SAMARTH EDUCATIONAL TRUST
ARVIND GAVALI COLLEGE OF ENGINEERING
ENGINEERING (B.Tech & M.Tech) BCA MCA B.VOC
NAAC & NBA Accredited AN AUTONOMOUS INSTITUTE ISO 9001:2015
Approved by AICTE, New Delhi, Recognised by Govt. Of Maha.,DTE Mumbai & Affiliated to Dr.Babasaheb Ambedkar Technological University (BATU), Lonere.

Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
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Website :-www.agce.edu.in
Institute Code : Engg. DTE EN-6545
BCA 6545, MCA 6545, B.Voc 6545

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

ABOUT THE DEPARTMENT

The Department of Electronics and Telecommunication Engineering is one of the leading departments of Arvind Gavali College of Engineering. The department is equipped with qualified and experienced faculty members, modern laboratories, advanced computing facilities, and research-oriented infrastructure to support quality education and innovation.

The department is committed to providing quality technical education and fostering excellence in teaching, research, and professional development. Keeping pace with rapid technological advancements and the growing demand for specialized professionals, the department is pleased to introduce a Postgraduate (PG) Program in Electronics and Telecommunication Engineering from the academic year 2026–27.

The postgraduate program will focus on emerging areas of Electronics and Communication Engineering, including Advanced Communication Systems, RF and Microwave Engineering, Embedded Systems, VLSI Design, Signal Processing, Internet of Things (IoT), Artificial Intelligence, and Next-Generation Wireless Networks. The curriculum is designed to meet the evolving requirements of industry, research organizations, and academia.

The department emphasizes outcome-based education, industry interaction, interdisciplinary research, innovation, entrepreneurship, and lifelong learning. Through projects, internships, industrial visits, workshops, seminars, and research activities, students develop analytical, technical, and professional competencies required to address complex engineering challenges.

The department strives to produce competent engineers, researchers, innovators, and technology leaders capable of contributing effectively to society and technological advancement.

Vision Statement:

"Empowering Innovation through Advanced Electronics and Communication Technologies."

The newly introduced PG program aims to create opportunities for advanced learning, research, and skill development, enabling graduates to contribute significantly to technological progress, industrial growth, and societal development.

DEPARTMENT VISION

To be a premier postgraduate programme in Electronics and Telecommunication Engineering that develops competent researchers, innovators, and technology leaders capable of providing sustainable solutions to industrial and societal challenges.

DEPARTMENT MISSION

M1	To impart advanced knowledge and research-oriented education in Electronics and Telecommunication Engineering through effective teaching-learning processes and modern technological tools.
M2	To nurture innovation, analytical thinking, professional competence, and multidisciplinary skills required for solving complex engineering problems and contributing to technological advancement.
M3	To inculcate ethical values, environmental consciousness, lifelong learning, and social responsibility among graduates for sustainable development and nation building.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO 1	Graduates will apply advanced concepts of Electronics and Telecommunication Engineering to analyze, design, and develop innovative solutions for industrial, societal, and research problems.
PEO 2	Graduates will apply advanced concepts of Electronics and Telecommunication Engineering to analyze, design, and develop innovative solutions for industrial, societal, and research problems.
PEO 3	Graduates will engage in lifelong learning, research, innovation, entrepreneurship, and ethical professional practices while contributing to society and sustainable development.

PROGRAM OUTCOMES (PO)

PO 1	Ability to demonstrate advanced knowledge and mastery in the area of Electronics and Telecommunication Engineering at a level higher than that of an undergraduate engineering programme.
PO 2	Ability to independently carry out research, investigation, and development work to solve complex engineering problems.

PO 3	Ability to effectively write, publish, and present technical reports, research papers, patents, and project outcomes.
PO 4	Ability to analyze, design, and develop innovative solutions for complex engineering and societal problems.
PO 5	Ability to apply modern engineering tools, simulation software, and experimental techniques for modelling, analysis, validation, and optimization of engineering systems.
PO 6	An ability to demonstrate professional ethics, leadership, teamwork, environmental consciousness, and a commitment to lifelong learning for sustainable technological development and societal welfare.

PROGRAM SPECIFIC OUTCOMES (PSO)	
PSO 1	Graduates will be able to analyze, model, design, and optimize advanced Electronics and Telecommunication systems in both the fundamental and emerging technologies.
PSO 2	Graduates will be able to undertake research, innovation, and product development activities by effectively utilizing modern engineering tools, simulation platforms, programming environments, and experimental methodologies to address industrial and societal needs.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
PEO 1	3	3	3	2	3	2
PEO 2	2	2	2	3	2	1
PEO 3	1	1	1	2	1	3

MAPPING OF PEO's TO PSO's		
	PSO 1	**PSO2**
PEO 1	3	2
PEO 2	3	3
PEO 3	1	3

As per NEP Guidelines Proposed Scheme of Credit Distribution

	Year	FY		SY		Actual Credit
Sr. No.		I	II	III	IV	
1	Basic Science Course	--	--	--	--	--
2	Engineering Science Course	--	--	--	--	--
3	Program/Professional Core Courses	9	5	--	--	14
4	Program/Professional Elective Course	6	3	--	--	9
5	Multi Minor	--	--	3	--	3
6	Open Elective	--	3	3	--	6
7	Vocational and Skill Enhancement Course	--	--	--	--	--
8	Ability Enhancement Course	--	--	--	--	--
9	Entrepreneurship /Economics/ Management Courses (Mgt./Economics/Mkt./Finance)	--	--	--	--	--
10	Indian Knowledge System	2	3	--	--	5
11	Value Education Course	--	--	--	--	--
12	Research Methodology	--	4	--	--	4
13	Common Egg. Project/Field Project (PBL/Seminar/Mini Project)	2	2	2	--	6
14	Project	--	--	10	20	30
15	Internship/OJT (PBL/Seminar/Mini Project/Virtual Internship/Physical)	--	--	--	--	--
16	Co-curricular Courses	1	2	--	--	3
	Total Credits	**20**	**22**	**18**	**20**	**80**

SEMESTER – I

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	PCC	26ETC1101	Signal Theory and Estimation Techniques	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
2	PCC	26ETC1102	Digital Image and Video Processing	4	0	0	4	4	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
3	PEC	26ETC1103X	Program Elective-I	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
4	PEC	26ETC1104X	Program Elective-II	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
5	PCC	26ETC1105L	PG Lab-I	0	0	4	4	2	CA1	25		45
									CA2	25		
									POE	50	20	
6	ELC	26ETC1106	Seminar I	0	0	4	4	2	CA1	25		45
									CA2	25		
									OE	50	20	
7	IKS	26ETC1107	Concepts & Applications in Engineering	2	0	0	0	2	CA1	25	20	20
									CA2	25		
									OE/POE	--	--	
8	CC	26ETC1108	YOGA for Stress Management	0	0	2	0	1	CA1	25	20	20
									CA2	25		
									OE/POE	--	--	
			Total	**15**	**0**	**10**	**21**	**20**		**700**		
Total Contact Hours – 21 Total Credits - 20												

Professional Elective Courses List for F. Y. M. Tech SEM – I

Sr. No.	Course Name	Course Code
PEC-I		
1	Algorithms and Quantum AI	26ETC11031
2	Electromagnetic Interference and Compatibility	26ETC11032
3	Signal Processing Algorithms & Applications	26ETC11033
4	Analog and Mixed Signal Processing	26ETC11034
PEC-II		
1	RF and Millimeter Wave circuit Design	26ETC11041
2	VLSI System Design	26ETC11042
3	Optical Fiber Communication	26ETC11043
4	Statistical Signal Processing	26ETC11044

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SEMESTER – II

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	PCC	26ETC1201	Detection, Estimation and Information Theory	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
2	RM	26ETC1202	Research Methodology	4	0	0	4	4	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
3	PEC	26ETC1203X	Program Elective-III	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
4	OE	26ETC1204X	Open Elective I	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
5	PCC	26ETC1205L	PG Lab-II	0	0	4	2	2	CA1	25		45
									CA2	25		
									POE	50	20	
6	ELC	26ETC1206	Seminar-II	0	0	4	2	2	CA1	25		45
									CA2	25		
									OE	50	20	
7	AEC/VEC /IKS	26ETC1207	Humanities and Social Sciences	3	0	0	3	3	CA1	25	20	20
									CA2	25		
									OE/POE	--	--	
8	CC	26ETC1208	Disaster Management	2	0	0	2	2	CA1	25	20	20
									CA2	25		
									OE/POE	--	--	
			Total	**18**	**0**	**10**	**22**	**22**		**700**		
Total Contact Hours – 22 Total Credits - 22												

Professional Elective and Open Elective Courses List for F. Y. M. Tech SEM – II:

Sr. No.	Course Name	Course Code
PEC-III		
1	Multirate Digital Signal Processing	26ETC12031
2	Intelligent Automotive Embedded Systems	26ETC12032
3	AI in wireless Communication	26ETC12033
4	System On-Chip	26ETC12034
Open Elective-I		
1	New Labour Codes of India	26ETC12041
2	Urban Utilities Planning: Water Supply, Sanitation and Drainage	26ETC12042
3	Environment and Development	26ETC12043
4	Entrepreneurship	26ETC12044

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SEMESTER – III

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	OE	26ETC2301X	Open Elective II	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
2	MDM	26ETC2302X	Multidisciplinary Minor	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
3	ELC	26ETC2303	Seminar III	0	0	4	2	2	CA1	25	20	20
									CA2	25		
									OE/POE	--	--	
4	PR	26ETC2304	Project Phase-I	0	0	0	20	10	CA1	25		45
									CA2	25		
									OE	50	20	
			Total	**6**	**0**	**4**	**28**	**18**		**350**		
Total Contact Hours –28 Total Credits - 18												

Multi-Disciplinary Minor and Open Elective Courses List for F. Y. M. Tech SEM – III:

