon and M. S. Alouini, Digital Communication over Fading Channels, Wiley.
5.	B. Sklar, Digital Communications: Fundamentals and Applications, Pearson.

Web Resources	
1.	A Comprehensive Review of 5G Wireless Communication: Spectrum Diversity with Technological Innovations and Current Challenges — *International Journal of Intelligent Systems and Applications in Engineering.* (IJISAE) Link → PDF / article (IJISAE)
2.	6G Wireless Communication Systems: Applications, Requirements, Technologies, Challenges, and Research Directions — arXiv preprint. (arXiv) Link → arXiv (arXiv)

Course Title: Artificial Neural Networks & Applications		
Course Code: PE251102		**Course Category: PEC-I**
Teaching Scheme	Examination Scheme	
Lectures:03hrs/week	CA-1	10 Marks
Tutorial:-----	CA-2	10 Marks
Credits:03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks

Course Prerequisite:

Course typically requires a strong foundation in mathematics (especially linear algebra, calculus, and probability) and programming (preferably Python), along with a basic understanding of machine learning principles.

Course Description:

An Artificial Neural Networks (ANN) and Applications course describes how ANNs, inspired by the human brain, use interconnected nodes (neurons) in layers to learn from data, recognize complex patterns, and make predictions for tasks like image analysis, language processing, and forecasting.

Course Objectives:

1. To introduce the neural networks for classification and regression
2. To give design methodologies for artificial neural networks
3. To demonstrate neural network applications on real-world tasks

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Define the differences between networks for supervised and unsupervised learning	L1 Remember
CO2	Explain the functionality of single and multi-layer feed-forward neural networks	L2 Understand
CO3	Apply their knowledge to design radial basis function networks and support vector machines for signal processing applications.	L3 Apply
CO4	Analyze PCA in the reduction of the feature vector dimension, and also develop self-organizing maps for real-world applications.	L4 Analyze

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1	-	-	1	-	-	-	-	-	-	-	2	2	2	2
CO2	1	2	2	2	-	-	-	-	-	-	-	1	3	3	2	2
CO3	-	2	2	1	2	-	-	-	-	-	-	2	3	3	2	2
CO4	-	2	-	1	2	-	2	-		-	-	2	3	3	2	3

Assessment	
CA-1(a) (10M)	Subjective Test/Open book test/etc.
CA-2(b) (10M)	Model Making/Assignment/Presentation/etc.
MSE(c) (20M)	Mid Sem Examination

Course Contents		
Unit1	**Introduction:** Neural networks characteristics, History of development in neural networks principles, Artificial neural net terminology, Model of a neuron, Topology, Learning, Types of learning, Supervised, Unsupervised, Reinforcement learning, knowledge representation and acquisition Learning Process: Competitive, Boltzmann learning, Credit Assignment Problem, Memory, Adaption, Statistical nature of the learning process.	6 Hrs
Unit2	**Single Layer Perceptions:** Adaptive filtering problem, Unconstrained Organization Techniques, Linear least square filters, least mean square algorithm, learning curves, Learning rate annealing techniques, perception – convergence theorem, Relation between perception and Bayes classifier for a Gaussian Environment.	6 Hrs
Unit3	**Multilayer Perceptions:** Back propagation algorithm XOR problem, Heuristics, Output representation and decision rule, Computer experiment, feature detection, Back propagation and differentiation, Hessian matrix, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning, accelerated convergence, supervised learning.	6 Hrs
Unit4	**Radial-Basis Function Networks:** Cover's theorem on the separability of patterns, separability and interpolation, Posed surface reconstruction, Solution of regularization equation: Greens function, Use of Greens function in regularization networks, Regularization networks and generalized RBF.	6 Hrs
Unit 5	**Support Vector Machines:** Optimal hyperplane for linearly separable patterns, Optimal hyperplane for non-separable patterns, How to build a support vector machine for pattern recognition, Support vector machines for nonlinear regression.	6 Hrs
Unit 6	**Principal Components Analysis:** Some intuitive principles of self-organization, Principal components analysis, Hebbian-based principal components analysis, Dimensionality reduction using PCA. Self-Organizing Maps: Basic feature mapping models, Self-organizing map, Learning vector quantization, Hierarchical vector quantization.	6 Hrs

Text Books	
1	B. Yegnanarayana - Artificial neural network PHI Publication.2005
2	S. Raj sekaran, Vijayalakshmi Pari - Neural networks, Fuzzy logic and Genetic Algorithms
Reference Books	
1	Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction - SPIE Press, 2005
2	Mohammad H. Hassoun – Fundamentals of artificial neural networks - MIT Press ,1995
3	S. Haykin, "Neural networks and Learning Machines", Pearson Education, 3rd Edition, 2013.
Web Resources	
1	https://ocw.mit.edu/courses/9-641j-introduction-to-neural-networks-spring-2005/
2	https://nptel.ac.in/courses/117105084

Course Title: Signal Processing Algorithms & Applications		
Course Code: PE251103	**Course Category: PEC-I**	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Basic knowledge of signals and systems, linear algebra, calculus, probability, and programming fundamentals.		
Course Description: This course introduces fundamental concepts and techniques of signal processing with emphasis on algorithms and applications in real-world systems.		
Course Objectives: The objective of this course is to develop an understanding of signal processing principles, design efficient algorithms, and explore their applications in practical domains.		

Course Outcomes:		
COs	**After completion of the course:** **Student should be able to**	**Bloom's Level**
CO1	Apply transform methods for analysis of discrete-time signals and systems.	L1 Remember
CO2	Analyze and design digital filters using various structures and techniques.	L2 Understand
CO3	Implement FIR and IIR filter design methods for practical applications.	L3 Apply
CO4	Demonstrate concepts of multirate signal processing and filter banks.	L4 Analyze

CO-PO Mapping

| CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	-	-	-	-	2	-	2	3	2	1	1
CO2	3	3	3	2	3	-	-	-	2	2	-	2	3	3	1	2
CO3	3	3	3	2	3	-	-	-	2	2	-	2	3	3	2	2
CO4	3	3	2	3	3	-	-	-	2	-	2	3	3	1	1	

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction and Transform Methods** Review of discrete-time signals and systems, transforms for discrete-time signal analysis (DTFT, DFT, Z-transform), Use of DFT in linear filtering and long data sequence processing, Spectrum computation and algorithms for convolution using DFT.	6 Hrs
Unit 2	**LTI Systems and Digital Filter Structures** Properties of LTI discrete-time systems in the transform domain, Simple digital filters: All-pass, Linear phase, Minimum/Maximum phase, Complementary transfer functions, FIR and IIR basic structures, Linear phase structures, Lattice structures (IIR, FIR, All-pass).	6 Hrs
Unit 3	**Digital Filter Design** General design considerations for digital filters, FIR filter design techniques (window and frequency sampling), IIR filter design from analog prototypes (Butterworth, Chebyshev, Elliptic), Frequency and spectral transformations in IIR filters, Least-square method for filter design.	6 Hrs
Unit 4	**Multirate Signal Processing** Sampling rate conversion concepts, Interpolators and decimators, polyphase decomposition, Analysis and synthesis filter banks, Orthogonal and orthonormal filter bank concepts	6 Hrs
Unit 5	**Signal Representation and Wavelets** Orthogonal representation of deterministic signals, Dimensionality of signal spaces, orthogonal basis functions, Time-bandwidth relationship, RMS duration, uncertainty relationsM, Multiresolution analysis and Wavelet Transform fundamentals.	6 Hrs
Unit 6	**Linear Prediction and Optimum Filter Design** Least-squares methods for system modeling and linear prediction, Adaptive filter concepts and algorithms (LMS, RLS – overview), Optimum filtering principles, Power spectrum estimation techniques.	6 Hrs

Text Books	
1	John G. Proakis, Dimitris G. Manolakis – Digital Signal Processing: Principles, Algorithms, and Applications – Pearson (Covers transforms, filter design, adaptive filters, multirate, spectrum estimation — a standard text)
2	A. V. Oppenheim, R. W. Schafer, J. R. Buck – Discrete-Time Signal Processing – Pearson (Strong on theory of DTFT, Z-transform, LTI systems, spectral analysis, filter design)
3	Sanjit K. Mitra – Digital Signal Processing: A Computer-Based Approach – McGraw-Hill (Practical approach with MATLAB examples, FIR/IIR design, multirate DSP)
4	P. P. Vaidyanathan – Multirate Systems and Filter Banks – Pearson (Authoritative text for Unit IV — interpolators, decimators, polyphase, filter banks, orthogonal/orthonormal basis)
Reference Books	
1	Simon Haykin, Barry Van Veen – Signals and Systems – Wiley (Good review of discrete-time signals, transforms, orthogonal basis, linear prediction fundamentals)
2	Monson H. Hayes – Statistical Digital Signal Processing and Modeling – Wiley (For optimum filters, spectrum estimation, linear prediction, LMS/RLS concepts)
3	K. P. Soman, K. I. Ramachandran – Insight into Wavelets: From Theory to Practice – Prentice Hall India (Dedicated wavelet treatment, multiresolution analysis, applications)
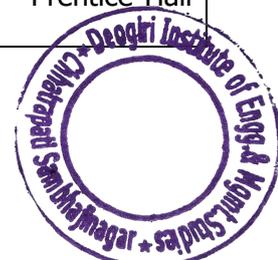
4	Andreas Antoniou – Digital Filters: Analysis, Design, and Applications – McGraw-Hill (Good advanced coverage of FIR/IIR structures, lattice structures, and filter design techniques)
Web Resources	
1	Signal Processing Algorithms and Architectures — NPTEL course by Prof. Anirban Dasgupta (IIT Guwahati) (NPTEL) https://onlinecourses.nptel.ac.in/noc25_ee176/preview
2	Digital Signal Processing and its Applications — NPTEL course by Prof. V. M. Gadre (IIT Bombay) (NPTEL) https://onlinecourses.nptel.ac.in/noc25_ee23/preview

Course Title: Advance Optical Fiber communication		
Course Code: PE251104		**Course Category: PEC-II**
Teaching Scheme	**Examination Scheme**	
Lectures: 03hrs/week	CA-1	10 Marks
Tutorial:-----	CA-2	10 Marks
Credits:03	MSE	20 Marks
Semester: First Year(Semester-I)	ESE	60 Marks

Course Prerequisite:
1. Basic knowledge of communication systems
2. Fundamentals of Optics: Understanding of light propagation, reflection, refraction, and basic properties of light
3. Basic Electronics and Semiconductor Physics

Course Description:

This course introduces the principles and practices of optical fiber communication systems. It covers fiber characteristics, light sources, detectors, switching systems, optical networks, and standards. Students will study optical amplifiers, WDM/DWDM technologies, access networks, and fiber protection techniques. Emphasis is placed on analyzing system performance, survivability, and applications in next-generation high-speed communication networks.

Course Objectives:

1.To understand the fundamentals of optical fiber communication, including fiber characteristics, light sources, and detectors.

2.To gain knowledge of switching systems, optical networks, and standards used in communication systems.

3.To study optical amplifiers and their role in WDM communication systems.

4.To explore optical networking concepts, including SONET/SDH, WDM/DWDM, and performance evaluation.

5.To learn architectures of access networks and next-generation optical networking technologies.

6. To analyze fiber optic protection techniques for reliability, survivability, and safety of communication

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Define the concepts of optical fiber communication, including fiber characteristics, attenuation, dispersion, light sources, detectors, amplifiers, and protection techniques.	L1 Remember
CO2	Explain the principles of switching systems, optical networks, WDM/DWDM, access networks, and optical amplification in modern communication systems.	L2 Understand
CO3	Apply suitable optical communication techniques, amplification methods, and networking approaches to design and implement reliable high-speed communication systems.	L3 Apply
CO4	Analyze the performance, limitations, and survivability of optical fiber communication systems, recommending suitable technologies for next-generation applications.	L4 Analyze

CO-PO Mapping

CO-PO Mapping																
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	1	-	-	-	-	-	-	-	2	2	3	3
CO2	3	2	1	-	2	-	-	-	-	-	-	-	2	2	2	2
CO3	3	3	2	2	3	-	-	-	-	-	-	-	2	2	2	2
CO4	3	3	2	3	2	-	-	-	-	-	-	-	2	2	2	2

Assessment	
CA-1 (a) (10M)	Subjective Test/Open booktest/etc
CA-2 (b) (10M)	Model Making/Assignment/Presentation/etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction** Optical fiber communication system, Attenuation, dispersion, Properties of light sources, detector	6 Hrs
Unit 2	**Switching systems and standards** Services, circuit switching, packet switching, optical networks, second generation optical networks, introduction to optical networks: layered view of optical networks, transparency and all optical networks, optical packet switching, wavelength standards, chirping, dispersion shifted fibers, non-zero dispersion fibers.	6 Hrs
Unit 3	**Optical Amplification** Doped Fiber Amplifiers, Semiconductor Optical Amplifiers, Raman Amplifiers, Optical Parametric Amplifier, Optical amplification in WDM communication systems.	6 Hrs
Unit 4	**Optical Networks** Basic networks, SONET/ SDH, wavelength routed networks, Nonlinear effects on network performance, performance of various systems (WDM, DWDM + SOA)	6 Hrs
Unit 5	**Access Networks** Network Architecture overview, Enhance HFC, Fiber to the Curb (FTTC), Buffering, Architectural choices for next generation optical networks.	6 Hrs
Unit 6	**Fiber optic protection techniques** Optical Safety, Open fiber control protocol, Network survivability: Unidirectional and Bidirectional Protection, Point to point links protection, Self healing rings, bidirectional line switched ring, Optical layer Protection schemes, Wave Length Conversion	6 Hrs

Text Books	
1	Ramaswami, Rajiv; Sivarajan, Kumar; Sasaki, Galen,"Optical Networks: A Practical Perspective" Morgan Kaufmann (edition 3rd), 2009
2	Biswanath Mukherjee, "Optical WDM Networks", springer, 2009
Reference Books	
1.	G.P. Agarwal, Fiber optic communication systems, 2nd Ed, John Wiley & Sons, New York, 1997.
2	Franz & Jain, Optical Communication Systems, Narosa Publications, New Delhi, 1 995
3	G. Keiser, Optical fiber communication systems, McGraw-Hill, New York, 2000.
4	Franz & Jain, Optical communication, Systems and components, Narosa Publications, New Delhi, 2000.
Web Resources	
1.	Advanced Optical Communication, IIT Bombay — NPTEL course page https://nptel.ac.in/courses/117101002
2	Fiber Optic Communication Technology, IIT Madras — NPTEL course page https://nptel.ac.in/courses/108106167

Course Title: Microelectronics			
Course Code: PE251105		**Course Category: PEC II**	
Teaching Scheme	**Examination Scheme**		
Lectures:03 hrs/week	**CA-1**	**10 Marks**	
Tutorial:-----	**CA-2**	**10 Marks**	
Credits:02	**MSE**	**20 Marks**	
Semester: First Year (Semester I)	**ESE**	**60 Marks**	

Course Prerequisite: Fundamentals of Semiconductor Devices (Diodes, BJTs, MOSFETs), Basics of Analog and Digital Electronic Circuits (UG level), Knowledge of Electronic Devices and Circuits Laboratory, Exposure to Signals & Systems and Basic Communication Principles.

Course Description: This course provides an in-depth understanding of semiconductor devices, analog and digital circuit design, IC fabrication, and advanced microelectronics applications. It covers MOS and BJT device models, scaling effects, and modern device structures. The course introduces analog building blocks such as current mirrors, differential amplifiers, and operational amplifiers, as well as digital circuits including CMOS logic, memory design, and low-power devices.

Course Objectives: Provide fundamental knowledge of semiconductor device operation and MOS/BJT modeling. Develop skills in designing analog circuits such as amplifiers, current mirrors, and op-amps. Enablestudentstodesigndigitalcircuitsandmemorystructuresconsideringpowerandscalingissues. Familiarize students with IC fabrication technologies and process integration.