Sr. No.	Course Name	Course Code
Multi-Disciplinary Minor		
1	Multirate Digital Signal Processing	26ETC23021
2	Intelligent Automotive Embedded Systems	26ETC23022
3	AI in wireless Communication	26ETC23023
4	System On-Chip	26ETC23024
Open Elective -II		
1	Organizational Behaviour	26ETC23011
2	Principles Of Finance and Economics	26ETC23012
3	Intellectual Property & Rights	26ETC23013
4	Constitution of India	26ETC23014

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SEMESTER – IV

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs. /Week	Cr	Components	Max	Min for Passing	
1	PR	26ETC2401	Project Phase - II	0	0	40	40	20	CA-1	25		45
									CA-2	25		
									OE	50	20	
			Total	**0**	**0**	**40**	**40**	**20**		**100**		
Total Contact Hours – 40 Total Credits - 20												

Title of the Course: Signal Theory and Estimation Techniques	**L**	**T**	**P**	**Credit**
Course Code: 26ETC1101	**3**	**-**	**-**	**3**

Course Pre-Requisites:

Students should possess the following prerequisite knowledge:

1. Engineering Mathematics
- Probability and basic statistics
- Matrix algebra and linear algebra fundamentals
- Differential and integral calculus
- Multivariable functions and partial differentiation
- Infinite series and convergence concepts

2. Signals and Systems
- Continuous-time and discrete-time signals
- System properties and classifications
- Convolution and correlation
- Fourier Series and Fourier Transform
- Power and energy spectral concepts

3. Digital Signal Processing Fundamentals
- Sampling theorem
- Random signal representation
- Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)
- Spectral analysis basics
- Digital filtering concepts

4. Communication Engineering
- Communication system fundamentals
- Noise in communication systems
- Signal transmission through channels
- Detection and estimation concepts in communication receivers
- Analog and digital communication basics

5. Probability and Statistics
- Random experiments and sample spaces
- Probability distributions
- Conditional probability and Bayes' theorem
- Mean, variance, covariance, and correlation
- Statistical inference fundamentals

6. Programming and Computational Tools
- Basic MATLAB/Python programming
- Numerical computation and visualization
- Data analysis and simulation fundamentals

Course Description:

Signal Theory and Estimation Techniques provides a comprehensive study of the mathematical and statistical foundations required for modeling, analyzing, and processing signals in the presence of uncertainty. The course introduces probability theory, random variables, and stochastic processes as essential tools for representing and analyzing random phenomena encountered in modern engineering systems. Students develop a strong understanding of statistical characterization, transformations of random variables, correlation

analysis, spectral representations, and random signal modeling techniques.

The course further explores the principles of estimation theory and optimal filtering, including Maximum Likelihood Estimation (MLE), Maximum A Posteriori (MAP) estimation, Bayesian estimation, Minimum Mean Square Error (MMSE) estimation, Wiener filtering, and Kalman filtering. These techniques enable the extraction of useful information from noisy observations and form the basis of modern signal processing, communication, and control systems.

Advanced topics in detection theory and statistical signal processing are also covered, including hypothesis testing, Neyman-Pearson detection, likelihood ratio tests, matched filtering, adaptive estimation, and Bayesian decision theory. The course emphasizes practical applications in wireless communications, radar and sonar systems, biomedical signal processing, speech and audio processing, intelligent sensing systems, and emerging AI-enabled signal analytics.

By the end of the course, students will be able to model random signals and systems, design optimal estimators and detectors, and apply statistical signal processing techniques to solve complex engineering problems involving uncertainty, noise, and decision-making. The course serves as a foundation for advanced studies and research in statistical signal processing, machine learning for signal analysis, communication engineering, radar systems, and intelligent sensing technologies.

Course Objectives:

1. Develop a strong foundation in probability theory, random variables, and probability distributions for modeling uncertainty in engineering systems.
2. Understand the statistical characterization and transformation of random variables using moments, correlation measures, characteristic functions, and convergence concepts.
3. Analyze stochastic processes and random signal models using correlation functions, spectral analysis, stationarity, ergodicity, and Markov processes.
4. Apply estimation theory and optimal filtering techniques, including MLE, MAP, Bayesian estimation, MMSE estimation, Wiener filtering, and Kalman filtering, to estimate unknown parameters and states from noisy observations.
5. Develop the ability to apply detection theory and statistical signal processing techniques for solving problems in wireless communications, radar, biomedical systems, intelligent sensing, and AI-enabled signal analysis.

Course Outcomes:

CO	After the completion of the course the student should be able to:
CO1	Apply probability theory, random variable concepts, probability distributions, and Bayesian principles to model and analyze engineering systems affected by uncertainty.
CO2	Analyze statistical characteristics and transformations of random variables using moments, correlation measures, characteristic functions, and convergence concepts.

CO3	Analyze stochastic processes and random signal models using stationarity, ergodicity, correlation functions, spectral analysis, and Markov processes for communication and signal processing applications.
CO4	Evaluate estimation techniques and optimal filtering methods, including MLE, MAP, Bayesian estimation, MMSE estimation, Wiener filtering, and Kalman filtering for parameter and state estimation problems.
CO5	Apply detection theory and statistical signal processing techniques to solve signal detection, classification, and decision-making problems in wireless communications, radar, biomedical systems, and intelligent sensing applications.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	-	2	1	-	3	1
CO2	3	3	-	2	2	-	3	1
CO3	3	3	-	3	2	-	3	2
CO4	3	3	1	3	3	-	3	3
CO5	3	3	2	3	3	1	3	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Probability Theory and Random Variables** Review of probability theory, Axiomatic approach to probability, Conditional probability and Bayes' theorem, Independence of events, Random experiments and sample spaces, Discrete and continuous random variables, PMF, PDF and CDF, Joint, marginal and conditional distributions, Standard distributions: Bernoulli, Binomial, Poisson, Uniform, Exponential, Gaussian, Rayleigh distributions, Law of total probability	8
2.	**Unit 2: Statistical Characterization and Transformations of Random Variables** Expectation and moments, Mean, variance and higher-order moments, Correlation and covariance, Characteristic functions, Moment-generating functions, Functions and transformations of random variables, and Multivariate Gaussian distribution, Central Limit Theorem, Modes of convergence	7
3.	**Unit 3: Random Processes and Signal Modeling** Random processes and classifications, Stationarity and ergodicity, Autocorrelation and cross-correlation functions, Power Spectral Density, Gaussian random processes, Poisson random processes, Markov chains and Markov processes, White noise and colored noise, Random signal modelling for communication systems	8
4.	**Unit 4: Estimation Theory and Optimal Filtering** Fundamentals of estimation theory, Properties of estimators: Unbiasedness, Consistency, Efficiency, and Sufficiency, Maximum Likelihood Estimation (MLE), Maximum A Posteriori (MAP) Estimation, Bayesian Estimation, MMSE Estimation, Least Squares Estimation, Cramer-Rao Lower Bound, Wiener Filtering, Introduction to Kalman Filtering	7
5.	**Unit 5: Detection Theory and Statistical Signal Processing Applications** Binary hypothesis testing, Neyman-Pearson criterion, Likelihood Ratio Test, Receiver Operating Characteristics (ROC), Signal detection in Gaussian noise, Matched Filter, Multi-hypothesis detection, Adaptive estimation concepts, Bayesian decision theory, Statistical signal processing applications: Wireless communication systems, Radar and sonar systems, Biomedical signal processing, Speech and audio processing, and Intelligent sensing systems, Introduction to probabilistic machine learning for signal processing	8

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Probability, Random Variables and Stochastic Processes	Athanasios Papoulis and S. Unnikrishna Pillai	4th edition, Tata McGraw Hill, 2017
2.	Probability, Statistics and Random Processes	T. Veerajan	Tata McGraw-Hill Education (India) Pvt Limited, Third Edition, 2008
3.	Statistical Digital Signal Processing and Modeling	Monson H. Hayes	Wiley, India
4.	Communication Systems	Simon Haykin	Wiley, India

Reference Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Fundamentals of Statistical Signal Processing: Estimation Theory	Steven M. Kay	Prentice Hall
2.	Fundamentals of Statistical Signal Processing: Detection Theory	Steven M. Kay	Prentice Hall
3.	Detection, Estimation, and Time Series Analysis	Harry L. Van Trees	Wiley-Interscience
4	Introduction to Probability Models	Sheldon M. Ross	Academic Press

Add resource link like NPTEL

Signal Detection and Estimation Theory - https://nptel.ac.in/courses/117103018

NPTEL Video Course: Estimation of Signals and Systems - http://digimat.in/nptel/courses/video/108105059/L05.html

Title of the Course: Digital Image and Video Processing Course Code: 26ETC1102	L	T	P	Credit
	4	-	-	4

Course Pre-Requisite: Engineering Mathematics III, Digital Signal Processing, Digital Image Processing

Course Description: This course aims to focus on applications of Image and Video Processing. Itincludes the concepts based upon Image enhancement, moving object detection, video compression etc.

Course Objectives:

1. Develop an understanding of advanced image enhancement and preprocessing techniques for improving image quality and facilitating further image analysis.
2. Acquire knowledge of image segmentation, feature extraction, and object recognition techniques for interpreting and analyzing visual information.
3. Understand the principles and applications of video processing, motion analysis, and video compression standards used in multimedia systems.
4. Apply modern image and video processing algorithms, computational methods, and software tools for solving real-world computer vision problems.
5. Analyze advanced video analytics techniques such as motion estimation, object tracking, activity recognition, and intelligent video surveillance applications.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Apply image enhancement techniques for improving image quality and preparing images for further analysis.
CO2	Analyze image segmentation and feature extraction methods for identifying and interpreting meaningful image regions and objects.
CO3	Evaluate object recognition and classification techniques using statistical, pattern recognition, and machine learning approaches.
CO4	Apply video processing and compression techniques for efficient video representation, storage, transmission, and analysis.
CO5	Analyze advanced video processing techniques such as motion estimation, object tracking, activity recognition, and video analytics for intelligent vision applications.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	1	-	2	3	-	3	2
CO2	3	2	-	3	3	-	3	2
CO3	3	2	1	3	2	-	3	3
CO4	3	1	-	2	3	-	3	2
CO5	3	3	1	3	3	1	3	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Image Enhancements** Filtering. Spatial filtering Denoising. Contrast Enhancement. Blurring: Gaussian Blur,Motion Blur, Blur kernels	7
2.	**Unit 2: Image Segmentation and Feature Analysis**	7

	Detection of Discontinuities, Edge operators, Edge linking and Boundary DetectionThresholding. Image Segmentation Background subtraction. Environment mating: basic concepts. Region based segmentation - Morphological Watersheds, use of Motion for Segmentation	
3.	**Unit 3: Object Recognition** Introduction – Pattern and Pattern Class – Selection Measurement Parameters – Approaches – Types of Classification – Bayes, Template matching, non-parametric density estimation, Neural Network approach – Applications	8
4	**Unit 4: Video Processing** Basics of video processing, Motion analysis, **Video compression:** Analog Video, Composite and Components Video, Digital Video,MPEG, MPEG-4, H.261standards video compression standards Case studies: Watermarking, Biometrics, Document analysis, Moving object detection	8
5	**Unit 5: Advanced Concepts in Video Processing** Fundamentals of Video Processing and Video Formats, Temporal and Spatial Redundancy in Video Signals, Frame Representation and Color Spaces for Video, Motion Estimation and Motion Compensation Techniques, Block Matching Algorithms, Optical Flow Estimation, Object Detection and Tracking in Video Sequences, Background Modeling and Foreground Extraction, Video Segmentation and Activity Recognition	8

Text Books

Sr.No	Title	Author	Publisher
1.	Digital Image Processing	Rafael C. Gonzalez, Richard E. Woods	Pearson , 4rd Edition
2.	Fundamentals of Digital Image Processing	Anit K. Jain	Prentice Hall
3.	Digital Video Processing	A. Murat Tekalp	first edition, Prentice Hall Gerd Keiser

Reference Books			
1.	Computer Vision A Modern Approach	H David Forsyth, Jean Ponce	PearsonPublication
2.	Computer Vision A Modern Approach David Forsyth	Jean Ponce , Pearson Publication	PearsonPublication
3.	Learning OpenCV 4 Computer Vision with Python		Packt Publications

Title of the Course: Algorithms and Quantum AI	**L**	**T**	**P**	**Credit**
Course Code: 26ETC11031	**3**	**-**	**-**	**3**

Course Prerequisite:

The following prerequisites are needed:

1. Fundamentals of Engineering Mathematics
   - Linear Algebra
   - Probability and Statistics
   - Matrices and Vector Spaces
2. Basics of Quantum Mechanics
   - Wave-particle duality
   - Quantum states and superposition
3. Fundamentals of Artificial Intelligence and Machine Learning
   - Neural Networks
   - Supervised and Unsupervised Learning
   - Optimization Techniques
4. Knowledge of Algorithms and Data Structures
   - Searching and optimization algorithms
   - Computational complexity basics
5. Basic Programming Skills
   - Python/C/C++ programming
   - Logical problem-solving
6. Fundamentals of Computer Architecture and Computing Systems
   - Classical computing concepts
   - Binary systems and logic gates

These prerequisites are suitable because the subject combines concepts from quantum computing, artificial intelligence, machine learning, cryptography, and optimization algorithms.

Course Description:

This course introduces the fundamental concepts of quantum technology, quantum computing, and Quantum Artificial Intelligence (Quantum AI) with emphasis on quantum algorithms and their applications in intelligent systems. The course covers the principles of quantum mechanics, differences between classical and quantum computing, and important quantum computing methods such as quantum cryptography, quantum error correction, and major quantum algorithms including Simon's, Shor's, and Grover's algorithms.

The course further explores the integration of quantum computing with artificial intelligence through Quantum Neural Networks, Quantum Machine Learning techniques, and hybrid quantum-classical models. It also discusses the advantages, challenges, and practical implementation aspects of Quantum AI systems.

In addition, the course focuses on real-world applications of Quantum AI in optimization problems, scientific simulations, drug discovery, cybersecurity, and data protection. The subject enables students to understand emerging trends in quantum computing and prepares

them for advanced research and industrial applications in Quantum AI and intelligent computing systems.

Course Objectives:

- To introduce the fundamental principles of quantum mechanics, quantum technology, and quantum computing along with their applications and comparison with classical computing systems.
- To understand important quantum computing methods, quantum cryptography, quantum error correction techniques, and major quantum algorithms used in secure and high-speed computation.
- To explain the concepts of Quantum AI and Quantum Neural Networks and understand the transition from classical AI systems to Quantum AI systems using quantum algorithms.
- To study Quantum Machine Learning methods, quantum data representation, and hybrid quantum-classical learning models for intelligent computing applications.
- To analyze the applications of Quantum AI in optimization, scientific simulations, drug discovery, cybersecurity, and advanced intelligent systems.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain the principles of quantum technology and quantum computing, differentiate between classical and quantum computing systems, and identify major applications of quantum computing.
CO2	Analyze quantum computing methods, explain quantum cryptography and error correction techniques, and understand the working principles of major quantum algorithms such as Simon's, Shor's, and Grover's algorithms.
CO3	Explain Quantum AI concepts, analyze Quantum Neural Networks, and evaluate the role of quantum algorithms in enhancing artificial intelligence systems.
CO4	Apply Quantum Machine Learning concepts, analyze hybrid quantum-classical learning models, and understand quantum learning techniques for intelligent data processing.
CO5	Analyze and explain the applications of Quantum AI in optimization problems, scientific simulations, drug discovery, cybersecurity, and data protection systems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	-	1	2	-	3	1
CO2	3	2	-	2	3	-	3	3
CO3	2	2	-	3	2	-	3	2
CO4	2	3	-	3	3	-	2	3
CO5	2	2	-	3	2	1	2	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Introduction to Quantum Technology** Introduction to Quantum Mechanics, Introduction to Quantum Technology, Introduction to Quantum Computing, Difference Between Traditional and Quantum Computing, Applications of Quantum Computing	6
2.	**Unit 2: Quantum Computing Methods** Quantum Error Correction, Quantum Fault Tolerance, Quantum Cryptography, Simon's Algorithm, The Prime Factorization Algorithm, Grover's Search Algorithm	8

3.	**Unit 3: Quantum AI** Introduction to Quantum Neural Networks, Utilizing Quantum Algorithms to Make the Transition from Classical AI to Quantum AI, Understanding the Difficulties and Advantages of Quantum AI	6
4.	**Unit 4: Quantum Machine Learning Techniques** Introduction to Quantum Machine Learning, Quantum Data Representation and Feature Mapping, Quantum Supervised and Unsupervised Learning, Hybrid Quantum-Classical Machine Learning Models, Quantum Reinforcement Learning, Challenges and Future Scope of Quantum Machine Learning	8
5.	**Unit 5: Applications of Quantum AI** Applications of Quantum AI for Optimization Problems, Quantum AI for Complex Scientific Simulations, Quantum AI for Drug Discovery, Quantum AI for Data Security	5

Text Books

Sr.No	Title	Author	Publisher
1.	Quantum Computation and Quantum Information	Michael A. Nielsen Issac L. Chuang	Cambridge University Press
2.	Quantum Computing for Computer Scientists	Noson S. Yanofsky Mirco A. Mannucci	Cambridge University Press
3.	Quantum Computing: A Gentle Introduction	Eleanor Rieffel Wolfgang Polak	MIT Press
4.	Quantum Machine Learning What Quantum Computing Means to Data Mining	Peter Wittek	Academic Press

Reference Books

Sr.No	Title	Author	Publisher
1.	Programming Quantum Computers: Essential Algorithms and Code Samples	Eric R. Johnston, Nic Harrigan, & Mercedes Gimeno-Segovia	O'Reilly
2.	Hands-On Quantum Machine Learning with Python Volume 1: Get Started	Frank Zickert	Independently Published
3.	Quantum Computing Explained	David McMahon	Wiley Publishing

Add resource link like NPTEL:

1. Introduction to Quantum Computing: Quantum Algorithms and Qiskit - https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_cs103
2. Quantum Algorithms and Cryptography: https://nptel.ac.in/courses/106106241
3. Quantum Information and Computing - https://nptel.ac.in/courses/115101092
4. IBM Quantum Platform - https://quantum.cloud.ibm.com/

Title of the Course: Electromagnetic Interference and Compatibility **Course Code:** 26ETC11032	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-requisite:

- Before studying Electromagnetic Interference and Compatibility (EMI/EMC), students should have basic knowledge of the following subjects and concepts:
- Engineering Physics - Fundamentals of electromagnetic fields and waves, Electric and magnetic field concepts
- Network Theory / Circuit Theory **-** RLC circuits, Frequency response and resonance, Transmission line basics
- Signals and Systems - Time and frequency domain representation, Fourier analysis concepts
- Analog and Digital Electronics - Electronic components and circuits, Switching characteristics and noise sources
- Electromagnetic Fields and Waves - Maxwell's equations, Wave propagation, Radiation and antenna fundamentals
- Communication Engineering Basics - Radio communication systems, Signal transmission and reception
- Basic Mathematics - Differential equations, Probability and statistics fundamentals
- Computer Simulation Fundamentals **-** Basic exposure to simulation/software tools used in electronics and communication engineering

Course Description:

The course Electromagnetic Interference and Compatibility (EMI/EMC) provides comprehensive knowledge of electromagnetic interference phenomena, compatibility requirements, and mitigation techniques used in modern electronic and communication systems. The course introduces the fundamentals of EMI generation, coupling mechanisms, electromagnetic standards, and the behavior of radiated and conducted emissions in electronic equipment.