Course Outcomes:

COs	After completion of the course: Student should be able to:	Bloom's Level
CO1	Explain the fundamentals of semiconductor physics, MOS, and BJT device operation	L1 Remember
CO2	Analyze and design analog microelectronic circuits such as current mirrors, differential amplifiers, and operational amplifiers	L2 Understand
CO3	Understand and evaluate IC fabrication technologies including lithography, doping, deposition, and testing	L4 Analyze
CO4	Apply microelectronic principles to mixed-signal, RF, MEMS, and advanced IC design applications	L5 Evaluate

CO-PO Mapping

CO-PO Mapping															
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	-	3	-	-	-	-	-	3	2	2	2
CO2	3	2	1	2	3	-	3	-	-	-	-	-	2	3	2	3
CO3	3	3	2	1	3	-	2	-	-	-	-	-	2	2	3	2
CO4	3	3	-	2	-	-	3	-	-	-	-	-	3	2	2	2

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Assignment
MSE(c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction to microelectronics and its scope:** Review of semiconductor physics: intrinsic and extrinsic semiconductors, carrier transport phenomena, p-n junction characteristics, small-signal and large-signal models, MOS capacitor: C–V characteristics, threshold voltage, charge distribution, Short-channel effects in MOS devices	6 Hrs
Unit 2	**MOSFET and Bipolar Devices:** MOSFET operation, I–V characteristics, sub threshold conduction, Scaling of Transistorize, hot-carrier effects, leakage currents, BJT fundamentals: operation, Ebers-Moll model, Gummel-Poon model, Comparison of MOSFETs and BJTs in integrated circuits, Advanced devices: Fin FETs, SOI MOSFETs, HEMTs.	6 Hrs
Unit 3	**Analog Microelectronic Circuits:** current mirrors, current sources, and active loads, Differential amplifiers: single-ended and differential operation, CMRR, Operational amplifiers: architecture, performance parameters, frequency compensation, Analog building blocks for signal processing, Low-power analog design considerations.	6 Hrs
Unit 4	**Digital Microelectronic Circuits:** CMOS logic gates: static and dynamic operation, Sequential circuits: latches, flip-flops, registers, Memory design: SRAM, DRAM, non-volatile memories (Flash, MRAM), Low-power digital design techniques.	6 Hrs
Unit 5	**Overview of IC fabrication process:** flow, Crystal growth, wafer preparation, oxidation, diffusion, ion implantation, Photolithography, etching, deposition (CVD, PVD),	6 Hrs
Unit 6	**Applications and Emerging Trends:** Mixed-signal ICs: ADCs, DACs, PLLs, RF and microwave integrated circuits, MEMS and sensors in microelectronics, VLSI and ULSI system design issues.	6 Hrs

Text Books	
1.	Sedra, A. S., and Smith, K. C. – Microelectronic Circuits – Oxford University Press (Comprehensive coverage of analog & digital circuits, op-amps, MOSFETs, BJTs)
2	Razavi, B. – Fundamentals of Microelectronics – Wiley (MOSFET, BJT operation, analog & digital design basics, excellent for undergraduates)
3	Millman, J., and Grabel, A. – Microelectronics – McGraw-Hill (Good for semiconductor physics, device models, fabrication process basics)
4	Streetman, B. G., and Banerjee, S. – Solid State Electronic Devices – Pearson (Covers semiconductor physics, MOS/BJT fundamentals, short-channel effects, advanced devices like Fin FETs, SOI)

Reference Books	
1.	Razavi, B. – Design of Analog CMOS Integrated Circuits – McGraw-Hill (Analog IC design, current mirrors, op-amps, low-power design techniques)
2	Weste, N. H. E., and Harris, D. – CMOS VLSI Design: A Circuits and Systems Perspective – Pearson (Digital microelectronics, CMOS logic, sequential circuits, SRAM/DRAM, low-power design)
3	Sze, S. M., and Ng, K. K. – Physics of Semiconductor Devices – Wiley (In-depth device physics, MOSFET scaling, HEMTs, advanced transistor technologies)
4	Jaeger, R. C., and Blalock, T. N. – Microelectronic Circuit Design – McGraw-Hill (Balanced treatment of analog, digital, and fabrication, with practical IC design examples)
Web Resources	
1.	**NPTEL – Microelectronics: Devices to Circuits** (IIT Roorkee) https://onlinecourses.nptel.ac.in/noc21_ee86/preview (NPTEL)

Course Title: Digital Image Processing and Applications	
Course Code: PE2521106	Course Category: PEC II

Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/week	CA-1	10 Marks
Tutorial:-----	CA-2	10 Marks
Credits:03	MSE	20 Marks
Semester First Year (Semester I)	ESE	60 Marks

Course Prerequisite:
Digital Signal Processing

Course Description:
Digital image processing deals with processing of images which are digital in nature. The first application is in improvement of pictorial information for human perception i.e. enhancing the quality of the image so that the image will have a better look. The second is for autonomous machine applications which have wider applications in industries, particularly for quality control in assembly automation and many similar applications. This course will introduce various image processing techniques, algorithms and their applications.

Course Objectives:
1. To Understand the fundamentals of digital image representation, sampling, quantization, and basic pixel relationships.
2. To Apply various image transforms (DFT, DCT, Wavelet, SVD, SIFT, Hough, etc.) for analysis and feature extraction.
3. To Develop techniques for image enhancement, restoration, denoising, and super-resolution in both spatial and frequency domains.
4. To Analyze image compression models, coding techniques, and international standards (JPEG, MPEG).
5. To Implement segmentation and representation methods for object detection, boundary analysis, and feature description.
6. To Utilize morphological image processing operations and explore applications in security, medical imaging, robotic surgery, and remote sensing.

Course Outcomes:		
COs	**After completion of the course:** **Student should be able to**	**Bloom's Level**
CO1	Define concepts of digital image processing including image representation, transformations, enhancement, restoration, compression, segmentation, morphology	L1 Remember
CO2	Explain image processing techniques and their significance in solving real-world imaging challenges.	L2 Understand
CO3	Apply suitable image processing technique to enhance, compress, restore, and segment images	L3
CO4	Analyze the efficiency and limitations of various image processing techniques and recommend suitable methods for different real-world applications.	L4 Analyze

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	2	2	2
CO2	3	2	1		2	-	-	-	-	-	-	-	2	2	2	2
CO3	3	3	3	2	3	-	-	-	-	-	-	-	3	3	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	-	3	3	2	2

Assessment	
CA-1(a) (10M)	Subjective Test/Open booktest/etc
CA-2(b) (10M)	Model Making/Assignment/Presentation/etc
MSE(c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Fundamentals of Digital Image Processing** Digital image representation, Fundamental steps in DIP, sampling and quantization, Basic relationships between pixels, Image geometry and transformations	6 Hrs
Unit 2	**Image Transforms** Two dimensional Discrete Fourier Transform, Discrete cosine transforms, Haar Transform, Discrete Wavelet Transform. Karhunen – Loeve transform. and SVD, Scale Invariant Feature Transform (SIFT), Hough Transform.	6 Hrs
Unit 3	**Image Enhancement, Restoration and Denoising** Image enhancement in spatial domain, enhancement through point processing, Histogram Processing, Basic grey level Transformations, Enhancement using arithmetic and logic operations. Image Enhancement in frequency domain, Image Smoothing, Image sharpening. Basic of Image Restoration and Classification Techniques, Classification on noise in image. Noise models, image denoising using linear filters, order statistics-based filters and wavelet shrinkage methods, Image super-resolution .	6 Hrs
Unit 4	**Image Compression** Image compression models, classification of image compression, Fundamentals of information theory, error free compression, variable length coding, Huffman coding, Arithmetic coding, bit plane coding,Run length coding, predictive coding, transform coding, image compression standards-JPEG, MPEG	6 Hrs
Unit 5	**Image Segmentation and Representation** Point, Line and Edge detection, Edge linking and boundary detection, Thresholding, Region based segmentation, Segmentation Using Morphological Watersheds, Image representation- Chain codes, Boundary and Regional	6 Hrs

	Descriptors. Graph-based techniques, Active Contours, Active Shape Models, Active Appearance Model.	
Unit 6	**Morphological Image Processing & Applications of Image Processing** Basic operations dilation and erosion, opening and closing operations, Basic Morphological algorithm such as region filling, thinning, thickening, pruning, skeletons, Numerical based on above. Applications: Security applications, Medical imaging , Robotic Surgery, Remote sensing	6 Hrs

Text Books	
1.	Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 4th Edition, 2018, Pearson, USA
2	Digital Image Processing- S Jayaraman, S. Essakkirajan, T. Veerakumar-TMH,2010
	Reference Books
1.	A. K. Jain, Fundamentals of Digital Image Processing, 2015, 3rd Edition, Pearson Education, USA
2.	William K. Pratt, Digital Image Processing, 2013, John Wiley & Sons, USA.
3.	S.Sridhar, Digital Image Processing, Oxford University Press
4.	Digital Image Processing using Matlab, Rafeal C. Gonzalez, Richard E. Woods, Steven L. Eddins, Pearson Education.
5.	Digital Image Processing and computer Vision-Somka, Halavac, Boyle - Cengage learning (Indian edition)2008
6.	Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology
	Web Resources
1.	Digital Image Processing (SWAYAM free online course, IIT Kharagpur) https://www.getyoureducation.net/course/digital-image-processing (getyoureducation.net)
2.	Digital Image Processing Applications (Open-access book, IntechOpen) https://www.intechopen.com/books/10991 (IntechOpen)

Course Title: Seminar		
Course Code: PE251401		**Course Category: VSE**
Teaching Scheme	**Examination Scheme (As Applicable)**	
Practical's/Sessions: 02 Hours/Week	CA-I	15 Marks
	CA-II	15 Marks
Semester: First Year (Semester-I)	ESE	20 Marks

Course Prerequisite:
1. Basic understanding of core subjects in specialization, Ability access, and interpret scientific literature.
2. Exposure to technical report writing and presentation.

Course Description:
The M.Tech Seminar course is designed to enhance student ability to identify, analyze and present research-oriented or industry-relevant topics related to their field of specialization. It provides a platform to review recent literature, critically analyze methodologies, and effectively communicate technical concepts written and oral forms. The course emphasizes independent learning analytical thinking presentation and interaction with peers and faculty to prepare students for research and professional careers.

Course Objectives:
1. To enhance the ability to conduct a comprehensive literature review on a selected research/technical topic.
2. To develop skills in critical analysis, organization, and synthesis of technical information.
3. To improve proficiency in technical report writing and formatting.
4. To strengthen communication skills through oral presentation and discussion.
5. To build confidence in defending technical ideas and responding to queries effectively.

Course Outcomes:		
COs	**After completion of the course:** **Students should be able to**	**Bloom's Level**
CO1	Identify and select a relevant research topic in E & TC Engineering through a literature survey.	L3–Apply
CO2	Analyze and summarize state-of-the-art developments in the chosen area.	L4 – Analyze
CO3	Prepare a well-structured seminar report following technical writing standards.	L5 – Evaluate
CO4	Deliver an effective oral presentation with clarity and professionalism.	L6- Create

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
									CO-PO Mapping							
CO1	3	2	1	3	2	1	1	1	2	2	1	3	3	3	2	1
CO2	3	3	2	3	2	1	1	1	2	2	1	3	2	2	3	2
CO3	2	2	2	1	2	1	1	2	2	3	2	3	3	2	2	1
CO4	1	1	1	2	1	1	1	1	3	3	2	3	1	2	1	1

Course Content
The seminar requires each candidate to prepare a report on a topic that they and their supervisor have mutually agreed upon. This topic must be a current problem in the field of Mechanical Engineering and should have a strong research orientation. The candidate is expected to demonstrate a thorough understanding of the recent developments related to their chosen topic. Once the report is complete, the candidate will present it to an examining committee, as well as to other faculty members from the department. The PG coordinator and the Head of the Mechanical Engineering Department will form this committee to evaluate the seminar.

Assessment

Evaluation and Examination

The seminar will be evaluated out of a total of 50 marks, with 30 marks for internal assessment and 20 marks for the semester-end examination. The semester-end examination will be conducted by a committee of three faculty members. Students must submit their completed reports, which should be authenticated by both their guide and the Head of the Department. Each student will individually present their work to the committee, who will then evaluate them and award marks.

CA-I (a) (15M)	Review-I: 15 Marks (Concept/knowledge in the topic:10 marks, Literature: 05 marks)
CA-II (b) (15M)	Review-II: 15 Marks (Report writing & Presentation: 15 Marks)
ESE (Practical/viva voce (c) (20M)	20 Marks (Individual evaluation through viva voce/test:20 marks)
Total (d) (50)	50 Marks

Course Title: PG Lab		
Course Code: PE251402		Course Category: VSE
Teaching Scheme	**Examination Scheme (As Applicable)**	
Practicals/Sessions: 02 Hours/Week	CA-I	15 Marks
	CA-II	15 Marks
Semester: First Year (Semester-I)	ESE	20 Marks
Course Prerequisite: Basic knowledge of Digital Signal Processing, Communication Systems, VLSI, Embedded Systems, and Image Processing.		
Course Description: This laboratory course focuses on simulation-based experiments in communication, biomedical, VLSI, sensor networks, and image processing using MATLAB and virtual lab platforms.		
Course Objectives: 1. To simulate and analyze advanced communication and signal processing systems. 2. To apply biomedical signal analysis for diagnostic feature extraction. 3. To design and evaluate digital filters for noise reduction. 4. To model and simulate VLSI logic circuits. 5. To compare routing protocols in wireless sensor networks. 6. To implement and analyze image processing algorithms for edge detection and segmentation.		

Course Outcomes:		
COs	**After completion of the course:** **Student should be able to**	**Bloom's Level**
CO1	Simulate and analyze advanced communication and signal processing systems using MATLAB and virtual platforms.	L1 Remember
CO2	Acquire, process, and interpret biomedical and image signals for feature extraction and classification.	L2 Understand
CO3	Design and evaluate digital filters and VLSI logic circuits for performance optimization.	L3 Apply
CO4	Compare and implement routing protocols in wireless sensor networks for energy-efficient communication.	L4 Analyze

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	3	-	-	-	2	2	3	3	3	2	2	
CO2	3	2	2	-	2	-	-	-	2	-	2	2	2	2	2	
CO3	3	3	3	2	3	-	-	-	2	2	3	3	3	2	2	
CO4	3	2	2	-	3	1	1	1	1	2	2	3	3	1	2	1

Assessment	
CA-I (a) (15M)	Laboratory performance and attendance Lab records and technical reporting
CA-II (b) (15M)	Experiment conduction, observation, and data collection Marks Viva-voce (during lab sessions)
Practical (d) (20M)	Particular Experiment number

Sr. No.	List of Experiments/Activities	Hours
1	To simulate a MIMO-OFDM communication system and evaluate BER performance under different channel conditions.	2 Hr
2	To acquire and process ECG signals, filter noise, detect QRS complexes, and compute heart rate variability.	2 Hr
3	To design and analyze FIR filters using Window methods and IIR filters using Butterworth/Chebyshev	2 Hr
4	To model and simulate CMOS inverter, NAND, and NOR circuits; study transfer characteristics, power, and delay.	2 Hr
5	To simulate sensor node deployment and compare routing protocols for energy efficiency and network lifetime.	2 Hr
6	To apply and compare edge detection algorithms and segmentation techniques on digital/medical images.	2 Hr

Text Books
1. Lab Manuals and Recent Research Papers related to analog and digital communication, Various Authors, Various Publishers, Latest Editions.