The course covers EMI measurement techniques, including radiated and conducted interference testing, open area test sites, and immunity evaluation methods used for compliance with international EMC standards. It also emphasizes practical EMI reduction techniques such as grounding, shielding, bonding, filtering, and suppression methods for improving system performance and reliability.

Advanced topics including probabilistic and statistical EMI/EMC models, electromagnetic compatibility in communication systems, computer-based EMI modeling, and signal integrity analysis are incorporated to address present-day industrial and research requirements. The course enables students to understand EMC challenges in high-speed electronic systems, wireless communication devices, and embedded systems.

The knowledge gained through this course helps students develop the ability to analyze electromagnetic compatibility issues, design EMI-resilient systems, and apply appropriate

EMC standards and mitigation strategies in real-world electronic product development and communication applications.

Course Objectives:

- Understand the fundamental concepts of electromagnetic interference, electromagnetic compatibility, EMI sources, coupling mechanisms, and EMC standards.
- Explain radiated and conducted interference phenomena along with EMI measurement techniques and compliance testing procedures.
- Apply grounding, shielding, bonding, filtering, and other EMI suppression techniques for minimizing electromagnetic interference in electronic systems.
- Analyze probabilistic and statistical EMI/EMC models and evaluate electromagnetic compatibility issues in communication systems.
- Develop the ability to use computer-based EMI modeling and signal integrity concepts for the design and analysis of modern electronic and communication systems.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the fundamentals of electromagnetic interference, electromagnetic compatibility, EMI sources, coupling mechanisms, and EMC standards.
CO2	Demonstrate the principles of radiated and conducted EMI measurements and interpret interference and immunity testing procedures.
CO3	Apply grounding, shielding, bonding, and filtering techniques to reduce electromagnetic interference in electronic systems.
CO4	Analyze probabilistic and statistical EMI/EMC models and evaluate EMC issues in terrestrial communication systems.
CO5	Use computer-based EMI modeling and signal integrity concepts for the analysis and design of electromagnetic compatible electronic systems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	-	1	1	-	3	1
CO2	2	1	-	2	3	-	2	2
CO3	2	2	-	3	3	-	3	2
CO4	3	3	-	2	2	-	3	2
CO5	2	3	-	3	3	-	2	3

Assessment Scheme:
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CA1	15
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MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Introduction to EMI/EMC** Introduction to Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC), EMI/EMC Standards - Need for EMI/EMC standards, Objectives of EMC regulations, Introduction to international EMC standards, CISPR standards, IEC standards, FCC regulations, Military EMC standards (MIL-STD), Emission and immunity requirements, Compliance testing and certification overview, Introduction to E, H, Near and Far Field Receptors - Concept of EMI source, coupling path, and receptor, Definition and characteristics of EMI receptors, Susceptibility of electronic systems to EMI, Types of receptors in communication and electronic systems, Factors affecting receptor sensitivity, Effects of electromagnetic interference on receptors, Receptors and Antennas, Different Types of EMI Sources and Possible Remedies - Natural EMI sources, Man-made EMI sources, EMI control at the source, Reduction of coupling paths, Protection of susceptible equipment, Introduction to shielding techniques, Introduction to grounding and bonding, Introduction to filtering techniques	7
2.	**Unit 2: Measurement Techniques in EMI** Introduction to EMI Measurement Techniques, Open area test sites - Concept and purpose of Open Area Test Sites, Characteristics of an ideal OATS, Site attenuation and site validation, Test site layout and configuration, etc., Radiated interference measurements - EMI receivers and spectrum analyzers, Antennas used in EMI measurements, Line Impedance Stabilization Network (LISN), Current probes and voltage probes, Signal generators and monitoring equipment, Calibration requirements for EMI measurements, Conducted interference measurements, Interference immunity	7

3.	**Unit 3: EMI Reduction Techniques** Introduction to EMI Reduction Techniques – Need, Sources of electromagnetic interference in electronic systems, EMI control strategy, Grounding - Fundamentals of electrical grounding, Objectives of grounding in EMC, Types of grounds, Single-point, Multi-point, and Hybrid grounding schemes, Shielding - Principles of electromagnetic shielding, Shielding effectiveness and its measurement, Reflection loss, Absorption loss, Multiple reflection effects, Bonding, EMI filters	7
4.	**Unit 4: Probabilistic and Statistical Physical Model** Introduction, Probability Considerations - Fundamentals of probability theory relevant to EMI analysis, Random variables and probability distributions, Probability density function (PDF), Cumulative distribution function (CDF), Mean, variance, and standard deviation, Probability of interference occurrence, Probability of system susceptibility, Statistical Physical Models of EMI/EMC - Introduction to statistical physical models, Development of EMI/EMC models using probabilistic approaches, Source–path–receptor modeling framework, Statistical prediction of interference levels, EMC of Terrestrial Radio Communication Systems	8
5.	**Unit 5: Computer Based Modeling and Simulation of EMI Models and Signal Integrity** Introduction to Computer-Based EMI Modeling, Fundamentals of EMI Modeling, Computer Based Modeling and Simulation of EMI Models and Signal Integrity - Introduction to electromagnetic simulation methods, Numerical approaches for EMI analysis, Field-based and circuit-based simulation techniques, Simulation of electromagnetic coupling mechanisms, etc., Introduction to signal integrity (SI), Relationship between EMI/EMC and signal integrity, Causes of signal degradation, Signal quality parameters, Reflection, ringing, overshoot, and undershoot, Crosstalk and electromagnetic coupling effects	7

Text Books

Sr.No	Title	Author	Publisher
1.	Engineering Electromagnetic Compatibility, Principles and Measurement Techniques	V. Prasad Kodali	IEEE Press
2.	Electromagnetic Compatibility, Principles and Applications	David A. Weston, Marcol Dekker	Marcel Dekker Inc
3.	Electromagnetic Compatibility Engineering	H. W. Ott	John Wiley & Sons
4.	Introduction to Electromagnetic Compatibility	C. R. Paul	Wiley, India

Reference Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Principles of Electromagnetic Compatibility	B. Keiser	Artech House
2.	Electromagnetic Compatibility Handbook	K. L. Kaiser	CRC Press
3.	Electromagnetic Compatibility, Understanding, Design, and Testing with Practical Solutions	M. Mardiguian	Springer

Add resource link like NPTEL

- Introduction to Electromagnetic Compatibility - https://nptel.ac.in/courses/108106138
- EMI/EMC and Signal Integrity: Principles, Techniques, and Applications - https://nptel.ac.in/courses/108105375
- Electromagnetic Compatibility - https://innovationspace.ansys.com/courses/learning-track/electromagnetic-compatibility/

Title of the Course: Signal Processing Algorithms and Applications	**L**	**T**	**P**	**Credit**
Course Code: 26ETC11033	**3**	**-**	**-**	**3**

Course pre-requisite:

Before studying Signal Processing Algorithms and Applications, students should have knowledge of the following subjects and concepts:

1. **Signals and Systems**
   - Continuous-time and discrete-time signals
   - Linear Time Invariant (LTI) systems
   - Convolution and correlation
   - Fourier series and Fourier transforms
   - Sampling theorem
2. **Digital Signal Processing**
   - Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)
   - Z-transform and its properties
   - FIR and IIR digital filters
   - Frequency response analysis
   - Filter realization structures
3. **Engineering Mathematics**
   - Linear algebra and matrices
   - Complex numbers and complex analysis
   - Probability and random processes
   - Differential and difference equations
   - Numerical methods and optimization basics
4. **Communication Systems**
   - Basics of analog and digital communication
   - Modulation and demodulation techniques
   - Noise and spectral analysis
5. **Programming and Computational Skills**
   - MATLAB/Python programming for signal processing
   - Basic algorithm development
   - Numerical computation techniques
6. **Transforms and Applied Mathematics**
   - Laplace Transform
   - Fourier Transform
   - Z-Transform
   - Orthogonal functions and vector spaces

These pre-requisites help students understand advanced DSP algorithms, multirate signal processing, adaptive filtering, wavelet transforms, and modern signal processing applications effectively.

Course Description:

This course provides an in-depth understanding of advanced digital signal processing algorithms and their practical applications in modern engineering systems. The course covers transform-domain analysis of discrete-time signals and systems, digital filtering techniques, realization structures, and efficient computational algorithms for signal processing operations.

The course emphasizes the design and analysis of FIR and IIR digital filters, multirate signal processing techniques, filter banks, and spectral transformation methods. It also introduces advanced concepts such as orthogonal signal representation, adaptive filtering, wavelet transform, multiresolution analysis, and power spectrum estimation.

The subject focuses on developing analytical and implementation skills required for solving real-world problems in communication systems, biomedical signal processing, multimedia systems, radar, speech processing, image processing, and embedded DSP applications. The course bridges theoretical DSP concepts with modern computational approaches and industry-oriented applications using contemporary signal processing algorithms.

Course Objectives:

- To understand transform-domain analysis, filtering techniques, and computational algorithms used in digital signal processing systems.
- To analyze and implement discrete-time systems and various digital filter realization structures for signal processing applications.
- To design FIR and IIR digital filters using transformation and optimization techniques for practical DSP applications.
- To understand multirate signal processing concepts and analyze filter bank structures used in modern communication and multimedia systems.
- To study advanced signal representation, adaptive filtering, and spectral estimation techniques for intelligent signal processing applications.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Analyze discrete-time signals and systems using transform-domain techniques and computational DSP algorithms.
CO2	Implement and evaluate various digital filter structures and discrete-time system realizations for signal processing applications.
CO3	Design FIR and IIR digital filters using appropriate transformation and optimization methods.
CO4	Apply multirate signal processing techniques and filter bank structures in modern communication and multimedia systems.
CO5	Analyze advanced signal processing methods including wavelet transforms, adaptive filtering, signal representation, and spectral estimation techniques.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	3	1	2	2	-	3	2
CO2	3	3	2	2	3	-	3	3
CO3	3	3	3	2	2	-	3	2
CO4	2	3	2	3	3	-	3	3
CO5	3	3	2	3	2	-	3	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

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CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Introduction** Review of discrete time signals and systems, Different transforms, Filtering, Use of DFT in linear filtering, Filtering of long data sequences, Spectrum, Algorithm for convolution and DFT	7
2.	**Unit 2: LTI DT System in Transform Domain and Digital Filter Structures** Simple Digital Filters, All Pass, Linear Phase and Minimum & Maximum phase and Complementary transfer functions. Basic FIR and IIR Digital Filter Structures, Linear Phase Structure, IIR, FIR and All Pass Lattice Structure	7

3.	**Unit 3: Design of Digital Filters** General Considerations, Design of FIR filters, Design of IIR filters from Analog filters, Frequency transformations, Design of Digital Filters Based on Least-Square Method, Spectral Transformation of IIR Filters	7
4.	**Unit 4: Multirate Signal Processing** Filter banks, Interpolators, Decimators, Polyphase decomposition, Analysis and synthesis, Orthogonal and Orthonormal filter banks	8
5.	**Unit 5: Signal Representation and Linear Prediction** Representation of deterministic signals, Orthogonal representation of signals, Dimensionality of signal spaces, Construction of orthogonal basis functions, Time-bandwidth relationship, RMS duration and bandwidth, Uncertainty relations, Multiresolution Analysis and Wavelet transform, Least squares method for system modeling, Adaptive filters, Power spectrum estimation	7

Text Books

Sr.No	Title	Author	Publisher
1.	Discrete Time Signal Processing	Alan V. Oppenheim, Ronald W. Schafer	Pearson
2.	Digital Signal Processing: Principles, Algorithms, and Applications	John G. Proakis, Dimitris G. Manolakis	Pearson
3.	Digital Signal Processing: A Computer-Based Approach	Sanjit Mitra	McGraw-Hill Education
4.	Multirate Systems and Filter Banks	P. P. Vaidyanathan	Prentice Hall

Reference Books

Sr.No	Title	Author	Publisher
1.	Digital Signal Processing: A Practical Approach	Emmanuel C. Ifeachor, Barrie W. Jervis	Pearson Education
2.	Wavelet Transforms: A Practical Approach	Lokenath Debnath	Birkhäuser
3.	Statistical Signal Processing and Modeling	Monson H. Hayes	Wiley India

Add resource link like NPTEL

NPTEL – Signal Processing Algorithms and Architectures: https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee176

NPTEL – Advanced Digital Signal Processing: Multirate and Wavelets: https://nptel.ac.in/courses/117101001

NPTEL – Foundations of Wavelets and Multirate Digital Signal Processing: https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee18

NPTEL Youtube Channel - https://www.youtube.com/user/nptelhrd

Title of the Course: Analog and Mixed Signal Processing **Course Code:** 26ETC11034	**L**	**T**	**P**	**Credit**
	3	**--**	**-**	**3**

Course pre-requisite: Students should be comfortable with analog circuits, signals & systems, control theory, and basic IC design concepts before taking this course.

Course Description: This course covers the fundamentals and design of analog and mixed-signal systems, including switched capacitor circuits, ADCs, DACs, and PLL/DLL-based frequency synthesis. It emphasizes performance analysis, non-idealities, and low-power design techniques, with applications in VLSI, communication, and embedded systems.

Course Objectives:
1. Develop a deep understanding of analog, discrete-time, and mixed-signal systems.
2. Design and analyze switched capacitor circuits, high-performance data converters (ADC/DAC), and PLL/frequency synthesis systems.
3. Explore non-idealities, optimization techniques, and low-power (green) design approaches.
4. Apply the concepts to modern VLSI, communication, and embedded system applications.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Analyze Analog and discrete-time signal processing systems.
CO2	Design switched capacitor filters and amplifiers, considering non-ideal effects.
CO3	Evaluate and design high-performance ADCs and DACs.
CO4	Analyze and design Analog/Digital PLLs and DLLs, and optimize circuits for low power, high speed, and high resolution, with application to real-world mixed-signal IC design.
CO5	

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	3	2	-	1	1	-	3	1
CO2	3	3	-	3	2	-	3	2
CO3	3	3	-	3	3	-	3	2
CO4	3	3	1	3	3	1	3	3

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

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ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Fundamentals of Analog and Mixed Signal Processing** Analog versus discrete-time signal processing ,Sampling theorem and Nyquist criterion ,Oversampling and undersampling concepts Quantization process and quantization noise ,Signal-to-noise ratio (SNR) ,Analog filters and amplifiers ,Introduction to mixed-signal integrated circuits ,Challenges in mixed-signal IC design	7
2.	**Unit 2: Switched Capacitor Circuits and Filters** Switched capacitor (SC) resistor realization **,**SC integrators and amplifiers **,**First-order and second-order SC filters **,**Bi quad filter structures **,**Design methodology of SC circuits **,**Applications of SC circuits	8
3.	**Unit 3: Analog-to-Digital and Digital-to-Analog Converters** ADC (Flash, SAR, DS, ΣΔ, Pipeline, TI, Multi-channel), DAC (BW, R-2R, CS, DEM), Metrics (SNR, SNDR, SFDR, DNL, INL, ENOB) with speed-resolution-power trade-offs	8
4.	**Unit 4: Data Converter Optimization Techniques** Static and dynamic converter errors ,Offset and gain errors Component mismatch effects ,Calibration techniques ,Foreground calibration ,Background calibration,Digital calibration ,Low-power ADC and DAC design techniques ,Speed-resolution-power trade-offs	7
5.	**Unit 5 : Frequency Synthesis and Mixed-Signal Applications** Analog PLL architecture **,** Digital PLL architecture ,Phase detector,Charge pump , Loop filter ,Voltage-controlled oscillator (VCO) ,PLL stability and performance ,Delay Locked Loop (DLL) , Direct Digital Synthesis (DDS)	6

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw-Hill Education
2.	CMOS Mixed-Signal Circuit Design	R. Jacob Baker	John Wiley & Sons
3.	Principles of Data Conversion System Design	Rudy J. van de Plassche	Springer
4.	CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters	Rudy J. van de Plassche	Springer

Reference Books			
1.	Analog Integrated Circuit Design	David Johns & Ken Martin	John Wiley & Sons
2.	PLL Performance, Simulation and Design	Dean Banerjee	National Semiconductor / Texas Instruments
3.	Analog and Mixed-Signal Circuits in Nanoscale CMOS	Rui Martins, Pui-In Mak	Springer

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https://onlinecourses.nptel.ac.in/noc24_ee100/preview?utm_source

Title of the Course: RF and Millimeter Wave Circuit Design	**L**	**T**	**P**	**Credit**
Course Code: 26ETC11041	**3**	**-**	**-**	**3**

Course Prerequisite:

The following prerequisites are needed:

1.Electromagnetic Field Theory

2.Microwave Engineering

3.Analog Communication Systems

4. Network Theory and Transmission Lines

5. Signals and Systems

6. Analog Electronics and RF Fundamentals

7. Antenna and Wave Propagation

8. Basic Semiconductor Devices

9. MATLAB/HFSS/CST/ADS simulation basics

Course Description:

This course introduces the design and analysis of RF and millimeter wave circuits used in modern wireless communication, radar, satellite, automotive, and 5G/6G systems. The course covers RF transmission lines, impedance matching techniques, microwave passive and active circuit design, scattering parameters, RF filters, amplifiers, oscillators, mixers, and low-noise amplifiers.

The course further explores millimeter wave propagation characteristics, planar transmission structures, MMIC concepts, RF subsystem design, and high-frequency measurement techniques. Emphasis is given to practical RF design methodologies, CAD-based simulation tools, and advanced applications in high-speed wireless systems, IoT, automotive radar, and next-generation communication systems.

Students will gain theoretical understanding and practical design knowledge required for RF and millimeter wave integrated circuit and subsystem development.

Course Objectives:

1.Understand the fundamentals of RF and millimeter wave systems, transmission lines, and microwave network analysis techniques.

2.Analyze and design RF passive circuits including matching networks, filters, couplers, and resonators.

3.Study RF active circuit design including amplifiers, oscillators, mixers, and low-noise amplifiers.

4.Develop knowledge of millimeter wave propagation, MMIC technology, and high-frequency subsystem integration.

5.Apply RF CAD tools and measurement techniques for RF and millimeter wave circuit analysis and implementation.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Analyze RF transmission lines, scattering parameters, impedance matching, and microwave network characteristics for high-frequency applications.
CO2	Design RF passive components such as filters, couplers, resonators, and matching networks for microwave communication systems.
CO3	Design and evaluate RF active circuits including amplifiers, oscillators, mixers, and low-noise amplifiers for wireless communication applications.
CO4	Analyze millimeter wave propagation, MMIC technologies, and RF subsystem integration techniques used in modern 5G/6G and radar systems.
CO5	Apply RF CAD tools and high-frequency measurement techniques for simulation, analysis, and implementation of RF and millimeter wave circuits.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	-	2	1	-	3	1
CO2	3	3	-	3	2	-	3	2
CO3	3	3	-	3	3	-	3	2
CO4	3	3	-	3	2	-	3	3
CO5	3	3	1	3	3	1	2	3

Assessment Scheme:

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Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Fundamentals of RF and Microwave Circuits** RF spectrum, microwave frequency bands, RF communication systems, transmission line theory, Smith chart, impedance matching, scattering parameters, microwave network analysis.	7
2.	**Unit 2: RF Passive Circuit Design:** Microwave filters, directional couplers, power dividers, resonators, matching networks, microstrip and stripline circuits, RF PCB design concepts.	7
3.	**Unit 3: RF Active Circuit Design** RF amplifiers, gain and stability analysis, low-noise amplifiers (LNA), RF oscillators, mixers, frequency synthesizers, power amplifiers.	7
4.	**Unit 4: Millimeter Wave Circuit Design:** Millimeter wave propagation, planar transmission structures, MMIC technology, substrate selection, packaging issues, antenna integration, 5G/6G RF front-end design.	7
5.	**Unit 5: RF Measurement and Applications:** Vector network analyzer (VNA), spectrum analyzer, noise figure measurement, RF simulation tools (ADS/HFSS/CST), radar systems, satellite communication, automotive radar and IoT applications.	7