Reference Books
1. Behzad Razavi – Design of Analog CMOS Integrated Circuits, McGraw Hill (Advanced CMOS/VLSI simulations)
2 John G. Proakis & Dimitris K. Manolakis – Digital Signal Processing: Principles, Algorithms, and Applications, Pearson
3 Rajkamal – Embedded Systems: Architecture, Programming and Design, Tata McGraw Hill
4 Andrea Goldsmith – Wireless Communications, Cambridge University Press

Web Resources
1. Digital Signal Processing (DSP) Virtual Lab — IIT Kharagpur, Hands-on experiments you can run online — including FIR/IIR filter design with window methods, FFT, convolution, etc.
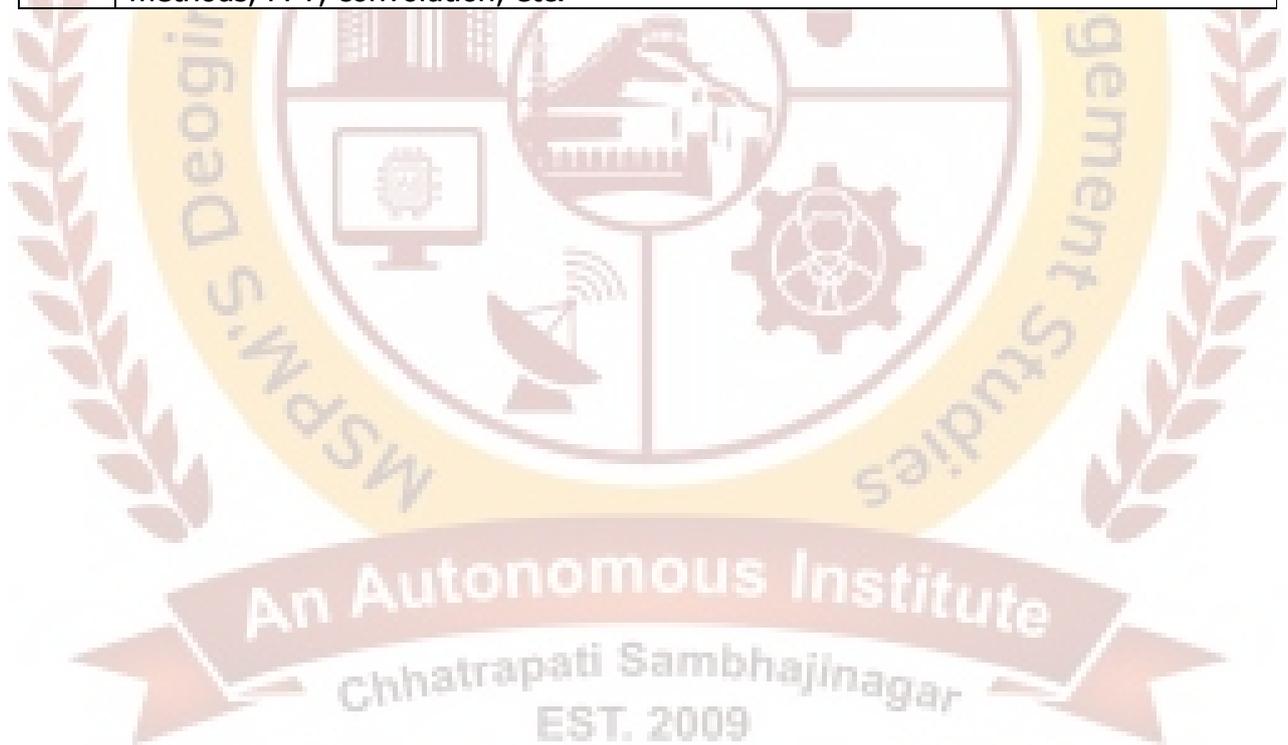
Course Title: Advance Digital Communication Systems		
Course Code:PE252004		**Course Category: PCC**
Teaching Scheme	**Examination Scheme**	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks
Course Prerequisite: Digital communication, Probability Theory, Signal Processing, Linear Algebra, and Basic Communication Systems.		
Course Description: Advanced Digital Communication System explores advanced modulation, coding, detection, and channel modeling techniques to design and analyze modern digital communication systems.		
Course Objectives: The course aims to help students learn advanced modulation and coding techniques, analyze detection and estimation methods, model and evaluate communication channels, assess error performance, explore spread spectrum and multicarrier systems, and design and optimize digital communication systems.		

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Explain the concepts of sampling, quantization, waveform coding, and their role in digital communication systems.	L2 Understand
CO2	Analyze digital modulation techniques (binary, quaternary, and M-array) with respect to bandwidth efficiency, error performance, and inter symbol interference.	L4 Analyze
CO3	Apply error control coding methods (block codes, cyclic codes, convolutional codes, and trellis codes) to improve reliability of digital communication.	L3 Apply
CO4	Evaluate and design spread spectrum communication systems using PN sequences, DSSS, and FHSS for practical applications.	L5 Evaluate

CO-PO Mapping																
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2			1							1	2	3	2	1
CO2	3	3	2	2	2							3	2	3	1	3
CO3	3	2	2	2	3	2						2	2	3	3	2
CO4	3	3	3	2	3		2					1	2	3	1	1

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Case Study /Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Sampling Process** Sampling theorem for low-pass and bandpass signals, Quadrature sampling and reconstruction of message signals from samples, Signal distortion in sampling and practical aspects of signal recovery, Pulse Amplitude Modulation (PAM) and Time Division Multiplexing (TDM)	6 Hrs
Unit 2	**Waveform Coding Techniques** Pulse Code Modulation (PCM): quantization noise and signal-to-noise ratio, Channel noise, error probability, and robust quantization, Differential PCM (DPCM), delta modulation, and adaptive techniques, Applications of waveform coding.	6 Hrs
Unit 3	**Digital Modulation Fundamentals** Digital modulation formats: coherent and non-coherent binary techniques, Coherent quadrature modulation and quaternary formats, Comparison of binary and quaternary techniques, Effect of intersymbol interference (ISI) on modulation schemes.	6 Hrs
Unit 4	**M-ary Modulation and Synchronization** M-ary modulation techniques and bandwidth efficiency, Power spectral properties and channel capacity considerations, Bit error vs. symbol error probabilities, Synchronization methods in digital communication.	6 Hrs
Unit 5	**Error Control Coding** Rationale and types of error control codes, Discrete memoryless channels, linear block codes, and cyclic codes, Convolutional codes: distance properties, maximum likelihood and sequential decoding, Trellis codes and coding applications	6 Hrs
Unit 6	**Spread Spectrum Techniques** Pseudo-noise (PN) sequences and principles of spread spectrum, Direct Sequence Spread Spectrum (DSSS) with coherent BPSK: signal space and processing gain, Frequency Hop Spread Spectrum (FHSS) and probability of error, Applications of spread spectrum systems.	6 Hrs

Text Books	
1.	Digital Communications by John G. Proakis
2	Principles of Digital Communication by Robert G. Gallager
3	Digital Communication Systems by Simon Haykin
4	Digital and Analog Communication Systems by K. Sam Shanmugam
5	Error Control Coding: Fundamentals and Applications by S. Lin and D. J. Costello
Reference Books	
1.	Modern Digital and Analog Communication Systems B.P. Lathi & Zhi Ding
2.	Digital Communications: Bernard Sklar
Web Resources	
1	IIT Madras / IIT Kanpur / IIT Kharagpur (variants exist) Platform: NPTEL (SWAYAM)

Course Title: MOOC/SWAYAM		
Course Code: PE252005		Course Category: PCC
Teaching Scheme	**Examination Scheme**	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks

Course Description:

This course is part of a curated set of MOOCs offered, with the specific courses selected and approved by the Board of Studies (BoS) to ensure alignment with current academic and industry standards.

Course Title: Wireless Sensor Network Design		
Course Code: PE252107		**Course Category: PEC -III**
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks

Course Prerequisite: Students should have prior knowledge of computer networks, digital communication, and basic embedded systems concepts. Familiarity with wireless communication fundamentals and microcontroller programming is desirable.

Course Description: This course provides an in-depth understanding of wireless sensor networks (WSNs), covering node architecture, communication protocols, operating systems, synchronization, power management, and security mechanisms. It emphasizes practical applications in domains such as healthcare, agriculture, environmental monitoring, and intelligent transportation systems.

Course Objectives: The primary objective of this course is to introduce students to the principles, design challenges, and architectures of WSNs. It aims to develop the ability to analyze and apply energy-efficient protocols, synchronization, and security techniques for reliable sensor network operation. Students will also gain exposure to sensor network operating systems, physical layer design issues, and routing strategies for real-world applications.

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Explain the fundamentals of wireless sensor networks, sensing principles, and their key application domains.	L1 Remember
CO2	Analyze the architecture and design considerations of sensor nodes including sensing, processing, and communication subsystems	L2 Understand
CO3	Apply power management, synchronization techniques, and security mechanisms to enhance WSN performance.	L3 Apply
CO4	Compare and evaluate operating systems designed for wireless sensor networks with respect to functional and non-functional requirements.	L4 Analyze

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	1	1	2	2	1			1		2	1	2	3
CO2	3	3	2	2	1	1	2						1	2	2	2
CO3	3	2	1	2	2	2	1						1	3	3	1
CO4	2	1	1	1	2	2	1						1	2	2	1

Assessment	
CA-1 (a) (10M)	Subjective Test
CA-2 (b) (10M)	Assignment
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction and Applications** Motivation for networks of wireless sensor nodes, Sensing principles and sensor types, Wireless network fundamentals for WSN, Design challenges and resource constraints in sensor networks Key applications: healthcare, agriculture, traffic monitoring, environmental systems.	6 Hrs
Unit 2	**Architectures of Wireless Sensor Nodes** Node architecture and design considerations, Sensing subsystem, processor subsystem, and communication subsystem, Interface and energy efficiency aspects,Case studies of sensor node platforms: LMote, XYZ, Hogthrob architectures.	6 Hrs
Unit 3	**Power Management, Synchronization, and Security** Power management techniques: local power, processor and communication subsystems, Time synchronization: need, challenges, and ranging techniques overview, Security in WSN: fundamentals, major threats, and attacks, Protocol mechanisms and lightweight security approaches.	6 Hrs
Unit 4	**Operating Systems for Sensor Networks** Functional and non-functional aspects of WSN operating systems, Overview of popular sensor OS prototypes: Tiny OS, SOS, Contiki, Lite OS, Introduction to sensor grid concepts and distributed OS features.	6 Hrs
Unit 5	**Physical Layer Design** Physical layer components for WSN, Source encoding and channel encoding methods, Modulation schemes for low-power networks, Signal propagation challenges in wireless sensor deployments	6 Hrs
Unit 6	**MAC and Network Layer Protocols** Medium Access Control (MAC) types, protocols, standards, and performance metrics, Network layer routing metrics and protocol requirements, Overview of routing techniques for energy-efficient and reliable communication.	6 Hrs

Text Books	
1.	Feng Zhao, Leonidas J. Guibas – Wireless Sensor Networks: An Information Processing Approach – Morgan Kaufmann
2	Kazem Sohraby, Daniel Minoli, Taieb Znati – Wireless Sensor Networks: Technology, Protocols, and Applications – Wiley
3	C. S. Raghavendra, Krishna M. Sivalingam, Taieb Znati (Eds.) – Wireless Sensor Networks – Springer
4	Anna Hac – Wireless Sensor Network Designs – Wiley
Reference Books	
1.	Holger Karl, Andreas Willig – Protocols and Architectures for Wireless Sensor Networks – Wiley
2	Edgar H. Callaway Jr. – Wireless Sensor Networks: Architectures and Protocols – CRC Press
3	Sergios Theodoridis, Rama Chellappa (Eds.) – Academic Press Library in Signal Processing: Sensor Networks – Elsevier
4	Philip Levis et al. – TinyOS Programming – Cambridge University Press
Web Resources	
1.	Wireless Ad Hoc and Sensor Networks (IIT Kharagpur) This is one of the primary NPTEL/SWAYAM courses covering ad-hoc & wireless sensor network fundamentals, architecture, MAC, routing, power, security, etc
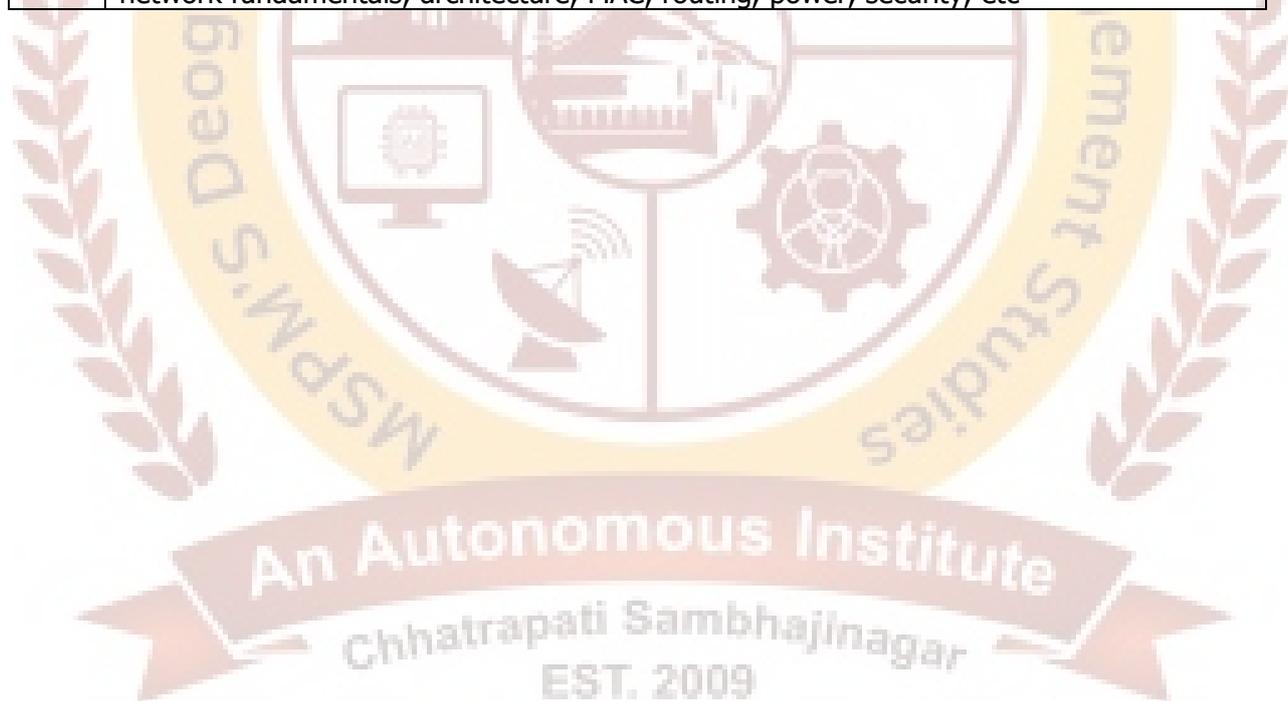
Course Title: Advance Embedded System Design		
Course Code: PE252108		**Course Category: PEC-III**
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks
Course Prerequisite: Basic knowledge of microprocessors, digital electronics, computer architecture, and C/C++ programming.		
Course Description: Study of hardware-software co-design, architectures, and programming techniques for developing efficient embedded systems.		
Course Objectives: Course Objectives: To equip students with the knowledge and skills to design, analyze, and implement reliable and efficient embedded systems.		

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Apply embedded system design principles by analyzing life-cycle models, identifying requirements, formulating specifications, and utilizing appropriate development tools.	L3 Apply
CO2	Demonstrate knowledge of ARM Cortex-M3 architecture including registers, stack, program counter, exceptions, interrupts, and instruction sets for efficient system design.	L2 Understand
CO3	Implement assembly and C programs on Cortex-M3/M4 processors using CMSIS, exception handling, vector table relocation, and interrupt-driven techniques.	L3 Apply
CO4	Illustrate the concepts of Linux operating system at the user level by creating processes, managing threads, implementing inter-process communication (IPC) using pipes, semaphores, mutexes, and shared memory.	L2 Understand

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	2	2	-	2						3	1	2	3
CO2	3	2	2	1	2	-							2	3	2	1
CO3	3	3	3	2	3	-		2					1	2	2	1
CO4	3	2	2	2	3	-	3						2	2	2	1

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction to Embedded Systems** Introduction to Embedded Systems, Architecture of Embedded System, Design Methodology, Design Metrics, General Purpose Processor, and System On chip. **Embedded system design and development:** Embedded system design, Life-Cycle Models, Problem solving, The design process, Requirement identification, Formulation of requirements specification. Development tools.	6 Hrs
Unit 2	**Overview of Cortex-M3 Cortex-M3 Basics**: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions.	6 Hrs
Unit 3	**Exceptions:** Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, Supervisor Call and Pendable Service Call,NVIC	6 Hrs
Unit 4	**Cortex-M3/M4 Programming:** Cortex-M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. **Exception Programming:** Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation. **Memory Protection Unit and other Cortex-M3 features:** MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication.	6 Hrs
Unit 5	**Linux OS Introduction & User Level Programming:** User/Kernel Model, Processes, Daemons, Threads, System Calls, Shell, Shell, Virtual Memory. Executable file layout Creating Processes, Linking/Loading, Signals, Shared Library, Threads and multithreaded program, Semaphores, Mutex, IPC mechanism Pipes, Shared memory.	6 Hrs
Unit 6	**Kernel Internals Basics** Process Internal representation, Linux File System Abstraction, Virtual File system, iNodes, files, /proc, Kernel Queue Data Structure, Memory Allocation (buddy system, slab cache), Embedded File systems	6 Hrs

Text Books	
1.	Raj Kamal – Embedded Systems: Architecture, Programming, and Design – McGraw Hill (Great for introductory concepts, architecture, design methodology, and tools)
2	Jonathan W. Valvano – Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers – CreateSpace (Strong coverage of Cortex-M3/M4 basics, registers, instruction set, interrupts, programming in C and Assembly)
3	Joseph Yiu – The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors – Newnes/Elsevier (Best reference for ARM Cortex-M architecture, NVIC, MPU, programming details, and exceptions)
4	Christopher Hallinan – Embedded Linux Primer: A Practical Real-World Approach – Pearson (Covers Linux OS introduction, user/kernel programming, processes, threads, IPC, embedded file systems)
Reference Books	
1.	David E. Simon – An Embedded Software Primer – Addison Wesley (Classic reference for embedded software design, life-cycle models, problem-solving approach)
2	Michael Barr, Anthony Massa – Programming Embedded Systems in C and C++ – O'Reilly (Hands-on focus on embedded programming with C, debugging, toolchains)
3	Kurt Wall, Mark Watson, Mark Whitis – Linux Programming by Example: The Fundamentals – Addison Wesley (Good for system calls, processes, threads, signals, IPC mechanisms in Linux)
4	Daniel P. Bovet, Marco Cesati – Understanding the Linux Kernel – O'Reilly (For kernel internals: process management, VFS, memory allocation, /proc, data structures)
Web Resources	
1	Embedded Systems Design – NPTEL Course https://nptel.ac.in/courses/108105156