Text Books			
Sr.No.	**Title**	**Author**	**Publisher**
1.	RF Microelectronics	Behzad Razavi	Pearson Education
2.	Microwave Engineering	David M. Pozar	John Wiley & Sons
3.	Foundations for Microwave Engineering	Robert E. Collin	John Wiley & Sons
4.	Millimeter Wave Wireless Communications	Theodore S. Rappaport	Pearson Education

Reference Books			
Sr.No.	**Title**	**Author**	**Publisher**
1.	RF Circuit Design	Christopher Bowick	Newnes
2.	Microwave Solid State Circuit Design	Inder Bahl	Wiley
3.	Advanced RF MEMS	Stepan Lucyszyn	Cambridge

Add resource link like NPTEL:

1.RF and Microwave Engineering: https://nptel.ac.in/courses/108101092

2.Microwave Integrated Circuits : https://nptel.ac.in/courses/117101054

3.Millimeter Wave Communication for 5G : https://onlinecourses.nptel.ac.in

Title of the Course: VLSI System Design **Course Code:** 26ETC11042	**L**	**T**	**P**	**Credit**
	3	**--**	**-**	**3**

Course pre-requisite: Semiconductor Devices and Electronic Circuits.,Digital Electronics and Logic Design.,Analog Electronics and MOSFET characteristics

Course Description: This course introduces the principles and methodologies involved in the design and implementation of Very Large Scale Integration (VLSI) systems. It covers MOS transistor operation, CMOS fabrication processes, layout design rules, scaling effects, subsystem design methodologies, FPGA-based systems, memory design, timing analysis, testing, and verification techniques. The course emphasizes the design flow from device-level concepts to system-level implementation and equips students with the knowledge required for modern integrated circuit design.

Course Objectives:

1. Understand MOS transistor characteristics, CMOS technology, and fabrication processes used in VLSI systems.
2. Apply layout design rules and analyze delay and performance parameters in CMOS circuits.
3. Study scaling principles and design methodologies for VLSI subsystems and arithmetic circuits.
4. Analyse programmable logic devices, FPGA architectures, and digital system implementation techniques.
5. Understand memory architectures, timing considerations, testing, and verification methods used in VLSI systems.

Course Outcomes:

CO No.	**Course Outcomes**
CO1	Explain MOS transistor characteristics, CMOS fabrication processes, and VLSI design flow.
CO2	Apply layout design rules and analyze delay, capacitance, and performance of CMOS circuits.
CO3	Design and evaluate VLSI subsystems using scaling principles and modular design methodologies.
CO4	Analyze and implement digital systems using programmable logic arrays and FPGA architectures.
CO5	Evaluate memory architectures, timing issues, testing, and verification techniques for reliable VLSI system design.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	-	1	1	-	3	1
CO2	3	3	-	2	3	-	3	2
CO3	3	3	-	3	2	-	3	2
CO4	3	3	1	3	3	-	3	3
CO5	2	3	1	3	3	2	2	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1 :Introduction to VLSI and MOS Technology** Brief History of VLSI, MOS Transistors, MOS Transistor Theory, Ideal and Non-Ideal I-V Characteristics, CMOS Logic, DC Transfer Characteristics. Fabrication of nMOS, CMOS (P-well, N-well, Twin-tub Processes), BiCMOS Technology and Comparison with CMOS.	8
2.	**Unit 2: MOS and BiCMOS Circuit Design Processes** MOS Layers, Stick Diagrams, Design Rules, Layout Design, Sheet Resistance, Area Capacitance of Layers, Delay Concepts, Inverter Delay Analysis, Driving Large Capacitive Loads, Introduction to CAD Tools for VLSI Design.	8
3.	**Unit 3: Scaling of MOS Circuits and Subsystem Design Processes** Scaling Models and Scaling Factors, Device Parameter Scaling, Limitations of Scaling, General Design Considerations, Design	8

	Methodology, Regularity and Modularity, Design of ALU Subsystems, Carry Chain and Adder Enhancement Techniques.	
4.	**Unit 4: Subsystem Design and FPGA-Based Systems** Architectural Issues, Switch Logic, Gate Logic, Parity Generators, Multiplexers, Programmable Logic Arrays (PLA), FPGA Concepts, FPGA Architecture, Digital Design using FPGA, FPGA-Based System Design and Physical Design Considerations.	8
5.	**Unit 5 : Memory, Timing, Testing and Verification** Memory Elements, SRAM and DRAM Concepts, Registers and Storage Elements, Timing Considerations in VLSI Systems, Logic Verification, Manufacturing Test Principles, Design for Testability (DFT), Fault Models and Testing Techniques.	8

Text Books

Sr. No.	**Title**	**Author**	**Publisher**
1	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste and David Money Harris	Pearson Education
2	Basic VLSI Design	Douglas A. Pucknell and Kamran Eshraghian	Prentice Hall of India (PHI)
3	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education
4	CMOS Digital Integrated Circuits: Analysis and Design	Sung-Mo Kang and Yusuf Leblebici	McGraw-Hill Education

Reference Books			
Sr. No.	**Title**	**Author**	**Publisher**
1	Essentials of VLSI Circuits and Systems	Kamran Eshraghian, Douglas A. Pucknell and Sholeh Eshraghian	Prentice Hall of India (PHI)
2	Principles of CMOS VLSI Design: A Systems Perspective	Neil H. E. Weste and Kamran Eshraghian	Addison-Wesley Publishing Company
3	VLSI Design Techniques for Analog and Digital Circuits	Randall L. Geiger, Phillip E. Allen and Noel R. Strader	McGraw-Hill International Edition
4	Introduction to VLSI Systems	Carver Mead and Lynn Conway	Addison-Wesley Publishing Company
5	CMOS Circuit Design, Layout and Simulation	R. Jacob Baker	Wiley-IEEE Press

NPTEL: https://nptel.ac.in/courses/108107129?utm_source=chatgpt.com

Title of the Course: Optical fiber communication	**L**	**T**	**P**	**Credit**
Course Code: 26ETC11043	**3**	**--**	**-**	**3**

Course Pre-Requisite: Students enrolling in Optical Fiber Communication should have prior knowledge of the Electromagnetic Field Theory, Analog and Digital Communication, Signals and Systems These prerequisites help students understand wave propagation, modal analysis, dispersion phenomena, and optical system design effectively.

Course Description: This course introduces the fundamentals of optical fiber communication systems including light propagation through optical fibers, modal analysis, fiber fabrication techniques, attenuation and dispersion mechanisms, nonlinear effects, and fiber-based devices. The course also covers optical amplifiers, fiber Bragg gratings, optical sensors, and photonic crystal fibers used in modern high-speed communication networks.

Course Objectives:

1. To understand the basic principles and importance of optical fiber communication systems.
2. To analyze light propagation mechanisms and electromagnetic wave behavior in optical fibers.
3. To study different optical fiber fabrication techniques, splicing, and connector technologies
4. To understand attenuation, dispersion, pulse propagation, and nonlinear effects in optical fibers.
5. To study the operation and applications of fiber-based devices such as optical amplifiers, fiber Bragg gratings, and optical sensors.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Recognize and classify the structures and types of optical fibers.
CO2	Demonstrate electromagnetic and mathematical analysis of light wave propagation.
CO3	Analyze fabrication techniques of different optical fibers.
CO4	Interpret dispersion compensation mechanisms, scattering effects, and modulation techniques.
CO5	Interpret the working of fiber-based devices

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	1	-	-	1	-	3	1
CO2	3	3	-	2	2	-	3	2
CO3	3	2	-	2	2	-	3	2
CO4	3	3	-	3	2	-	3	2
CO5	2	3	1	3	3	1	2	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Introduction to Optical Fiber** Introduction and importance of fiber optic technology ,Ray analysis of optical fiber ,Propagation mechanism of rays ,Meridional rays and skew rays ,Numerical aperture ,Dispersion	8
2.	**Unit 2: Electromagnetic Analysis of Optical Fibers** Electromagnetic (modal) analysis of step index multimode fibers, Wave equation and boundary conditions ,Characteristic equations, TE, TM and Hybrid modes ,Weakly guiding approximation ,Linearly polarized modes ,Single mode fiber ,V-parameter ,Power confinement and mode cutoff ,Mode field diameter	8

3.	**Unit 3: Graded Index Fibers and Fabrication Techniques** Modal analysis of graded index fibers,WKB analysis ,Optimum profile ,Fiber fabrication techniques: OVD ,VAD ,CVD ,MCVD PMCVD ,Fiber characterization ,Splices ,Connectors ,Fiber cable	6
4.	**Unit 4: Loss Mechanisms and Dispersion** Absorption loss ,Scattering loss ,Bending loss ,Splice loss ,Pulse propagation in dispersive and non-dispersive medium ,Pulse broadening and chirping ,Group velocity and phase velocity Intermodal and intramodal dispersion ,Material and waveguide dispersion ,Higher order dispersion ,Fiber bandwidth	8
5.	**Unit 5: Dispersion Compensation and Nonlinear Effects** Dispersion compensating fibers **,**Dispersion tailored fibers **,**Fiber birefringence **,**Polarization mode dispersion **,**Nonlinear effects: Stimulated Raman Scattering (SRS) , Stimulated Brillouin Scattering (SBS), Self Phase Modulation (SPM), Cross Phase Modulation (XPM), Optical Solitons	8

Text Books

Sr.No	Title	Author	Publisher
1.	Introduction to Fiber Optics	A. K. Ghatak& K. Thyagarajan	Cambridge University Press (1998)
2.	Fiber Optic Communication Systems	G. P. Agarwal	John Wiley Sons (1997)..
3.	Fundamentals of Optical Fibers	John A. Buck	Wiley Interscience, (2004).