Course Title: Biomedical Signal Processing		
Course Code:PE252109		**Course Category: PEC-III**
Teaching Scheme		**Examination Scheme**
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks
Course Prerequisite: Fundamentals of signals and systems, basic digital signal processing, and linear algebra.		
Course Description: This course focuses on the analysis, processing, and interpretation of biomedical signals using advanced signal processing techniques for healthcare applications.		
Course Objectives: Students will be able, 1. To study different types of biomedical signal. 2. To analyze and identify different biomedical signals. 3. Exposure and applications related to biomedical signal processing		

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Describe the origin, types, and parameters of bio-signals and explain the role of electrodes and signal acquisition systems.	L1 Remember
CO2	Apply Fourier, wavelet, and statistical techniques (PCA, ICA, regression, correlation) for the processing and interpretation of biomedical signals..	L2 Understand
CO3	Classify and analyze deterministic, stochastic, and non-stationary bio-signals using spectral, multiresolution, and chaotic signal analysis approaches	L3 Apply
CO4	Design and implement pattern classification methods (supervised/unsupervised, neural networks, SVM, HMM) for biomedical applications.	L4 Analyze

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	1	2	-	-	-	1	2	-	2	3	2	3	1
CO2	3	3	3	2	3	-	-	-	2	2	2	3	3	3	1	2
CO3	3	3	3	2	3	-	-	-	2	3	2	3	3	3	1	1
CO4	3	3	3	3	-	-	-	2	3	3	3	3	3	1	2	

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, study of diagnostically significant bio-signal parameters	6 Hrs
Unit 2	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	6 Hrs
Unit 3	Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time-frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)	6 Hrs
Unit 4	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.	6 Hrs
Unit 5	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).	6 Hrs
Unit 6	Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.	6 Hrs

Text Books	
1.	Rangayyan, R. M. – Biomedical Signal Analysis: A Case-Study Approach – Wiley/IEEE Press
2	D. C. Reddy – Biomedical Signal Processing: Principles and Techniques – McGraw-Hill
3	Metin Akay – Biomedical Signal Processing – Academic Press
4	Willis J. Tompkins (Ed.) – Biomedical Digital Signal Processing – Prentice Hall
Reference Books	
1.	S. Palani, A. Balasubramanian – Biomedical Signal Processing: Principles and Techniques – PHI Learning
Web Resources	
1.	https://onlinecourses.swayam2.ac.in/nptel20_bi16/preview
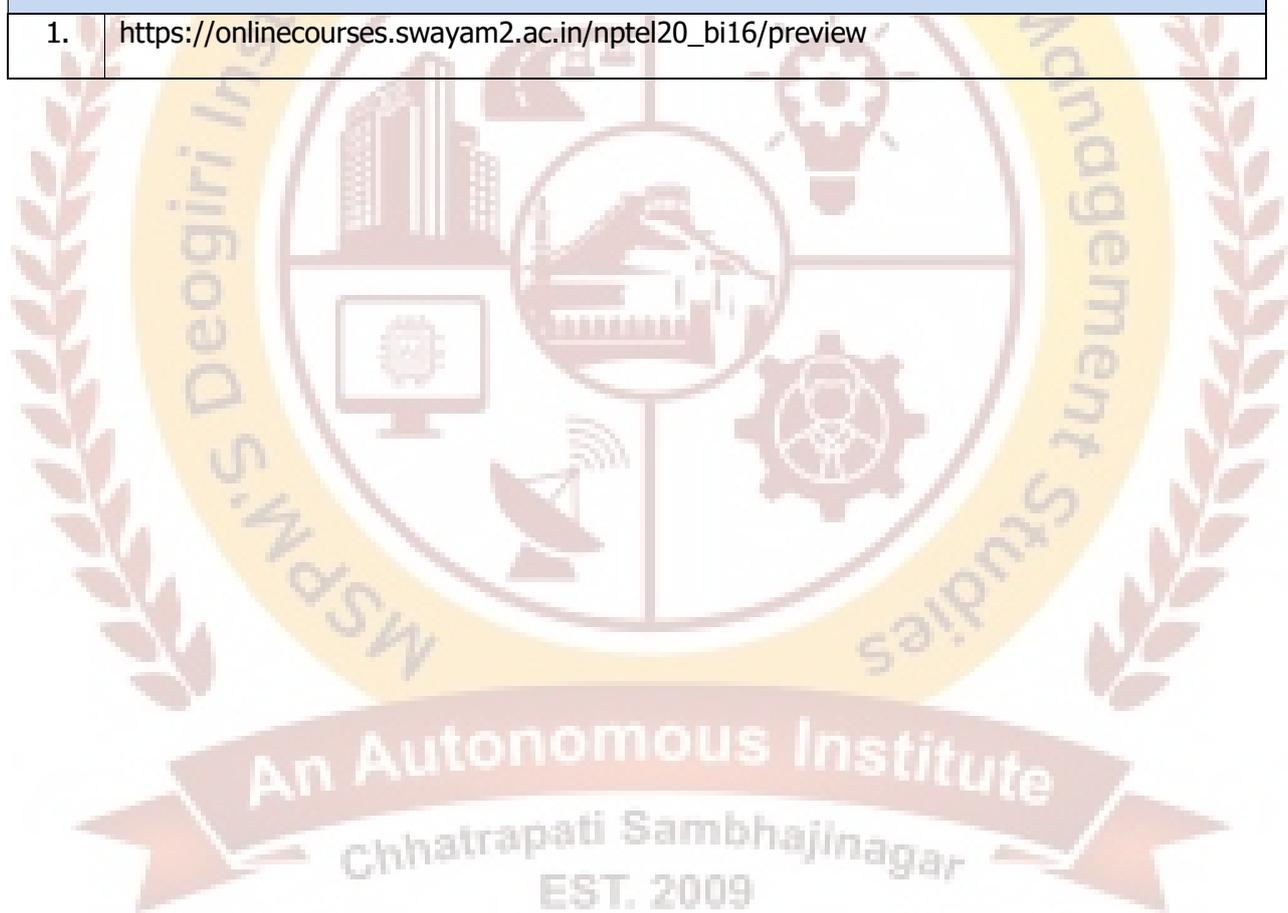
Course Title: IoT and Systems			
Course Code:PE252110		Course Category:PEC IV	
Teaching Scheme		**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1		10 Marks
Tutorial: -----	CA-2		10 Marks
Credits: 03	MSE		20 Marks
Semester: First Year (Semester II)	ESE		60 Marks

Course Prerequisite: Students should have basic knowledge of digital electronics, computer networks, and microcontroller programming. Familiarity with embedded systems and automotive fundamentals will be an added advantage.

Course Description: This course introduces the fundamentals of automotive systems along with the principles of IoT hardware and communication. It covers IoT architectures, protocols, networking basics, embedded communication interfaces, system design principles, and applications across various domains, including home automation, agriculture, industry, and transportation.

Course Objectives: The course aims to provide students with an understanding of automotive subsystems and the role of IoT in modern connected vehicles and environments. It seeks to develop knowledge of IoT architectures, communication protocols, and hardware platforms, while fostering skills in prototyping, system integration, and application design using embedded platforms like Arduino and Raspberry Pi.

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	**Explain** the fundamentals of IoT, its applications, benefits, challenges, and key components including DSP, transmission, backend analysis, and power considerations.	L2 Understand
CO2	**Differentiate and select** suitable sensors, actuators, and transducers for IoT systems by analyzing their characteristics, interfaces, and energy requirements.	L4 Analyze
CO3	**Illustrate** the architecture of IoT and the Web of Things, highlighting standards, security, privacy, and enterprise data management.	L2 Understand
CO4	**Compare and apply** IoT protocols and software such as MQTT, CoAP, HTTP, XMPP, and gateway solutions for specific IoT applications	L3 Apply

CO-PO Mapping															
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2			1			2					3	1	1	2
CO2	3	3	2	2	2								1	2	2	1
CO3	2	2		2	2	2				2			1	3	2	1
CO4	3	2	2	2	3								1	2	1	2

Assessment	
CA-1 (a) (10M)	Subjective Test
CA-2 (b) (10M)	Assignment
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**IoT Introduction and Fundamentals:** Deciphering the term IoT Applications, where IoT can be deployed, Benefits/Challenges of deploying an IoT, IoT components: Digital Signal Processing, Data transmission, Choice of channel (wired/wireless), back-end data analysis. Understanding packaging and power constraints for IoT implementation.	6 Hrs
Unit 2	**Signals, Sensors, Actuators, Interfaces:** Introduction to sensors, transducers and Actuator, Introduction to electrodes & biosensors, Static and dynamic characteristics of sensors, Different types of sensors/ actuators, Selection criteria's for sensors/transducers/ actuators, Signal conditioning modules of IoT system, Energy and power considerations, , Wireless sensor node structure, positioning topologies for IoT infrastructure.	6 Hrs
Unit 3	**The Architecture of IoT :** Opportunities for IoT, Some interesting IoT projects\ Architecture of IoT. The Web of Things: Linked data-value is greatest when linked, Enterprise data – shared v. public v. private, Importance of security, privacy and authenticity Standards, Web of Things layer – driver for IOT systems	6 Hrs

Unit 4	**IoT protocols and software:** MQTT, UDP, MQTT brokers, publish-subscribe modes, HTTP, COAP, XMPP and gateway protocols.	6 Hrs
Unit 5	**IoT point-to-point communication technologies**: IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE, SIG, NFC, LORA, LiFi, Widi)	6 Hrs
Unit 6	**IoT application and its Variants. Case studies**: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of Things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards, Interfacing sensors with target boards (Arduino/ESP32/Raspberry Pi).	6 Hrs

Text Books	
1.	**Arshdeep Bahga, Vijay Madisetti** – *Internet of Things: A Hands-On Approach* – Universities Press
2	Cuno Pfister – Getting Started with the Internet of Things – O'Reilly
3	Adrian McEwen, Hakim Cassimally – Designing the Internet of Things – Wiley
4	Daniel Minoli – Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications – Wiley
Reference Books	
1.	Olivier Hersent, David Boswarthick, Omar Elloumi – The Internet of Things: Key Applications and Protocols – Wiley
2	Pethuru Raj, Anupama C. Raman – The Internet of Things: Enabling Technologies, Platforms, and Use Cases – CRC Press
3	Raj Kamal – Internet of Things: Architecture and Design Principles – McGraw Hill
4	Marco Giordano, Claudio Pastrone et al. – IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – Cisco Press
Web Resources	
1.	https://onlinecourses.swayam2.ac.in/

Course Title: Analog VLSI Design	
Course Code: PE252111	**Course Category: PEC-IV**

Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks

Course Prerequisite: Basic knowledge of Digital Circuits, Analog Electronics and Designing concepts.

Course Description: This course provides an in-depth study of analog VLSI design principles, focusing on MOS device physics, CMOS technology, and analog building blocks. It covers operational amplifier design, data converters, and analog layout techniques with an emphasis on performance optimization and reliability. Students will gain hands-on experience in designing low-power, high-performance analog circuits for modern VLSI applications.

Course Objectives:
1. To introduce fundamental concepts of analog VLSI design, MOS device modeling, and CMOS technology.
2. To develop skills for designing key analog circuits such as current mirrors, differential amplifiers, and operational amplifiers.
3. To impart knowledge of analog layout techniques, matching strategies, and reliability considerations.
4. To provide understanding of data converters, analog signal processing circuits, and advanced low-power design techniques.

Course Outcomes:		
COs	**After completion of the course:** **Student should be able to**	**Bloom's Level**
CO1	Analyze the fundamental concepts of analog VLSI design, MOS device physics, CMOS technology to differentiate between analog and digital circuits.	L4 Analyze
CO2	Design and implement basic analog building blocks such as current mirrors, differential amplifiers, gain stages, and operational amplifiers with appropriate biasing and frequency response considerations.	L4 Analyze
CO3	Apply analog layout techniques including matching strategies, parasitic effect minimization, and reliability measures for efficient and robust circuit design.	L5 Evaluate
CO4	Evaluate and design data converters (ADC/DAC) and advanced analog systems like filters, PLLs, and low-power circuits by assessing key performance metrics such as INL, DNL, SNR, and ENOB.	L5 Evaluate

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	-	-	-	-	-	2	3	-	2	2	1	2	2
CO2	3	3	2	2	-	-	-	-	2	3	-	3	2	2	1	2
CO3	2	2	3	-	-	-	-	-	3	3	2	-	2	1	3	2
CO4	2	2	-	3	3	-	-	-	2	2	-	3	3	2	2	3

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	Introduction to Analog VLSI Design, Introduction to VLSI and its analog aspects, Differences between Analog and Digital VLSI, Basic MOS device physics and modeling, MOSFET as an analog device CMOS technology overview: scaling, fabrication basics Review of basic analog building blocks	6 Hrs
Unit 2	Analog CMOS Sub circuits , Current mirrors and biasing techniques, Differential amplifiers, Gain stages and output stages, Common-mode feedback (CMFB), Frequency response of analog circuits	6 Hrs
Unit 3	Operational Amplifier Design, One-stage and two-stage op-amps, Telescopic and folded cascode op-amps, Slew rate, power dissipation, gain-bandwidth product, Compensation techniques: Miller, pole-zero cancellation	6 Hrs
Unit 4	Analog Layout Techniques, Layout considerations for analog circuits, Matching techniques: common-centroid, interdigitated layouts, Parasitics and their impact ,Latch-up and its prevention	6 Hrs
Unit 5	Data Converters, Overview of data conversion systems, Sample-and-hold circuits ,Analog-to-Digital Converters (ADC): Flash, SAR, Pipeline, Digital-to-Analog Converters (DAC): R-2R, Current steering Performance metrics: INL, DNL, SNR, ENOB, SFDR	6 Hrs
Unit 6	Advanced Topics & Applications, Low-power and low-voltage analog design techniques, Design for reliability and yield, Analog signal processing: filters, multipliers,Phase-locked loops (PLL) and VCOs	6 Hrs

Text Books	
1.	Razavi, B. – Design of Analog CMOS Integrated Circuits
2	Gray, Meyer, Lewis, Hurst – Analysis and Design of Analog Integrated Circuits
3	Johns & Martin – Analog Integrated Circuit Design
Reference Books	
1	Allen & Holberg – CMOS Analog Circuit Design
Web Resources	
1	Analog IC Design (NPTEL – IIT Madras / IIT Kanpur) Online NPTEL courses.

Title of the Course: Pattern Recognition		
Course Code:PE252112		**Course Category: PEC-IV**
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs / week	CA-I	10 Marks
Tutorial: --	CA-II	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester-II)	ESE	60 Marks

Course Prerequisite: Knowledge of linear algebra, calculus, probability, statistics, and programming (Python/MATLAB). Prior exposure to machine learning or digital signal processing is recommended.

Course Description: This course covers fundamental and advanced techniques for automated pattern recognition, integrating statistical, geometric, and neural approaches. Topics include Bayesian decision theory, feature extraction, clustering, and deep learning architectures. Emphasis is placed on real-world applications in image analysis, bioinformatics, and speech recognition.

Course Objectives:
1. To establish a mathematical foundation for pattern classification and feature analysis.
2. To develop proficiency in supervised/unsupervised learning algorithms.
3. To design and evaluate neural networks for complex pattern detection.
4. To apply pattern recognition techniques to interdisciplinary problems (e.g., computer vision, bioinformatics).
5. To prepare students for research in AI/ML through rigorous analytical training.

Course Outcomes:		
CO	**After the completion of the course the student should be able to**	**Bloom's Level**
CO1	Apply Bayesian decision theory to solve classification problems.	L3 Apply
CO2	Analyze feature extraction techniques (PCA, LDA) for dimensionality reduction.	L4 Analyze
CO3	Design clustering algorithms (k-means, hierarchical) for unsupervised learning.	L5 Evaluate
CO4	Evaluate neural networks (CNNs, RNNs) for image/speech recognition.	L5 Evaluate

CO-PO-PSO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2										3	2	1	1
CO2	3	3	3	2									3	3	1	1
CO3	3	3	3	3	2								3	3	2	1
CO4	3	3	3	3	3	2				2			3	3	3	1
CO5	3	3	3	3	3	3	2			3			3	3	3	2
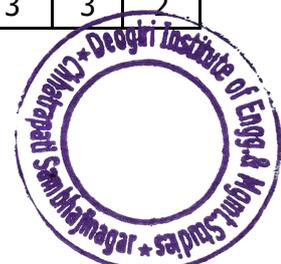
Assessment:	
CA-I (a) (10M)	Case Study (e.g., diagnosing diseases via medical image patterns)
CA-II (b) (10M)	Algorithmic Implementation (Python-based project)
MSE (c) (20M)	Descriptive Test

Course Contents:		
Unit 1	**Introduction & Bayesian Decision Theory** Bayes' theorem, ML/MAP estimation, ROC curves, Naive Bayes, Minimum Risk Classifiers, Hypothesis Testing	6 Hrs.
Unit2	**Feature Extraction & Selection** PCA, LDA, Kernel-PCA, Mutual Information, Chi-square, Wrapper/Filter methods	6 Hrs.
Unit3	**Clustering & Unsupervised Learning** K-means clustering, EM algorithm, spectral clustering; Validation metrics	6 Hrs.
Unit 4	**Neural Networks for Patterns** Introduction of Neural networks in Pattern recognition, CNNs for image recognition, RNNs for sequences; Transfer learning	6 Hrs.
Unit 5	**Advanced Topics** Support Vector Machines (SVMs), hidden Markov models; Applications in bioinformatics/speech.	6 Hrs.
Unit 6	**Real-World Systems** Case studies (e.g., facial recognition, fraud detection); Ethical considerations.	6 Hrs.

Text Books	
1.	Pattern Recognition by Anuj Bharadwaj and Parag Verma, Alpha science Intl. ltd.
Reference Books	
1	Pattern Classification by Richard O. Duda, Peter E. Hart, and David G. Stork.
2	Pattern Recognition and Machine Learning by Christopher M. Bishop.
3	Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
4	The Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani, and Jerome Friedman.
5	Computer Vision: Algorithms and Applications by Richard Szeliski.
Web Resources	
1	**Coursera: https://www.coursera.org/**
2	**Swayam NPTEL: https://onlinecourses.nptel.ac.in/**
3	**Simplilearn: https://www.simplilearn.com/**

Course Title: Research Methodology	
Course Code: PG252601	Course Category: EL

Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks

Course Prerequisite: Basic knowledge of engineering fundamentals, Familiarity with undergraduate-level mathematics and statistics, Ability to use computers and standard engineering software tools

Course Description:
This course introduces postgraduate engineering students to the principles, processes, and practices of research methodology. It emphasizes problem identification, literature review, research design, data collection, analysis, and interpretation. The course also covers ethical practices, mathematical modeling, computational tools, and scientific communication through thesis, research papers, and presentations. It aims to equip students with essential skills to undertake independent research projects and contribute effectively to the advancement of science and technology.

Course Objectives:
1**.** To provide a clear understanding of the fundamentals and process of research in engineering.
2. To develop the ability to identify research problems through literature review and formulate hypotheses.
3. To impart knowledge of research ethics, integrity, and professional responsibility.
4. To familiarize students with research design, data collection, analysis, and interpretation techniques.
5. To introduce mathematical modelling and computational tools relevant to engineering research.
6. To develop effective academic writing and presentation skills for disseminating research outcomes.

| Course Outcomes:		
Cos	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Recall the meaning, objectives, and types of research, along with problem identification and hypothesis formulation.	L1
CO2	Demonstrate understanding of ethical issues, research integrity, plagiarism, and intellectual property rights.	L2
CO3	Design appropriate research methodologies, select data collection methods, and apply suitable statistical techniques for analysis.	L3
CO4	Develop and validate mathematical and computational models for engineering applications using appropriate tools/software.	L4
CO5	Write and present research outputs in the form of proposals, reports, papers, and presentations adhering to academic standards.	L5

CO PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	2	1	1			1	1		2	1	1	-	2
CO2	2	2	2	2	2	3			3	2		2	-	-	-	3
CO3	3	3	3	3	3	2						2	2	3	2	1
CO4	3	3	3	1	3	1			2			2	3	2	3	1
CO5	2	2	2	2	2	2			3	2		2	1	-	1	3

Assessment	
CA-1 (a)(10M)	Subjective Test / Open book test / Assignment.
CA-2 (b)(10M)	Assignment / Presentation/ Case Study
MSE (c)(20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction to Research:** meaning, objectives, motivation, types, Research process, Criteria of good research, Importance of literature review in defining a problem, Literature review: primary and secondary sources, Critical literature review, Identifying gap areas from literature and research database, Research problem: selection, necessity and formulation, Technique Involved in Defining a Problem, Hypothesis formation, Problems Encountered by Researchers	6 Hrs
Unit 2	**Research Ethics:** Ethical considerations in research, Plagiarism, Intellectual Property, Research Integrity, and misconduct, Ethical issues in data collection, experimentation, and analysis, Ethical considerations in publication and peer review, Case studies of ethical dilemmas in engineering research, Conflict of interest, Ethics in Emerging Technologies like AI	6Hrs
Unit 3	**Research Design, Experimentation, Analysis And Data Analysis and Interpretation:** Experimental and non-experimental research designs, Sampling techniques, and sample size determination, Data collection methods: Surveys, interviews, and observation, Instrumentation and measurement techniques, Reliability and validity in research, Design of experiments and analysis of results, Data processing and cleaning, Statistical analysis: Descriptive and inferential statistics, Advanced data analysis techniques: Regression, ANOVA, and multivariate analysis, Interpretation of results. Reporting and presenting data	6 Hrs
Unit 4	**Mathematical Modeling in Engineering Research, Use of Computer Technology and Software:** Introduction to mathematical modeling, Types of models: Deterministic and probabilistic, Model development and validation, Applications of mathematical Modeling, Introduction to computational tool, Data analysis software: Usage and applications	6 Hrs
Unit 5	**Writing and Presenting Research: Writing a thesis and project report:** Structure and content, Writing progress reports and project updates, Structuring a research paper, Writing research proposals and grants, Writing for journals and conferences, Incorporating references and citations: APA, MLA, IEEE styles, Managing references with citation management software (e.g., End Note, Zotero), Preparing and delivering oral presentations, Creating effective visual aids (charts, graphs, tables), Poster presentations: Design and delivery, The publication process and peer review, Communicating research to non-specialists and stakeholders	6Hrs
Unit 6	**Case Studies and Applications:** Case studies of successful engineering research, Application of research methodologies to real-life projects, Problem-solving through interdisciplinary approaches, Integration of ethical, technical, and methodological aspects, Emerging trends in engineering research.	6 Hrs

Text/Reference Books	
Text Books	
1	C. R. Kothari, Research Methodology, New Age Publishers.
2	Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners
3	Herman Tang, Engineering Research: Design, Methods, and Analysis
4	Douglas C. Montgomery, Design and Analysis of Experiments
5	C. Neal Stewart Jr., Research Ethics for Scientists: A Companion for Students
Reference Books	
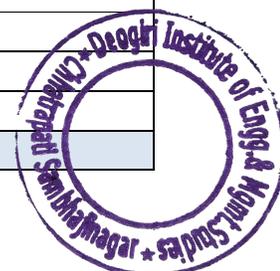
1	Cooper, D.R. & Schindler, P.S. – Business Research Methods, McGraw Hill.
2	Montgomery, D.C. – Design and Analysis of Experiments, Wiley.
3	Krishnaswamy, K.N., Sivakumar, A.I., Mathirajan, M. – Management Research Methodology, Pearson.
4	Deborah Rumsey – Statistics for Dummies, Wiley.

Web Resources	
1	MIT OpenCourseWare: Research Methods (https://ocw.mit.edu)
2	NCBI – PubMed Central (https://www.ncbi.nlm.nih.gov/pmc/)
3	https://researcheracademy.elsevier.com/
4	https://link.springer.com/

Course Title: Interdisciplinary Perspective on Indian Science and Technology		
Course Code: PG252501		Course Category: IKS
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Semester II	ESE	60 Marks
Course Prerequisite: None		

Course Description:

The course Interdisciplinary Perspective on Indian Science and Technology introduces students to India's rich contributions in mathematics, astronomy, architecture, metallurgy, textiles, and agriculture. It emphasizes the scientific principles embedded in traditional practices, tracing their historical development and global impact. Students will explore how ancient Indian innovations such as the number system, astronomical instruments, town planning, metallurgy, and sustainable farming shaped modern science and engineering. The course bridges theoretical understanding with practical relevance, enabling appreciation of indigenous knowledge systems and their applications in contemporary contexts.

Course Objectives:

1. To understand the foundational concepts and necessity of the Indian Knowledge System.
2. To identify key historical contributions of Indian scholars in mathematics, astronomy, architecture, metallurgy, textiles, and agriculture.
3. To interpret the scientific principles and techniques underlying traditional Indian practices.
4. To analyze the relevance of IKS in modern scientific and technological contexts.
5. To appreciate the global influence and sustainability of Indian innovations throughout history.

Course Outcomes:		
COs	**After completion of the course, students should be able to**	**Bloom's Level**
CO1	Recall key concepts, terminologies, historical developments, and contributions in Indian Mathematics, Astronomy, Architecture, Metallurgy, Textiles, and Agriculture.	L1 Remember
CO2	Explain the principles, methods, and scientific basis of Indian Knowledge Systems in various domains such as mathematics, astronomy, architecture, metallurgy, textiles, and agriculture.	L2 Understand
CO3	Use traditional Indian scientific and technological methods to address contemporary or theoretical problems in relevant fields.	L3 Apply
CO4	Examine the relevance, strengths, and limitations of Indian Knowledge Systems in addressing contemporary scientific, environmental, technological, and societal challenges.	L4 Analyze

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		1											1	1	1	1
CO2		1				1							1	1	1	1
CO3		1				1							1	1	1	1
CO4	1												1	1	1	1

Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc.
CA-2 (b)	Model Making / Assignment / Presentation / etc.
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	**Indian Mathematics** Necessity of Indian Knowledge System, Defining Indian Knowledge System, Contributions of Indian Mathematicians, Historical Evidence and features of Indian Numerical Number System, The Idea of Zero and Infinity, Decimal System, Representation of Large Numbers, Global Spread and Adoption of Indian Numericals, Arithmetic (Square of a Number, Square Root, Series and Propagation), Geometry (Simple Constructions from Sulba-Sutras,e.g, Right Angle Triangle, The Value of Pi), Trigonometry and Algebra in IKS, Modern Indian Contributions to Mathematics	4 Hrs
Unit 2	**Indian Astronomy** Historical Development of Indian Astronomy, Astronomy for Timekeeping, Solar and Lunar Motions, The Celestial Coordinate System, Various Regional Indian Calendar Systems, Planetary Model of Aryabhata and Nilakantha, Astronomical Instruments, Various Royal Endeavors for Astronomy (e.g., Jaisingh's Jantar Mantar), Modern Indian Contributions to Astronomy	4 Hrs
Unit 3	**Indian Architecture and Town Planning** Sthapatya-Veda and Vastu-Shastra, Historical Features of Indian Town Planning, Water Management and Drainage Systems, Town Town Planning of Harappan Cities, Temple Architecture, Features and Examples of Cave, Rock Cut, Nagara, Dravida, Kalinga, Vesara, Deccan, Rajput, Mughal, Indo-Saracenic Architecture Styles, Modern Indian Contributions to Architecture and Town Planning	4 Hrs

Unit 4	**Indian Metallurgy** Ancient Mining and Ore Extraction Technologies, Mining and Manufacture of Zinc, Copper and its Alloys, Silver, Gold, Mercury and Lead, Iron Extraction from Biotite, Steel Manufacturing, Global Influence of Wootz Steel, Wax Casting, Modern Indian Contributions to Metallurgy	4 Hrs
Unit 5	**Indian Textile** Textile Traditions in Ancient India, The Variety and Diversity of Indian Textiles, Types of Fabrics and Materials, Cotton and Silk, Weaving Techniques and Looms, Dyeing Process and Natural Colors, Major Textile Centers, Significance of Indian Textile in Historical Global Trade, Fall of Indian Textile in Colonial Era, Modern Indian Contributions to Textile	4 Hrs
Unit 6	**Indian Agriculture** Importance of Agriculture in Ancient India, Traditional Crops (Grains, Fruits, Vegetables Spices), Significance of Indian Agricultural Products in Historical Global Trade, Significance of Agriculture and Irrigation for the Indian Kings, The Ery System of South India, Traditional Farming Techniques (Land Preparation, Sowing Techniques, Weeding and Pest Management, Harvesting and Storage), Irrigation Techniques and Rainwater Harvesting, Modern Indian Contributions to Agriculture	4 Hrs

Textbooks	
1.	D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., A Concise History of Science in India, 2nd Ed., Universities Press, Hyderabad, 2010.
2.	B. Mahadevan, Nagendra Pavana, Vinayak Rajat Bhat, Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning, 2022
3.	Kapil Kapoor, Awadhesh Kumar Singh, Indian Knowledge Systems, D.K. Print World Ltd; First Edition (15 October 2005)
4.	Bhag Chand Chauhan, IKS: The Knowledge system of Bharata, Garuda Prakashan (13 March 2023)
5.	Science in India: A Historical Perspective by B V Subbarayappa, Rupa & Co (2013)
Reference Books	
1.	G. G. Joseph, Indian Mathematics Engaging the World from Ancient to Modern Times, World Scientific, London, 2016
2.	History of Astronomy: A Handbook, Edited by K. Ramasubramanian, Aniket Sule, andbMayank Vahia, SandHI, IIT Bombay, and T.I.F.R. Mumbai, 2016.
3.	History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishna Mission Institute of Culture, Kolkata (2014).
4.	Christopher Tadgell, History of Architecture in India, Architecture Design and Technology Press (1990)
5.	Bindia Thapar, Introduction to Indian Architecture, Periplus Asian Architecture Series
Web Resources	
1.	Indian Knowledge System Division, Ministry of Education, Government of India, https://iksindia.org/lectures-and-videos.php

Course Title: Mini Project			
Course Code: PE252602		**Course Category:** EL	
Teaching Scheme		**Examination Scheme (As Applicable)**	
Practicals/Sessions: 02 Hours/Week		CA-I	15 Marks
		CA-II	15 Marks
Semester: First Year (Semester-II)		ESE	20 Marks

Course Prerequisite:
1. Basic understanding of core subjects in specialization, Ability to access, and interpret scientific literature.
2. Exposure to technical report writing and presentation.

Course Description:
The Mini Project course provides students with an opportunity to apply theoretical knowledge gained during coursework to a small-scale practical problem in E & TC Engineering. It enables students to experience the process of identifying a problem, reviewing literature, formulating objectives, and developing solutions using experimental, analytical, or simulation-based approaches. The course emphasizes independent learning, teamwork, critical thinking, innovation, and technical communication.

Course Objectives:
1. Develop the ability to identify, analyze, and solve engineering problems using modern tools and techniques.
2. Encourage creativity, innovation, and research aptitude in addressing mechanical engineering challenges.
3. Provide hands-on exposure to design, modeling, analysis, and/or experimental work on a defined problem.
4. Strengthen teamwork, project management, and professional ethics in executing engineering tasks.
5. Enhance technical writing and oral presentation skills through project documentation and seminars.

Course Outcomes:		
COs	**After completion of the course:** **Students should be able to**	**Bloom's Level**
CO1	Identify and define a relevant problem in the domain of ETC Engineering.	L3 Apply
CO2	Conduct a literature survey and establish research/technical objectives.	L2 Understand
CO3	Apply appropriate engineering methods, tools, and techniques to develop and implement solutions.	L4 Analyze
CO4	Work independently or in a team, demonstrating project management, ethical practices, and leadership.	L3 Apply

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	2	3	3	2	1
CO2	2	3	2	3	2	1	1	1	1	2	1	2	2	2	1	2
CO3	3	3	3	3	3	1	2	1	2	2	2	3	3	3	2	1
CO4	2	2	3	2	2	2	1	2	3	2	3	3	3	2	1	2

Course Contents
The mini project is designed to help students identify, analyze, and solve real-world problems in Mechanical Engineering and management. This project also aims to improve their overall skills and capabilities. Each student should choose a topic they are interested in. The project's content must be relevant to emerging areas within the field, address current issues with a research focus, or be based on industrial visits. Students can also select a practical problem from the field of Mechanical Engineering to work on. By the end of the semester, each student must submit a final report to the Head of the Department. The report must be authenticated by their guide.
Assessment
The mini project is worth a total of 50 marks, with 30 marks for the internal assessment and 20 marks for the semester-end examination. The semester-end examination will be conducted by a committee of three faculty members. Students must bring their completed reports, which should be duly authenticated by their guide and the Head of the Department. Each student will individually present their work to the committee, who will then evaluate them and award marks accordingly.