Reference Books

Sr.No	Title	Author	Publisher
1.	Fundamentals of Optical Waveguides	K. Okamoto	Academic Press, (2000)
2.	Elements of Photonics Vol I &II	K. Iizuka	Wiley-Interscience (2002)
3.	Photonic Crystal	D. W. Prather et.al	Wiley (2009).

Title of the Course: Statistical Signal Processing	**L**	**T**	**P**	**Credit**
Course Code: 26ETC11044	**3**	**-**	**-**	**3**

Course Prerequisite:

Based on the proposed syllabus contents, the following prerequisites are recommended for the course:

1. **Engineering Mathematics**
   - Probability and Statistics
   - Random Variables and Probability Distributions
   - Linear Algebra and Matrices
   - Vector Spaces and Eigenvalues
   - Differential Equations
2. **Signals and Systems**
   - Continuous-time and discrete-time signals
   - System properties and classifications
   - Convolution and correlation
   - Fourier Series and Fourier Transform
   - Z-Transform and Laplace Transform
3. **Digital Signal Processing**
   - Sampling and reconstruction
   - Discrete Fourier Transform (DFT) and FFT
   - Digital filter concepts
   - FIR and IIR systems
   - Spectral analysis basics
4. **Linear Algebra and Numerical Methods**
   - Matrix operations
   - Orthogonalization techniques
   - Least squares solutions
   - Eigenvalue decomposition
   - Singular Value Decomposition (SVD) basics
5. **Communication Engineering Fundamentals**
   - Random processes in communication
   - Noise in communication systems
   - Signal estimation concepts
   - Detection and filtering basics
6. **Programming and Computational Skills**
   - MATLAB/Python programming basics
   - Algorithm implementation
   - Numerical computation techniques

Course Description:

This course introduces the fundamental principles and advanced techniques of Statistical Signal Processing with emphasis on stochastic signal analysis, signal modeling, optimum filtering, and estimation methods. The course begins with the study of random variables, stochastic processes, stationarity, ergodicity, and spectral estimation concepts required for

statistical analysis of signals.

The course further covers stochastic signal models such as autoregressive (AR), moving average (MA), and autoregressive moving average (ARMA) models along with power spectral density estimation methods. It also introduces optimum linear filtering techniques including Wiener filtering, linear prediction, inverse filtering, and deconvolution methods used for signal estimation and noise reduction.

In addition, the course focuses on algorithms and structures for optimum filters such as Levinson-Durbin recursion, Schur algorithms, lattice structures, Toeplitz matrix inversion, and Kalman filtering techniques for efficient real-time signal processing implementation. The course also covers least squares filtering and parameter estimation methods including orthogonalization techniques and singular value decomposition (SVD)-based solutions.

The subject enables students to develop analytical, mathematical, and computational skills required for modern applications in communication systems, speech processing, biomedical signal processing, radar systems, image processing, adaptive filtering, and intelligent signal analysis systems.

Course Objectives:

- To introduce the fundamental concepts of random variables, stochastic processes, stationarity, ergodicity, and spectral estimation required for statistical analysis of signals.
- To understand stochastic signal models such as AR, MA, and ARMA models along with power spectral density and spectral estimation techniques for signal characterization and analysis.
- To study optimum linear filtering, linear prediction, inverse filtering, and deconvolution techniques used for signal estimation and noise reduction.
- To understand computational algorithms and structural implementations of optimum filters including Levinson-Durbin recursion, lattice structures, Toeplitz matrix inversion, and Kalman filtering techniques.
- To learn least squares estimation and filtering methods along with orthogonalization and SVD-based techniques for solving signal estimation and adaptive filtering problems.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain the concepts of random variables, stochastic processes, stationarity, ergodicity, and spectral estimation used in statistical signal analysis.
CO2	Analyze stochastic signal models such as AR, MA, and ARMA models and evaluate power spectral density estimation techniques for signal characterization.

CO3	Apply optimum linear filtering, linear prediction, inverse filtering, and deconvolution techniques for signal estimation and noise reduction problems.
CO4	Analyze the algorithms and structural implementations of optimum filters including Levinson-Durbin recursion, lattice structures, Toeplitz matrix inversion, and Kalman filtering techniques.
CO5	Evaluate least squares filtering and estimation techniques using orthogonalization and SVD-based methods for adaptive signal processing applications.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	-	1	1	-	3	1
CO2	3	3	-	2	2	-	3	2
CO3	3	2	-	3	2	-	3	2
CO4	3	3	-	3	3	-	3	3
CO5	3	3	1	3	3	-	3	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1: Introduction** Random Signals, Spectral Estimation, Adaptive Filtering, Random Variables, Distribution and Density Functions, Random Vectors - Definition, Transformation and Linear Combination of Random Vectors, Linear System with Stationary Input, Innovations and Representation of Real Vectors, DT Stochastic Process - Stationarity, Ergodicity, and Frequency Domain Representation of SP, Principles of Estimation	6
2.	**Unit 2: Stochastic Processes and Models** Characterization of DT Stochastic Process, Correlation Matrix, Properties of Correlation Matrix, Stochastic Models: MA and AR Models, ARMA Models Hold Decomposition, Asymptotic Stationarity of AR Process, Yule Walker Equations, Power Spectral Density, Properties of Power Spectral Density, Transmission of Stationary Process Through a Linear Filter, Other Statistical Characteristics of Stochastic Process, Power Spectral Estimation, Spectral Correlation Density, Polyspectra	8
3.	**Unit 3: Optimum Linear Filters** Optimum Signal Estimation, Linear Mean Square Estimation, Solution of Normal Equations, Optimum FIR Filters, Linear Prediction: Linear Signal Estimation, Forward Linear Estimation, Backward Linear Estimation, Stationary Processes and Properties, Optimum IIR Filters, Inverse Filtering and Deconvolution.	8
4	**Unit 4: Algorithms and Structures for Optimum Filters** Fundamentals of Order-Recursive Algorithms, Interpretation of Algorithmic Quantities, Order-Recursive Algorithms for Optimum FIR Filters, Algorithms of Levinson and Levinson-Durbin, Lattice Structure for Optimum Filters, Schur Algorithm, Triangularization and Inverse of Toeplitz Matrices, Kalman Filter Algorithm.	8
5	**Unit 5: Least Squares Filtering** Principle of LS, Linear Least Square Error Estimation, Least Square Filter, Linear Least Square Signal Estimation, LS Computation using Normal Equations, LS Computation using Orthogonalization Techniques, LS Computation using Singular Value Decomposition Techniques, Problems.	6

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Statistical Digital Signal Processing and Modeling	Monson H. Hayes	Wiley India
2.	Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing	Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon	Artech House Publishers
3.	Adaptive Filter Theory	Simon Haykin	Pearson Education
4.	Fundamentals of Statistical Signal Processing: Estimation Theory	Steven M. Kay	Prentice Hall

Reference Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Detection, Estimation and Modulation Theory: Part 1	Harry L. Van Trees	Wiley India
2.	Optimal Filtering	Brian D O Anderson John B. Moore	Dover Publications
3.	Introduction to Random Signals and Applied Kalman Filtering	Patrick Y. C. Hwang Robert Grover Brown	Wiley India

Add resource link like NPTEL:

- Statistical Signal Processing - https://nptel.ac.in/courses/108103158
- Digital Signal Processing - https://nptel.ac.in/courses/108106151
- Introduction to Adaptive Signal Processing - https://nptel.ac.in/courses/108105191
- Probability and Random Variables - https://nptel.ac.in/courses/117104117

Title of the Course: Digital Image and Video Processing Laboratory	**L**	**T**	**P**	**Credit**
Course Code: 26ETC1105L	**-**	**-**	**4**	**2**

Course Pre-Requisite: Engineering Mathematics III, Digital Signal Processing, Digital Image Processing

Course Description:

This course aims to focus on practical approach on Image and Video Processing. It includes the concepts based upon Image enhancement, Image Compression, edge detection,, video processing etc.

Course Objectives:

1. Develop practical skills in image preprocessing and enhancement techniques.
2. Apply image segmentation, edge detection, and feature extraction methods for image analysis.
3. Implement object detection and recognition techniques using computer vision tools.
4. Perform video processing, motion analysis, and object tracking operations.
5. Analyze video compression and advanced video analytics techniques using modern software tools.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Apply image sampling, quantization, intensity transformation, and image enhancement techniques using modern image processing tools.
CO2	Apply edge detection, image segmentation, and feature extraction techniques for image analysis and interpretation.
CO3	Analyze background subtraction, moving object detection, and object recognition techniques for computer vision applications.
CO4	Perform video frame extraction and video processing operations for representation and analysis of video data.
CO5	Analyze motion estimation, object tracking, and video compression techniques for advanced video processing and intelligent vision applications.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	3	1	-	2	3	-	3	1
CO2	3	1	-	3	3	-	3	2
CO3	3	2	-	3	3	-	3	2
CO4	3	1	-	2	3	-	3	3
CO5	3	2	1	3	3	1	3	3

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	25
MSE	--
CA2	25
POE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.
POE is based on 100% course content with 60-70% weightage for course content covered.