CA-I (a)	Review-I: 15 Marks (Concept/knowledge in the topic = 10 marks, Literature- 05 marks)
CA-II (b)	Review-II: 15 Marks (Report writing & Presentation =15 Marks)
Practical/ viva voce (c)	20 Marks (Individual evaluation through viva voce / test (20 marks)
Total (d)	50 Marks

Course Title: Robotics		
Course Code: PE253006		**Course Category: PCC**
Teaching Scheme	**Examination Scheme**	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite: Students are expected to have knowledge of Engineering Mathematics, Control Systems, Mechanics & Kinematics, Signals & Systems, Programming & Tools, Programming & Tools.

Course Description: This course provides an in-depth study of the modeling, analysis, and control of robotic systems. It introduces the fundamentals of robot kinematics, dynamics, trajectory planning, and control strategies, followed by advanced topics such as intelligent robotics, machine vision, and artificial intelligence techniques for autonomous systems. Students will explore mobile and humanoid robotics along with emerging trends such as cloud robotics and Industry 4.0 applications. The course emphasizes both theoretical foundations and practical applications, preparing students to design and develop advanced robotic solutions for industrial, medical, and service domains.

Course Objectives:. The objectives of this course are to:
1. **Provide** a strong foundation in the kinematics, dynamics, and control of robotic systems.
2. **Develop** the ability to model, analyze, and simulate robotic manipulators and mobile robots using mathematical and computational tools.
3. **Introduce** advanced techniques in artificial intelligence, machine vision, and path planning for autonomous and intelligent robotic systems.
4. **Prepare** students to design and implement innovative robotic solutions for industrial, medical, and emerging applications in Industry 4.0.

| Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	**Analyze** forward and inverse kinematics, dynamics, and trajectory planning of robotic manipulators using mathematical models.	L4 Analyze
CO2	**Apply** control strategies such as PID, adaptive, and robust control to ensure precise motion and stability of robotic systems.	L3 Apply
CO3	**Evaluate** AI-based techniques including path planning, machine vision, and learning algorithms for autonomous and intelligent robotic systems.	L5 Evaluate
CO4	**Design and develop** robotic solutions for real-world applications such as mobile robots, humanoids, and Industry 4.0 systems.	L6 Create

CO-PO Mapping

CO-PO Mapping															
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	-	-	-	-	-	-	2	1	1	2	1
CO2	3	2	2		3	-	-	-	-	-	-	2	1	1	1	1
CO3	2	3	2	3	3	-	-	-	-	-	-	2	1	2	1	1
CO4	3	3	3	2	3	1	1	1	1	1	1	3	3	3	3	3

Course Contents		
Unit 1	Introduction to Robotics: History and evolution of robotics, types and classification of robots, Specifications and applications in industries, healthcare, defense, and service sectors, Components of robotic systems: sensors, actuators, controllers, and end-effectors	6 Hrs
Unit 2	Kinematics of Robots: Direct (forward) and inverse kinematics, Denavit–Hardenberg (DH) representation, Homogeneous transformation matrices, Velocity kinematics and Jacobian formulation, Singularities and workspace analysis	6 Hrs
Unit 3	Dynamics of Robots: Euler–Lagrange formulation and Newton–Euler formulation, Dynamics of manipulators with multiple DOF, Trajectory planning and motion profiles (linear, polynomial, spline), Control of joint forces and torques	6 Hrs
Unit 4	Robot Control Systems: Control architectures: position control, force control, hybrid control, Linear and nonlinear control of robotic manipulators, Adaptive and robust control techniques, PID and model-based controllers for robots, Case Studies of industrial Robot Controller	6 Hrs
Unit 5	Artificial Intelligence in Robotics: Path planning and navigation (graph-based, sampling-based methods), Machine vision and image processing for robotics, Machine learning approaches in robotics (supervised, reinforcement learning), Human–robot interaction and collaborative robotics, Human–robot interaction and collaborative robotics.	6 Hrs
Unit 6	Advanced Topics & Applications: Mobile robots: kinematics, dynamics, and control, Autonomous robotic systems, Humanoid robotics fundamentals, Surgical and service robots, Recent trends: cloud robotics, IoT-enabled robots, Industry 4.0 applications	6 Hrs

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination
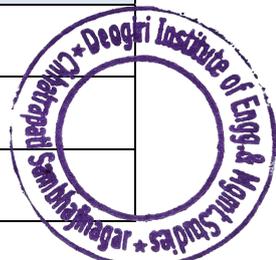
Text Books
1.	**M.P. Groover**, Industrial Robotics: Technology, Programming and Applications, McGraw Hill.

Reference Books
1	**John J. Craig**, Introduction to Robotics: Mechanics and Control, Pearson.
2	**Mark W. Spong, Seth Hutchinson, M. Vidyasagar**, Robot Modeling and Control, Wiley.
3	**Bruno Siciliano & Lorenzo Sciavicco**, Robotics: Modelling, Planning and Control, Springer.
4	**Roland Siegwart, Illah Nourbakhsh & Davide Scaramuzza**, Introduction to Autonomous Mobile Robots, MIT Press.

Web Resources
1.	https://nptel.ac.in/domains/discipline/115?course=115_9

Course Title: Intellectual Property Rights		
Course Code: PE253341	**Course Category: OE**	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:
Basic understanding of computing concepts such as software, hardware, and digital technologies, General awareness of legal and ethical issues

Course Description: This course provides a comprehensive introduction to Intellectual Property Rights (IPR) and the legal frameworks governing innovation, creativity, and digital activities. It familiarizes students with the evolution, significance, and protection mechanisms of various forms of intellectual property in national and international contexts.

Course Objectives:
1. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.
2. To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work and for this they must have knowledge of patents, copy right, trademarks, designs and information Technology Act.
3. Further teacher will have to demonstrate with products and ask the student to identify the different types of IPR's.

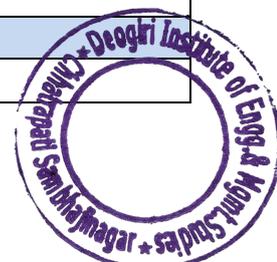| Course Outcomes:		
COs	**After completion of the course: Students should be able to**	**Bloom's Level**
CO1	The students once they complete their academic projects, they get awareness of acquiring the patent.	Remember L1
CO2	They also learn to have copyright for their innovative works.	Understand L2
CO3	They also get the knowledge of plagiarism in their innovations which can be questioned legally.	Apply L3

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1
CO2	1	2	-	-	-	-	-	-	-	-	-	-	1	1	2	1
CO3	3	1	-	1	-	-	-	-	-	-	-	-	1	1	1	2

Assessment	
CA-1 (a) (10M)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b) (10M)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c) (20M)	Subjective Test

Course Contents		
Unit 1	**Introduction to Intellectual Property Rights** Introduction to IPR: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Introduction to TRIPS and WTO, Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade; Secret and trade dress, Design, Layout Design, Geographical Indication, Plant. Varieties and Traditional Knowledge	6 Hrs.
Unit 2	**Patent and Copyright: Legal Framework, Rights, and Procedures** Patent Rights and Copy Rights— Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.	6 Hrs.
Unit 3	**Copyright Law and Digital Content Protection** Copy Right—Origin, Definition &Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.	6 Hrs.
Unit 4	**Fundamentals of Trademarks and Cyber Domain Protection** ITrade Marks: Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Domain Names on cyber space.	6 Hrs.
Unit 5	**Design Protection and Fundamentals of Quantum Gates** Design- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.Quantum Gates, Reversible nature of Quantum Gates, Single Qubit Gates: Quantum NOT Gate, Pauli-X, Pauli-Y, Pauli-Z Gates, Hadamard Gate, Phase Gate (S Gate), T Gate (π/8 Gate)	6 Hrs.
Unit 6	**Information Technology Act 2000** Basic Tenents Of Information Technology Act-2000, IT Act - Introduction, E-Commerce and legal provisions, E- Governance and legal provisions, Digital signature and Electronic Signature. Cybercrimes	6 Hrs.

Textbooks	
1.	Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
2.	Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
Reference Books	
1.	IPR by P. Narayanan.
2.	Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.
Web Resources	
1.	https://onlinecourses.nptel.ac.in/noc23_hs55/preview

Course Title: Business To Business Marketing (B2B)	
Course Code: PE253342	**Course Category: Open Elective**

Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite: Basic knowledge of marketing principles, management concepts, and organizational behavior

Course Description: This course explores strategies, tools, and practices for managing marketing activities between businesses to build value-driven relationships and achieve competitive advantage.

Course Objectives:
1. To develop an understanding of key concepts, strategies, and practices in business-to-business marketing.
2. To analyze organizational buying behavior and decision-making processes in industrial markets.
3. To enhance skills in building and managing long-term business relationships and networks.
4. To apply advanced marketing tools for effective B2B product and service positioning.
5. To evaluate and design strategic plans for competitive advantage in B2B markets.
6. To integrate digital technologies and innovations into B2B marketing practices.

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Apply fundamental concepts and strategies of B2B marketing in real-world scenarios.	L3 Apply
CO2	Analyze industrial buyer behavior and formulate effective marketing decisions.	L4 Analyze
CO3	Understand and implement relationship management strategies for business clients.	L2 Understand
CO4	Evaluate the impact of digital tools and technologies on B2B marketing practices.	L5 Evaluate

CO-PO Mapping

CO-PO Mapping															
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	-	-	-	-	2	3	-	2	2	1	2	2
CO2	3	3	2	2	-	-	-	-	2	3	-	3	2	2	1	2
CO3	2	2	3	-	-	-	-	-	3	3	2	-	2	1	3	2
CO4	2	2	-	3	3	-	-	-	2	2	-	3	3	2	2	2

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction to B2B Marketing** Definition, scope, and importance of B2B marketing, differences between B2B and B2C marketing, types of business markets – industrial, reseller, government, and institutional markets, B2B marketing environment – economic, technological, competitive, and regulatory factors, role of B2B marketing in supply chain and value creation, challenges and opportunities in B2B marketing, overview of current trends and global developments.	6 Hrs
Unit 2	**Organizational Buying Behavior** Understanding organizational customers, buying process models – Buygrid framework, Webster and Wind model, and Sheth model, roles and responsibilities in the buying center, stages of the organizational buying process, factors influencing buying behavior – environmental, organizational, interpersonal, and individual factors, customer relationship life cycle, vendor selection and evaluation criteria, procurement and sourcing strategies.	6 Hrs
Unit 3	**B2B Marketing Strategies** Segmentation, targeting, and positioning strategies for B2B markets, development of value propositions, product and service strategies – core, actual, and augmented offerings, B2B branding and brand equity, pricing approaches – cost-based, competition-based, and value-based pricing, bidding and tendering processes, distribution and channel management strategies, competitive positioning and differentiation techniques.	6 Hrs
Unit 4	**Relationship Management and Networks** Importance of long-term customer relationships in B2B markets, principles of relationship marketing, customer retention strategies, key account management (KAM), partner relationship management (PRM), managing supply chain relationships, role of trust, commitment, and collaboration in networks, strategies for conflict resolution and negotiation, measurement of relationship performance.	6 Hrs

	Digitalization and Technology in B2B Marketing	
Unit 5	Impact of technology on B2B marketing, B2B e-commerce platforms and marketplaces, use of Customer Relationship Management (CRM) systems, marketing automation tools, data-driven marketing strategies, leveraging big data and analytics for decision-making, role of social media and content marketing in B2B, integrating digital marketing with traditional B2B strategies, cybersecurity and data privacy considerations.	6 Hrs
Unit 6	**Emerging Trends and Global Perspectives** Global B2B marketing practices and challenges, international market entry strategies, cross-cultural considerations in B2B marketing, sustainability and green marketing in industrial contexts, ethical issues and corporate social responsibility, innovations in B2B business models, future trends such as artificial intelligence, IoT, and blockchain in B2B marketing, case studies of leading global B2B companies.	6 Hrs

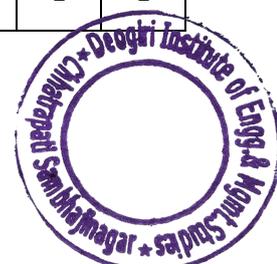| Text Books	
1.	Michael D. Hutt and Thomas W. Speh – Business Marketing Management: B2B, Cengage Learning.
2	Robert F. Dwyer and John F. Tanner – Business Marketing: Connecting Strategy, Relationships and Learning, McGraw Hill.
3	Sharad Sarin – Business-to-Business Marketing: Concepts and Cases, McGraw Hill Education.
Reference Books	
1	Brennan, Ross, Canning, Louise, and McDowell, Raymond – Business-to-Business Marketing, Sage Publications.
2	Vitale, Robert P. and Giglierano, Joseph J. – Business-to-Business Marketing: Analysis and Practice, South-Western College Publishing.
3	Gary L. Lilien – Handbook on Business-to-Business Marketing, Edward Elgar Publishing.
4	Anderson, James C. and Narus, James A. – Business Market Management: Understanding, Creating, and Delivering Value, Pearson.
5	Webster, Frederick E. – Industrial Marketing Strategy, Wiley.
Web Resources	
1.	Coursera – International B2B Marketing www.coursera.org/learn/b2b-marketing
2.	Kellogg Executive Education – B2B Marketing: Growth Strategies for Your Organization www.kellogg.northwestern.edu/executive-education/individual-programs/online-programs/bmkt.aspx

Course Title: Quantum Computing		
Course Code: PE253343		**Course Category: Open Elective**
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite: Basic knowledge of linear algebra, probability, complex numbers, basic quantum mechanics, algorithms, and programming (preferably Python).

Course Description: This course introduces to the principles and applications of quantum computing, focusing on quantum algorithms, programming frameworks, and emerging research directions.

Course Objectives:
1. To introduce the fundamental principles of quantum mechanics relevant to computation and information processing.
2. To develop mathematical foundations for representing and analyzing quantum states, gates, and circuits.
3. To explore quantum algorithms and their applications in solving complex computational problems.
4. To familiarize students with quantum programming frameworks and simulation tools.
5. To analyze the advantages and limitations of quantum computing compared to classical computing.
6. To encourage research orientation by linking quantum computing concepts with emerging technologies and real-world applications.

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Apply the principles of quantum mechanics to model and analyze quantum information systems.	L3 Apply
CO2	Design and simulate quantum circuits and algorithms for computational problem-solving.	L2 Understand
CO3	Understand the efficiency, complexity, and limitations of quantum algorithms compared to classical approaches.	L2 Understand
CO4	Understand the use of quantum programming frameworks to implement and test quantum applications.	L2 Understand

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2	2	-	-	-	-	1	1	2	3	1	1	1
CO2	3	3	3	2	3	-	-	-	1	2	2	2	2	3	2	2
CO3	3	3	2	3	2	-	-	-	-	2	2	3	1	1	1	1
CO4	3	3	3	3	3	-	-	-	1	2	2	3	3	1	1	1

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Introduction to Quantum Computing** Classical vs Quantum computation, Postulates of quantum mechanics relevant to computing, Qubits, superposition, entanglement, measurement, Quantum gates and quantum circuits.	6 Hrs
Unit 2	**Mathematical Foundations** Complex numbers and vector spaces, Linear algebra for quantum states (Hilbert spaces), Unitary transformations and Hermitian operators, Tensor products and multi-qubit systems.	6 Hrs
Unit 3	**Quantum Algorithms – I** Quantum parallelism, Deutsch and Deutsch–Jozsa algorithms, Simon's algorithm, Quantum Fourier Transform (QFT) basics.	6 Hrs
Unit 4	**Quantum Algorithms – II** Shor's algorithm for factoring, Grover's search algorithm, Amplitude amplification, Complexity classes (BQP vs P and NP).	6 Hrs
Unit 5	**Quantum Error Correction and Cryptography** Quantum noise and decoherence, Quantum error correction codes, Quantum key distribution (BB84, E91 protocols), Applications in secure communication.	6 Hrs
Unit 6	**Quantum Programming and Emerging Applications** Quantum programming frameworks (Qiskit, Cirq, Q), Simulation of quantum circuits, Quantum machine learning basics, Applications in optimization, chemistry, and material science.	6 Hrs

Text Books	
1.	Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.
2	Eleanor G. Rieffel and Wolfgang H. Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2014.
3	Nouredine Zettili, Quantum Mechanics: Concepts and Applications, Wiley, 2009.

Reference Books	
1	Phillip Kaye, Raymond Laflamme, and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press, 2007.
2	Noson S. Yanofsky and Mirco A. Mannucci, Quantum Computing for Computer Scientists, Cambridge University Press, 2008.
3	Jack D. Hidary, Quantum Computing: An Applied Approach, Springer, 2019.
4	Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.
5	Thomas G. Wong, Introduction to Classical and Quantum Computing, 2nd Edition, 2021 (available online).
Web Resources	
1	IBM Quantum Learning [www.ibm.com/quantum-computing/learn] (https://www.ibm.com/quantum-computing/learn)
2	Microsoft Azure Quantum Learning Resources [www.azure.microsoft.com/en-in/resources/training-and-certifications/quantum-computing] (https://www.azure.microsoft.com/en-in/resources/training-and-certifications/quantum-computing)
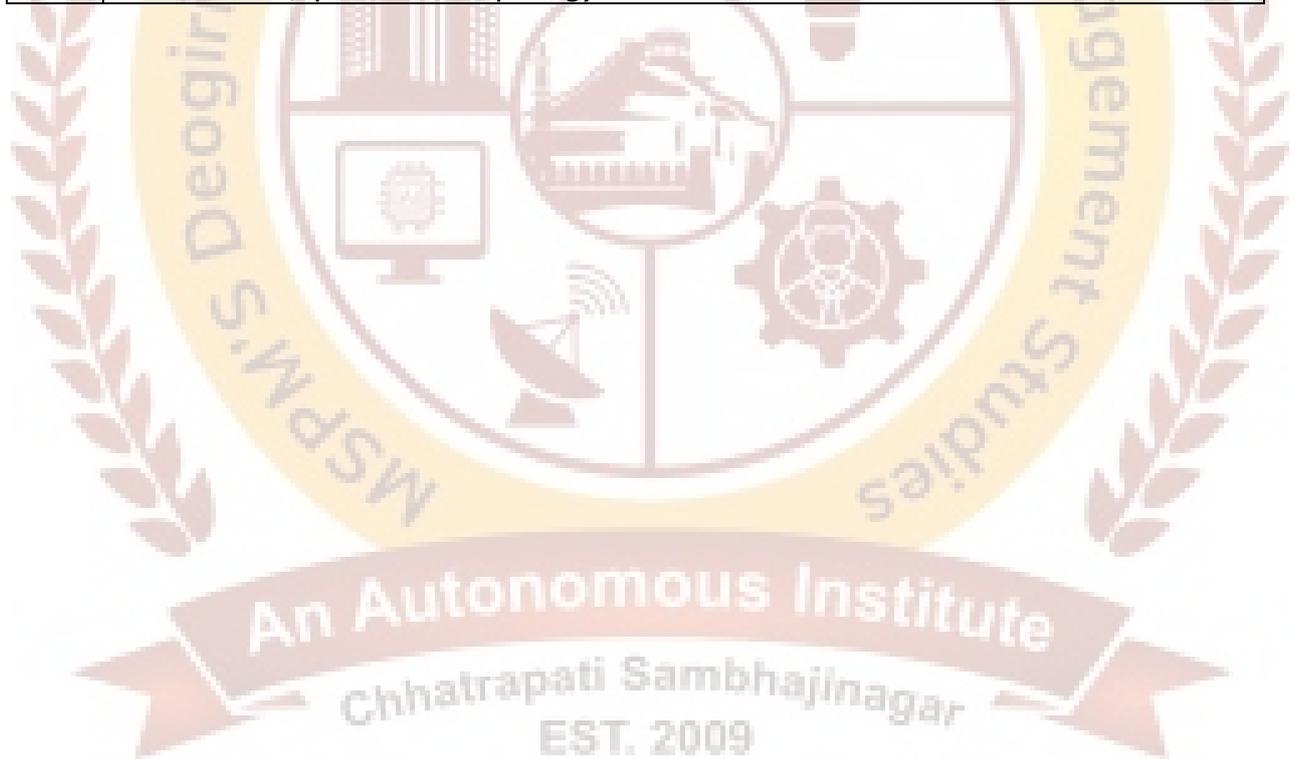
Course Title: Advance Computer Networking		
Course Code: PE253201	Course Category: Multi-Disciplinary Minor (MDM)	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite: Basic knowledge of Computer Networks (OSI/TCP-IP models, switching, routing).Fundamentals of Wireless Communication and Data Communication principles. Awareness of Cryptography basics and network security concepts.

Course Description: This course focuses on advanced computer networks with emphasis on wireless technologies, energy management, and security.It covers wired-to-wireless evolution, WLANs, MANs, PANs, WANs, and routing strategies. Students learn cryptographic algorithms, security protocols, authentication, and intrusion prevention systems. Emerging topics such as secure routing, cognitive radio, and SDN security are also discussed.

Course Objectives:

1. Understand advanced concepts of computer network architectures, QoS, and fundamentals of wireless networks.
2. Explore design, operation, and applications of WLANs, MANs, PANs, WANs, and sensor networks.
3. Analyze medium access mechanisms and routing protocols in wireless networks.
4. Evaluate energy management strategies and cross-layer approaches for extending network lifetime.
5. Apply cryptographic techniques and security protocols to protect communication systems.
6. Examine advanced security mechanisms in Internet and wireless environments, including intrusion detection and secure routing.

Course Outcomes:		
COs	**After completion of the course:** **Student should be able to**	**Bloom's Level**
CO1	Explain advanced network architectures, wireless technologies, and quality of service requirements.	L1 Remember
CO2	Analyze medium access methods, routing strategies, and energy management techniques in wireless networks.	L2 Understand
CO3	Apply cryptographic algorithms, authentication mechanisms, and security protocols to safeguard communication.	L3 Apply
CO4	Evaluate advanced security solutions and emerging trends such as secure routing, cognitive radio, and SDN.	L4 Analyze

CO-PO Mapping

CO-PO Mapping																
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	-	-	-	-	-	-	-	-	2	2	2	1	2
CO2	-	3	2	2	3	-	1	-	-	-	-	-	3	3	2	2
CO3	-	2	2	-	2	2	1	-	-	-	-	2	3	3	2	1
CO4	2	-	2	-	2	-	-	-	1	2	2	3	2	2	2	1

Assessment	
CA-1 (a)	Subjective Test / Open book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination
Practical (d)	Particular Experiment number

Course Contents		
Unit 1	**Overview of Advanced Computer Networks** Review of layered network architectures (OSI, TCP/IP), Evolution of wired to wireless networks, Quality of Service (QoS) and traffic engineering, Fundamentals of wireless networks and security requirements.	6 Hrs
Unit 2	**Wireless LANs, MANs, PANs, and WANs** IEEE 802.11 standards, WLAN architecture and protocols, Wireless PAN (Bluetooth, ZigBee, UWB) fundamentals, Wireless MAN/WAN technologies: WiMAX, LTE overview, Ad hoc wireless networks and applications, Wireless Sensor Networks (WSN) and Wireless Body Area Networks (WBAN) basics.	6 Hrs
Unit 3	**Medium Access and Routing in Wireless Networks** IEEE 802.11 MAC fundamentals: CSMA/CA, Distributed Coordination Function (DCF), Point Coordination Function (PCF), QoS enhancements: IEEE 802.11e and HCF, Routing protocols for Ad Hoc Wireless Networks: Proactive, Reactive, Hybrid,Routing in Wireless Sensor Networks: flat vs hierarchical routing.	6 Hrs

Unit 4	**Energy Management and Network Lifetime** Power management in wireless nodes and protocols, Sleep scheduling and duty cycling, Network lifetime enhancement strategies, Cross-layer approaches for energy optimization.	6 Hrs
Unit 5	**Network Security and Cryptography** Security goals, threats, and attack models in computer networks, Cryptography basics: Symmetric key and Asymmetric key algorithms,Digital signatures and RSA, Security protocols: SSL/TLS, IPsec, VPNs,User authentication and key management techniques.	6 Hrs
Unit 6	**Advanced Internet and Wireless Security** Email and web security: PGP, S/MIME, HTTPS, Firewalls, Intrusion Detection and Prevention Systems (IDPS),Secure routing in wireless networks, Case studies: Security in WLAN, WSN, and Mobile Ad Hoc Networks (MANETs),Future trends: Cognitive radio networks, Software Defined Networking (SDN) security.	6 Hrs

Text Books	
1	Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill.
2	William Stallings, Wireless Communications and Networks, Pearson.
3	William Stallings, Cryptography and Network Security: Principles and Practice, Pearson.
4	Jochen Schiller, Mobile Communications, Pearson Education.
Reference Books	
1	Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Pearson.
2	C. Siva Ram Murthy and B.S. Manoj, Ad Hoc Wireless Networks: Architectures and Protocols, Pearson.
3	Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: Private Communication in a Public World, Pearson.
4	Nirwan Ansari and Jie Wu, Wireless Network Security, Springer.
Web Resources	
1	https://nptel.ac.in/courses

Course Title: Satellite Communication			
Course Code: PE253202	**Course Category :Multi-Disciplinary Minor(MDM)**		
Teaching Scheme		**Examination Scheme**	
Lectures: 03 hrs/ week		CA-1	10 Marks
Tutorial: -----		CA-2	10 Marks
Credits: 03		MSE	20 Marks
Semester: Second Year (Semester III)		ESE	60 Marks
Course Prerequisite: Basics of Communication Engineering (analog & digital). Fundamentals of Electromagnetic Waves and Antennas. Knowledge of Wireless Communication concepts.			
Course Description: This course introduces the fundamentals and advanced aspects of satellite communication. It covers orbital mechanics, satellite subsystems, and link budget design, along with multiple access and modulation techniques. Students learn about earth station design, propagation effects, and satellite applications including navigation, broadcasting, and remote sensing. Emerging technologies such as HTS, LEO mega-constellations, optical links, and satellite–5G/6G integration are also discussed.			
Course Objectives: 1. Understand orbital mechanics, satellite subsystems, and frequency spectrum considerations. 2. Apply link budget analysis and evaluate satellite link performance. 3. Analyze multiple access, modulation, and coding schemes for satellite communication. 4. Examine earth station design, propagation effects, and mitigation methods. 5. Explore various satellite applications including broadcasting, navigation, and remote sensing. 6. Evaluate emerging satellite technologies and integration with modern networks.			

Course Outcomes:

COs	After completion of the course: Student should be able to	Bloom's Level
CO1	Explain the basic concepts of satellite communication including orbits, subsystems and spectrum.	L1 Remember
CO2	Apply link design and multiple access techniques for satellite communication systems.	L2 Understand
CO3	Analyze earth stations, propagation effects and performance improvement methods.	L3 Apply
CO4	Evaluate satellite applications, emerging technologies and integration with modern networks.	L4 Analyze

CO-PO Mapping

CO-PO Mapping															
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	2	-	-	-	-	-	-	-	-	3	2	1	1
CO2	3	3	2	-	2	-	-	-	-	-	-	-	3	2	2	1
CO3	2	3	2	-	-	-	-	-	-	-	-	2	3	1	2	2
CO4	2	-	2	-	3	-	-	-	-	-	-	2	3	2	1	2

Assessment

CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents

Unit 1	**Introduction to Satellite Communication** Overview of satellite communication systems, Orbital mechanics: types of satellite orbits (LEO, MEO, GEO), Launch vehicles and satellite subsystems (power, thermal, propulsion, telemetry, and tracking), Frequency allocations and spectrum considerations.	6 Hrs
Unit 2	**Satellite Link Design** Basic link design equation and link budget analysis, Free space loss, antenna parameters, system noise temperature, Uplink and downlink power calculations, C/N ratio and G/T requirements for earth stations.	6 Hrs
Unit 3	**Multiple Access and Modulation Techniques** FDMA, TDMA, CDMA in satellite systems, Random access techniques (ALOHA, Slotted ALOHA), Digital modulation schemes: BPSK, QPSK, 8PSK, QAM,Error control coding for satellite links.	6 Hrs
Unit 4	**Earth Stations and Propagation Effects** Earth station design considerations and components, VSAT systems and small satellite terminals, Propagation impairments: rain attenuation, scintillation, and depolarization, Fade countermeasures and diversity techniques.	6 Hrs
Unit 5	**Satellite Applications** Fixed Satellite Services (FSS) and Broadcast Satellite Services (BSS),Mobile Satellite Services (MSS): LEO/MEO constellations (Iridium, Globalstar), Navigation satellite systems (GPS, GLONASS, Galileo, NavIC),Remote sensing and weather satellites.	6 Hrs
Unit 6	**Emerging Technologies and Future Trends** High Throughput Satellites (HTS) and Ka-band systems, Low Earth Orbit (LEO) mega-constellations (Starlink, OneWeb), Inter-satellite links and optical satellite communication, Satellite Internet-of-Things (IoT), cognitive satellite networks, and integration with 5G/6G.	6 Hrs

Text Books

1.	Timothy Pratt, Charles W. Bostian, Jeremy Allnutt, Satellite Communications, Wiley.
2	Dennis Roddy, Satellite Communications, McGraw-Hill.
3	Wilbur L. Pritchard, Robert A. Nelson, Henri G. Suyderhoud – *Satellite Communication Systems Engineering*, Pearson.
4	Bruce R. Elbert – *Introduction to Satellite Communication*, Artech House.

	Reference Books
1	Tri T. Ha – *Digital Satellite Communications*, McGraw Hill.
2	Gagliardi R.M. – *Satellite Communications*, CBS Publishers.
3	M. Richharia, L. Steer – *Satellite Communications Systems: Principles and Technologies*, Wiley.
4	Gerald Maral, Michel Bousquet – *Satellite Communications Systems: Systems, Techniques and Technology*, Wiley.
	Web Resources
1	https://nptel.ac.in/courses

Course Title: Advance Mobile computing	
Course Code: PE253203	**Course Category: Multi-Disciplinary Minor (MDM)**

Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite: Basic knowledge of Computer Networks and Wireless Communication. Fundamentals of Operating Systems and Computer Architecture. Awareness of Internet and IP-based communication systems.

Course Description: This course introduces the foundations and advanced concepts of Mobile Computing, focusing on next-generation wireless communication technologies, mobile device architectures, operating systems, and communication protocols. It emphasizes context awareness, ubiquitous computing, security and privacy, and emerging research trends such as 5G/6G, mobile AI/ML, and energy-efficient systems. Students will gain a comprehensive understanding of mobile networking principles, system-level architectures, and application domains including IoT, smart cities, and healthcare, preparing them for innovation in modern and future mobile environments.

Course Objectives:
1. Understand the fundamentals of mobile computing, wireless communication technologies, and mobility management.
2. Analyze mobile device architectures, operating systems, and middleware platforms for efficient application development.
3. Examine mobile communication protocols including WLANs, MANETs, VANETs, and TCP/IP enhancements for wireless environments.
4. Explore context-aware computing, ubiquitous systems, and applications of mobile computing in real-world domains.
5. Identify security, privacy, and trust challenges in mobile systems and study cryptographic and blockchain-based solutions.
6. Investigate emerging trends in mobile computing including 5G/6G, mobile AI/ML, edge/fog computing, AR/VR, and satellite integration.

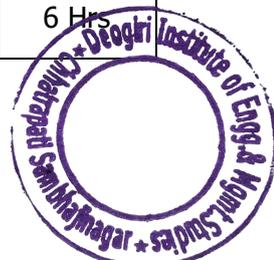| Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Explain the principles of mobile computing, its architectures, and communication mechanisms.	L1 Remember
CO2	Analyze mobile communication protocols, context-aware applications, and system - level operations.	L2 Understand
CO3	Evaluate security, privacy, and trust issues in mobile environments.	L3 Apply
CO4	Discuss emerging trends and future directions in mobile computing technologies.	L4 Analyze

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
									CO-PO Mapping							
CO1	3	2	1	-	-	-	-	-	-	-	-	2	2	1	1	1
CO2	-	3	2	2	3	-	-	-	-	-	-	-	1	3	1	1
CO3	-	-	3		2	1	1	-	-	-	-	2	2	2	1	1
CO4	2	-	-	-	-	-	-	-	1	2	2	2	1	2	1	2

Assessment	
CA-1 (a) (10M)	Subjective Test / Open book test / etc
CA-2 (b) (10M)	Model Making / Assignment / Presentation / etc
MSE (c) (20M)	Mid Sem Examination

Course Contents		
Unit 1	**Mobile Computing Foundations** Overview of mobile computing and next-generation networks (4G/5G/6G), Mobile and wireless communication basics: GSM, CDMA, LTE, Mobility management: location tracking, handover concepts, Mobile IP and packet delivery mechanisms, QoS requirements for mobile multimedia.	6 Hrs
Unit 2	**Mobile Architecture and Operating Systems** Mobile device architectures and constraints (power, memory, processing), Operating systems for mobile devices: Android, iOS, Embedded Linux, Virtualization and containerization in mobile computing, Cross-platform application development and middleware support,Case study: Android system internals and security.	6 Hrs
Unit 3	**Mobile Communication Protocols** Wireless LANs, PANs, MANETs and VANETs: design considerations, Routing protocols in mobile ad-hoc networks (AODV, DSR, OLSR), Mobility models and performance metrics, TCP/IP enhancements for wireless and mobile environments,Mobile cloud computing concepts and architectures.	6 Hrs
Unit 4	**Context Awareness and Ubiquitous Computing**	6 Hrs

		Context-aware computing and location-based services (LBS), Sensor fusion and mobile sensing platforms, Human-centric mobile computing and pervasive systems, Mobile edge computing (MEC) and fog computing integration, Applications in smart cities, healthcare, and IoT.	
Unit 5	**Security, Privacy and Trust in Mobile Systems** Threats and vulnerabilities in mobile environments, Authentication, encryption, and key management for mobile networks, Secure routing and intrusion detection in MANETs and VANETs, Privacy-preserving protocols and secure location services, Blockchain-based solutions for mobile applications.		6 Hrs
Unit 6	**Emerging Trends in Mobile Computing** 5G/6G and ultra-low latency communications, Mobile AI/ML: on-device learning and federated learning, Energy-aware computing and green mobile systems,Mobile augmented reality (AR) and virtual reality (VR), Future research directions: satellite-integrated mobile networks, digital twins for mobile systems.		6 Hrs

Text Books	
1.	Jochen Schiller, Mobile Communications, 2nd Edition, Pearson Education.
2	Raj Kamal, Mobile Computing, Oxford University Press.
3	Asoke K. Talukder, Roopa R. Yavagal, Hasan Ahmed, Mobile Computing: Technology, Applications and Service Creation, McGraw Hill.
4	William Stallings, Wireless Communications and Networks, Pearson.
Reference Books	
1	George F. Elmasry, Fundamentals of Mobile Computing, Cambridge University Press.
2	Dharma P. Agrawal and Qing-An Zeng, Introduction to Wireless and Mobile Systems, Cengage.
3	Reza B'Far, Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML, Cambridge University Press.
4	Vijay Garg, Wireless Communications and Networking, Morgan Kaufmann.
Web Resources	
1.	https://nptel.ac.in/courses

Course Title: Project-I		
Course Code: PE253603		**Course Category: EL**
Teaching Scheme	**Examination Scheme (As Applicable)**	
Practical's/Sessions:10Hours/Week	CA-I	25Marks
	CA-II	25Marks
Semester: Second Year (Semester-III)	ESE	50Marks

Course Prerequisite:
1. Basic understanding of core subjects in specialization, ability access, and interpret scientific literature.
2. Exposure to technical report writing and presentation.