Course Contents

Experiment No.	Experiment Title	Hours
1.	Image sampling and quantization using MATLAB/Python	2
2.	Intensity transformation of images using negative, log, gamma, and contrast stretching methods	2
3.	Image enhancement using spatial filtering, denoising, Gaussian blur, and motion blur	2
4.	Edge detection using Sobel, Prewitt, Roberts, and Canny operators	2
5.	Image segmentation using thresholding, region-based segmentation, and morphological watershed	2
6 .	Background subtraction and foreground extraction for moving object detection	2
7.	Object recognition using template matching and feature-based classification	2
8.	Video frame extraction and basic video processing operations	2
9.	Motion estimation and object tracking in video sequences using block matching or optical flow	2
10.	Video compression and analysis of compressed video using MPEG/H.264 concepts	2

Text Books			
Sr. No.	**Title**	**Author(s)**	**Publisher**
1	Digital Image Processing (4th Edition)	Rafael C. Gonzalez, Richard E. Woods	Pearson Education
2	Fundamentals of Digital Image Processing	Anil K. Jain	Prentice Hall
3	Digital Video Processing (1st Edition)	A. Murat Tekalp	Prentice Hall

Reference Books			
Sr. No.	**Title**	**Author(s)**	**Publisher**
1	Computer Vision: A Modern Approach	David A. Forsyth, Jean Ponce	Pearson Education
2	Image Processing, Analysis and Machine Vision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Springer
3	Learning OpenCV 4: Computer Vision with Python	Joseph Howse, Joe Minichino	Packt Publishing
4	Digital Image Processing Using MATLAB	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins	Pearson Education

Add resource link like NPTEL

https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee116

Title of the Course: Concepts & Applications in Engineering **Course Code:** 26ETC1107	**L**	**T**	**P**	**Credit**
	2	**--**	**-**	**2**

Course Objectives:

1.Introduce students to the foundational concepts, philosophies, and components of Indian knowledge systems, including ancient scriptures, philosophies, and traditional practices.

2. Introduce students to Vedic mathematical principles and computational techniques from ancient Indian texts, demonstrating their practical use in engineering calculations.

3. Explore the potential benefits of incorporating yogic and meditative practices into engineering to enhance focus, creativity, and overall well-being.

4. Study architectural concepts from Indian traditions and evaluate how they can inform modern urban planning and sustainable architecture.

5. Encourage students to draw inspiration from IKS to develop innovative engineering solutions that align with ancient wisdom while meeting contemporary needs.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Gain a comprehensive understanding of the philosophical, scientific, and technological aspects of Indian Knowledge Systems and their historical development.
CO2	Understand the philosophical underpinnings of IKS, including concepts like dharma, karma, and holistic thinking, and explore their relevance to engineering.
CO3	Understand Vedic mathematical principles and computational methods, and their potential relevance in solving modern engineering problems.
CO4	Investigate the connections between yoga, meditation, and stress management, and their potential impact on mental well-being in engineering contexts.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	1	-	-	-	-	3	-	-
CO2	1	1	-	1	-	3	-	-
CO3	2	2	-	2	1	2	1	-
CO4	-	1	-	1	-	3	-	-

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	25
MSE	--
CA2	25
ESE	--

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Unit 1:Indian Knowledge System – An Introduction & Vedic Corpus:** What is IKS? Why do we need IKS? Organization of IKS, Historicity of IKS, Some salient aspects of IKS, Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas, Prologue on Śikṣā and Vyākaraṇa, Basics of Nirukta and Chandas, Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.	7
2.	**Unit 2 : Number system & Mathematics** Number systems in India - Historical evidence, Salient aspects of Indian Mathematics, Bhūta Saṃkhyā system, Kaṭapayādi system, Measurements for time, distance, and weight, Piṅgala and the Binary system. Introduction to Indian Mathematics, Unique aspects of Indian Mathematics, Indian Mathematicians and their Contributions, Algebra, Geometry, Trigonometry, Binary mathematics, and combinatorial problems in Chandaḥ Śāstra, Magic squares in India	7
3.	**Unit 3: Engineering Technology: Metal & Other applications:** Wootz Steel: The rise and fall of a great Indian technology, The Indian S & T heritage, Mining and ore extraction, Metals and metalworking technology, Iron and steel in India, lost wax casting of idols and artefacts, Apparatuses used for extraction of metallic components. Irrigation systems and practices in South India, literary sources for science and technology, Physical structures in India, irrigation and water management, dyes and painting technology, the art of making perfumes, Surgical techniques, shipbuilding, sixty-four art forms (64 Kalās) status of Indigenous S & T.	7
4.	**Unit 4: Knowledge Framework and classifications** Indian scheme of knowledge, The knowledge triangle, Prameya – A vaiśeṣikan approach to physical reality, Dravyas – the constituents of the physical reality, Attributes – the properties of substances and Action – the driver of conjunction and disjunction, Sāmānya, viśēṣa, samavāya, Pramāṇa – the means of valid knowledge, Saṃśaya – ambiguities in existing knowledge, Framework for establishing valid knowledge, Deductive or inductive logic framework, Potential fallacies in the reasoning process, Siddhānta: established tenets in a field of study.	7

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Introduction to Indian Knowledge System: Concepts and Applications	Mahadevan, B., Bhat, V. R., and Nagendra Pavana R. N	PHI Learning Pvt. Ltd., New Delhi
2.	Indian Knowledge Systems: An Introduction	Balram Gupta	DK Printworld, New Delhi
3.	The Roots of Ancient Indian Science	B. V. Subbarayappa	Chaukhamba Sanskrit Series Office, Varanasi, Reprint Edition

Reference Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts	Dharampal	India Press
2.	Indian Knowledge Systems: Vol. I & II	Kapil Kapoor and Avadesh Kumar Singh	D.K. Printworld
3.	History of Science, Philosophy and Culture in Indian Civilization	D. P. Chattopadhyaya	Centre for Studies in Civilizations

Add resource link like NPTEL

https://onlinecourses.swayam2.ac.in/imb23_mg53/preview

Title of the Course: YOGA for Stress Management	**L**	**T**	**P**	**Credit**
Course Code: 26ETC1108	**--**	**--**	**2**	**1**

Course pre-requisite:

Basic awareness of health, stress, and well-being, along with a willingness to practice yoga techniques and lifestyle modifications, is desirable.

Course Description: This course introduces the concepts of stress and its management through modern scientific and traditional yogic perspectives. It covers the causes and effects of stress, stress physiology, sleep, diet, and assessment methods, along with the role of yoga in preventing and managing stress-related disorders. The course also includes practical training in yoga postures (Asanas), breathing techniques (Pranayama), meditation, relaxation techniques, and integrated yoga modules to promote physical, mental, and emotional well-being

Course Objectives:

1. Understand the physiological and psychological aspects of stress and its impact on overall well-being.
2. Learn and practice specific yoga postures, breathing exercises, and relaxation techniques to alleviate stress.
3. Explore the connection between mindfulness, meditation, and stress reduction, fostering mental clarity.
4. Discover holistic practices that promote better sleep, nutrition, and overall lifestyle habits for stress management.
5. Develop practical skills to manage stress in daily life, enhancing resilience and promoting emotional balance.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Recognize the signs and sources of stress, understanding its effects on mental and physical well-being.
CO2	Master a variety of yoga techniques, including postures, breathing, and meditation, to effectively manage stress.
CO3	Acquire relaxation strategies that promote calmness, reduce anxiety, and enhance overall mental clarity.
CO4	Incorporate healthy habits inspired by yoga principles to foster better sleep, nutrition, and self-care routines.
CO5	Develop practical skills to navigate and cope with stress, enhancing emotional balance and promoting a more harmonious life.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	-	-	-	-	-	3	-	-
CO2	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	3	-	-
CO5	-	1	-	1	-	3	-	-

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2),) having 50%, weightage.

Assessment Component	Marks
CA1	25
MSE	--
CA2	25
ESE	--

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

Course Contents

Module No.	Module Content	Hours
1.	**Module 1:** Introduction to Yoga for Stress Management - 1 Introduction to Yoga for Stress Management - 2 Stress according to Western perspective Stress Eastern Perspective Developmental process: Western and Eastern Perspective Stress Hazards and Yoga	2
2.	**Module 2:** Meeting the challenges of Stress - 1 Meeting the challenges of Stress - 2 Introduction to Stress Physiology Stress, Appetite and Dietary management- Modern and Yogic perspective Sleep and Stress: understanding the relationship for effective management of stress	2
3.	**Module 3:** Stress Assessment methods- a valuable tool toward stress management	2

	Role of Yoga in prevention and management of stress related disorders – a summary of research evidence Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 1 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 2 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 3	
4	**Module 4:** Concept of stress and its management - perspectives from Bhagavad Gita - Part 1 Concept of stress and its management - perspectives from Bhagavad Gita - Part 2 Concept of stress and its management - perspectives from Bhagavad Gita - Part 3	2
5	**Module 5:** Asana practices – 1 Tadasana, Ardhakati Chakrasana, Ardha Chakrasana, Trikonasana, Vrikshasana Asana practices – 2 Vakarasana, Janu Sirshasana, Ushtrasana, Sashankasana, Asana practices – 3 Ardhamatseyndrasana, Paschimottanasana, Poorvottanasana, Gomukhasana Asana practices – 4 Makarasana, Bhujangasana, Salambha Shalabahasana, Dhanurasana Asana practices – 5 Setubandhasana, Sarvangasana, Mastyasana, Deep Relaxation Technique (DRT)	2

Text Books

Sr. No.	Title	Author	Publisher
1	Yoga for Stress Management	Dr. H. R. Nagendra	Swami Vivekananda Yoga Prakashana (SVYP), Bengaluru
2	The Science of Yoga	Dr. H. R. Nagendra	Swami Vivekananda Yoga Prakashana (SVYP), Bengaluru
3	Asana Pranayama Mudra Bandha	Swami Satyananda Saraswati	Yoga Publications Trust, Munger, Bihar
4	Yoga and Health	Swami Kuvalayananda	Kaivalyadhama, Lonavala

Reference Books			
Sr. No.	**Title**	**Author**	**Publisher**
1	Bhagavad Gita	Swami Sivananda	Divine Life Society, Rishikesh
2	Light on Yoga	B.K.S. Iyengar	HarperCollins Publishers
3	The Complete Book of Yoga	Swami Vivekananda	Advaita Ashrama, Kolkata

NPTEL:https://onlinecourses.swayam2.ac.in/aic23_ge10/preview#:~:text=In%20this%20course%20we %20intend,meeting%20the%20 challenges%20of%20stress