Course Description: Project-I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work; the candidate shall deliver a presentation on progress of the work on the selected dissertation topic. The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

Course Objectives:
1. To enable students to identify and define a research/industrial problem.
2. To develop skills for conducting a comprehensive literature review.
3. To formulate objectives, scope, and methodology for the proposed work.
4. To strengthen technical writing, presentation, and project planning skills.
5. To prepare a well-structured project synopsis in line with research/industry requirements

Course Outcomes:		
COs	After Successful Completion of Project-I Course Contents:	**Bloom's Level**
CO1	Identify and define a research/engineering problem relevant to the specialization.	L3–Apply
CO2	Perform a critical literature review and identify research gaps.	L4– Analyze
CO3	Formulate clear objectives, scope, and methodology for the project proposal.	L5 – Evaluate
CO4	Develop project planning with milestones, deliverables, and resources.	L3 – Apply

CO-PO Mapping

CO-PO Mapping																
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	2	3	3	2	2
CO2	2	3	-	3	2	-	1	1	1	-	1	2	2	2	1	3
CO3	3	3	3	3	3	1	2	1	2	2	2	-	3	3	2	1
CO4	-	2	3	-	2	-	1	2	3	-	3	3	-	2	1	2

Course Contents:

1. **Identification of Research Area / Problem Statement**
   Selection of topic based on current research trends, industrial problems, or societal needs.
2. **Literature Survey**
   Review of recent and relevant literature from journals, conferences, patents, and standards.
3. **Problem Formulation**
   Statement of objectives, scope, and significance of the problem.
4. **Methodology and Approach**
   Proposed methods, design, tools, software, experimental setup, or simulation plan.
5. **Project Planning**
   Defining project milestones, deliverables, and timelines.
6. **Preparation and Presentation Proposal**
   Writing of a structured synopsis/proposal, including references, and presenting before a review panel.

Assessment	
Project-I will have internal marks of 50 and a Semester-end examination of marks 50.	
Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.	
CA-I(a)	Review-I: 25 Marks (Concept/knowledge in the topic = 10 marks, Literature-05 marks)
CA-II(b)	Review-II: 25 Marks (Report writing & Presentation =25 Marks)
Practical / viva voce (c)	50 Marks (Individual evaluation through viva voce / test (50marks)
Total(d)	100Marks

Course Title: Project-II		
CourseCode:PE254604	**Course Category:** EL	
Teaching Scheme	**Examination Scheme(As Applicable)**	
Practical's/Sessions:20Hours/Week	CA-I	50Marks
	CA-II	50Marks
Semester: Second Year(Semester-IV)	ESE	100Marks

Course Prerequisite:
1. Basic understanding of core subjects in specialization, ability access, and interpret scientific literature.
2. Exposure to technical report writing and presentation

Course Description :M.Tech Project–II (Dissertation) is a culmination of the postgraduate program where students demonstrate their ability to independently identify, formulate, and solve research or industry oriented engineering problems. The dissertation involves systematic literature review, problem definition, research methodology, experimentation/simulation, result analysis, and formulation of conclusions. The course aims to develop presearch aptitude, technical depth, and professional presentation skills aligned with the Program Outcomes (POs).

Course Objectives:
1. To enable students to undertake independent research or applied problem-solving in their domain.
2. To develop analytical and experimental skills through design, simulation, or experimental validation.
3. To strengthen technical communication through research publications and dissertation writing.
4. To encourage innovative thinking, ethical research practices, and professional responsibility.

Course Outcomes:		
COs	**After Successful Completion of Project-II Course Contents:**	**Bloom's Level**
CO1	Formulate and define research problem with appropriate objectives and scope.	L3 Apply
CO2	Critically review and analyze literature to identify research gaps.	L4 Analyze
CO3	Develop methodology / experimental /simulation framework for problem-solving.	L5 Evaluate
CO4	Conduct experiments /simulations and analyze results with proper validation.	L5 Evaluate

CO-PO Mapping

CO-PO Mapping															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	1	1	1	1	2	2	3	2	3
CO2	2	3	-	1	2	-	1	1	1	-	1	2	2	2	1	2
CO3	3	2	2	3	3	1	2	1	2	2	2	-	3	3	3	3
CO4	2	2	3	2	2	-	1	2	3	-	3	3	-	2	2	2

Course Contents:

1. **Problem Definition & Literature Review**
   - Identification of research problem based on gap analysis.
   - Comprehensive literature survey from journals, patents, and technical reports.
2. **Research Methodology & Design**
   - Development of methodology/experimental setup/modeling/simulation framework.
   - Selection of tools, techniques, and optimization methods.
3. **Implementation &Analysis**
   - Data collection through experiments/simulations/field studies.
   - Analysis, validation, and comparison with existing methods.
4. **Dissertation Documentation &Presentation**
   - Dissertation writing as per standard guidelines.
   - Drafting technical papers from dissertation outcomes.
   - Final presentation and defense.

Assessment

Project-II will have internal marks 100 and Semester-end examination marks 100.

Internal examination will be conducted by a committee consisting of five faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and internal marks shall be awarded as follows.

1. Review-I:25Marks, Review-25

2. GuideEvaluation-50Marks

 Total-100 Marks

External Examination Marks:

1. Guide-50Marks

2. Externalexaminerevaluation-20Marks

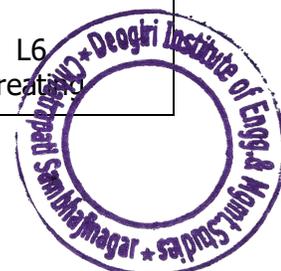3. DPACEvaluation-30Marks

Total-100marks

Assessment Criteria:

- Novelty and relevance of problem (10%)
- Depth of literature review and problem definition (15%)
- Methodology and implementation (25%)
- Analysis, validation, and discussion of results (25%)
- Quality of dissertation and presentation (25%)
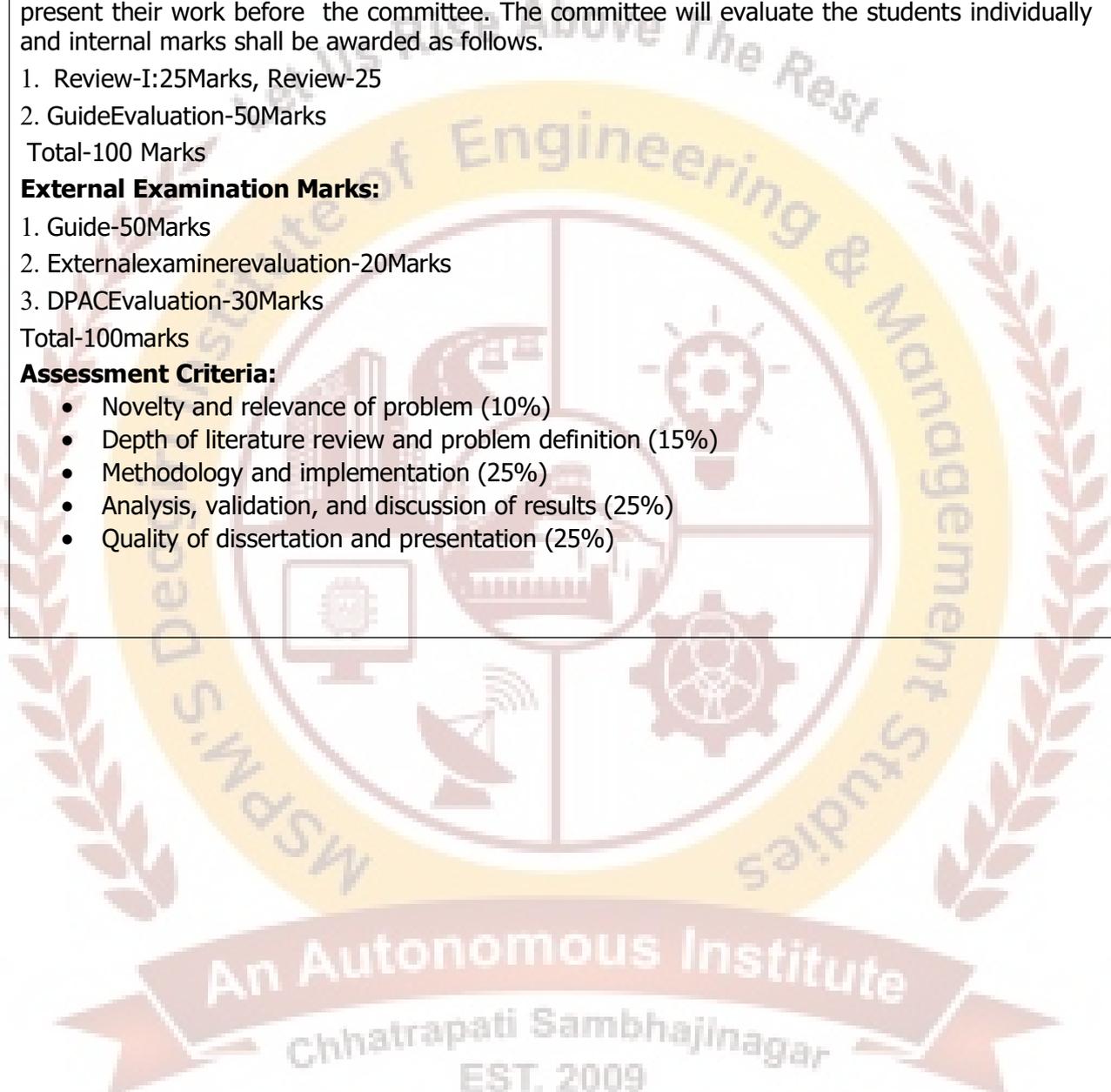
Course Title: Communication skill and technical writing			
Course Code: PE254701		Course Category: CC	
Teaching Scheme		**Examination Scheme**	
Lectures:02hrs/week	CA-1	**25 Marks**	
Tutorial:-----	CA-2	**25 Marks**	
Credits:02	MSE	-	
Semester: PG First year (Semester IV)	ESE	-	

Course Prerequisite:

Basic English composition or introductory technical communication; familiarity with engineering fundamentals

Course Description:

This course equips engineering students with essential communication skills for professional and academic success, focusing on technical writing and oral presentations. Students learn to craft clear, concise technical reports, research proposals, and documentation, as well as deliver effective presentations tailored to engineering. Topics include audience analysis, research document structure, visual aids, professional correspondence, and ethical communication. Through hands-on practice for drafting technical research papers, peer reviews, and research projects, students would be able to apply skills to real-world engineering contexts, such as presenting research. The course prepares students for thesis work, industry reports, and collaborative engineering environments.

Course Objectives:

1. Understand the principles, structure, and ethical conventions of research writing to support effective documentation in engineering applications.
2. Formulate research problems and develop structured technical documents, including abstracts, introductions, and methodologies, for engineering contexts.
3. Apply data collection and analysis techniques, such as questionnaires and observation methods, to enhance research writing for engineering projects.
4. Produce professional correspondence and technical papers formatted for submission to engineering platforms

Course Outcomes:		
COs	**After completion of the course: Student should be able to**	**Bloom's Level**
CO1	Explain the principles and conventions of research writing, including its purpose, structure, and ethical considerations, to support engineering applications.	L2 Understanding
CO2	Formulate research problems and structure technical documents.	L6 Creating
CO3	Apply data collection and analysis techniques, including questionnaire design and observation methods, to support research writing in engineering projects.	L3 Applying
CO4	Produce professional correspondence and prepare technical papers for submission to engineering platforms	L6 Creating

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	-	-	2	2	3	-	2	-	2	3	-	1	1
CO2	2	3	2	2	1	1	2	2	-	2	1	2	3	-	1	1
CO3	2	2	2	3	2	1	2	1	1	1	1	1	3	-	1	1
CO4	-	1	1	1	2	2	1	1	2	3	1	2	-	3	1	1

Assessment	
CA-1(a)	Paper writing/ Presentations
CA-2(b)	Paper publication/ Paper submission

Course Contents		
Unit 1	**Fundamentals of Research Writing** Introduction to research writing - Knowing the details of research writing-Planning the purpose and material-Practicing for the audience and content delivery. Different Methods in Research Writing Nature and meaning of research methods-Types of research – pure and applied research - Types of communication research – Quantitative, Qualitative and Rhetorical - Questionnaire and observation methods - Data collection and data analysis - Thesis/Synopsis writing - Structure and importance	6 Hrs
Unit 2	**Mechanics of Research Writing** Research writing in broader spectrum - The tone -The language - Conventions of research – Evidence-based arguments - Thesis-driven analysis – Complexity and higher- order thinking.	4 Hrs

Unit 3	**Components of Research Writing:** Formatting a research paper – Title page – Abstract – Introduction – Methodology – Conclusion – Proof reading – Citing sources	2 Hrs
Unit 4	**Communication and Communication Processes** Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication **Reading Skills:** Introduction to Reading, Types of Readers and Reading, Barriers to Reading, Strategies for Reading, Comprehension. **Listening Skills**: Importance of Listening, Types of Listening, Barriers to Listening. **Speaking &Verbal &Non-verbal Communication**: Use of Language in Spoken Communication ,Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-Verbal Communication, Presentation Skills, Extempore, Elocution.	6 Hrs
Unit 5	**Professional Correspondence:** Writing emails, memos, and cover letters for engineering contexts	2 Hrs
Unit 6	**Technical Paper Submission Platforms for Engineering:** IEEE Xplore (Journals and Conferences), Elsevier Journals (Science Direct), Springer Journals etc	2 Hrs

Textbooks
1. Hamlin, A., Rubio, C., & DeSilva, M.(2017).Technical Writing. Open Oregon Educational Resources. 2. Last, S., Neveu, C., Smith, M., & Nielsen, D. (2019). Technical Writing Essentials : Introduction to Professional Communications in the Technical Fields. B C campus. 3. Oshima, A., & Hogue, A.(2006). Writing Academic English (4thed.).Pearson Longman 4. Introducing Research Methodology : A Beginner's Guide to Doing a Research Project - Uwe Flick 5. Research Design: Qualitative, Quantitative and Mixed Methods Approaches-J. David Creswell and John W. Creswell 6. The Craft of Research-Gregory G. Colomb, Joseph M. Williams, and Wayne C Booth 7. Foundations of Behavioral Research-Fred N. Kerlinge 8. Technical Writing Styleby–Dan Jones, Sam Dragga
Reference Books
9. Work book for Advanced Research and Writing by Dr. L. Kavitha Nair, EFL, SRMIST, KTR. 10. HandbookofTechnicalWritingby–Walter.E.ollu8.TechnicalWritingProcess by – Kieran Morgan and Sanja Spejic