Vidya Pratishthan's Kamalnayan Bajaj Institute of Engineering and Technology, Baramati

Department of Electronics and Telecommunication Engineering

T.Y. B. Tech Syllabus 2025-26 (As per NEP 2020)

(2023 Pattern)

About E&TC Department

- Involvement of Experts from IITs, Govt. Colleges, Reputed Industries, Alumni and Students in development of curriculum.
- Automatic Bank Credit System (ABC)
- Choice of Electives
- Remedial Teaching
- Sponsorship for Publications and IPR
- Research Mentorship
- Industry Internship
- Provision of Credit Transfer Scheme (CTS)
- Peer Teaching Scheme
- Teacher Guardian Scheme (TGS)
- Proficiency Courses
- MOUs with Industries

INSTITUTE VISION AND MISSION

VISION

To achieve Academic Excellence through Persistent and Synergic Collaborations amongst all Stakeholders.

MISSION

1. To ensure holistic development of students as lifelong learners and problem solvers through value-based quality education.
2. To motivate faculty to attain the state-of-the-art knowledge and wisdom in their domain and be a facilitator towards co creation of knowledge.
3. To frame and deploy conducive and empowering policies for multifaceted growth of students, faculty and staff to make them contributors towards excellence.
4. To partner with industry for mutually beneficial relations to generate employable and deployable workforce.
5. To fulfill the aspirations of alumni, parents, society, region and nation at large by generating technically competent and contributing manpower.

DEPARTMENT VISION AND MISSION

VISION

To develop professionals in Electronics and Telecommunication Engineering to contribute in solving technological problems faced by society.

MISSION

1. To impart value added education for developing professional competencies and life skills.
2. To empower facilitators with knowledge, skills and conducive work culture.
3. To reciprocate with collaborating organizations and industries to ensure continual improvements.
4. To integrate efforts of all stake holders for the benefit of society.

Programme Educational Objectives (PEOs)

A graduate in E&TC will be able to demonstrate:

PEO1: To apply the knowledge of Electronics and Telecommunication Engineering to build career in core and allied industries.

PEO2: To prepare students for higher studies, competitive exams and multidisciplinary work.

PEO3: To follow professional ethics and address social concerns.

PEO4: To be lifelong learner to engross newer technologies.

Program Specific Outcomes (PSOs)

At the end of the programme students will be able to demonstrate:

PSO1: To develop competencies to solve real-life problems in the Electronics and Telecommunication Engineering domain at the same time inculcate professional behavior imbibe with human values and ethics.

PSO2: To acquire the knowledge of embedded systems, communication, signal processing for hardware/software design and development.

PSO3: To demonstrate the competencies to use modern tools and techniques to design electronic systems in diverse fields as per societal needs.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Third Year (TY B. Tech.) Electronics and Telecommunication Engineering

w. e. f. AY:2025- 2026 (2023 Pattern)

SEMESTER-I

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
		TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
ET23301	Digital Signal Processing	3	2	-	10	30	60	-	30	-	**130**	3	1	-	4
ET23302	Embedded System & RTOS	3	2	-	10	30	60	-	30	-	**130**	3	1	-	4
ET23303	Programme Elective Course 1	3	2	-	10	30	60	30	-	-	**130**	3	1	-	4
ET230XX	Multidisciplinary Minor Course	2	2	-	20	20	50	20	-	-	**110**	2	1	-	3
HS23301	Universal Human Values	2	-	-	10	-	60	-	-	-	**70**	2	-	-	2
OE230XX	Open Elective	2	-	-	-	-	50	-	-	-	**50**	2	-	-	2
ET23304	Community Engagement Project/ Field Project	-	4	-	10	-	-	30	-	30	**70**	-	2	-	2
HS23302	Audit Course - Constitution of India	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**16**	**12**	**0**	**70**	**110**	**340**	**80**	**60**	**30**	**690**	**15**	**6**	**0**	**21**

SEMESTER-II

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
		TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
ET23311	Mobile Communication and Networks	3	2	-	10	30	60	-	-	30	**130**	3	-	1	4
ET23312	Programme Elective Course 2	3	2	-	10	30	60	-	30	-	**130**	3	1	-	4
ET23313	Programme Elective Course 3	3	2	-	10	30	60	-	30	-	**130**	3	1	-	4
ET230XX	Multidisciplinary Minor Course	2	2	-	20	20	50	20	-	-	**110**	2	1	-	3
HS23311	Environmental Studies	2	-	-	10	-	60	-	-	-	**70**	2	-	-	2
OE230XX	Open Elective	2	-	-	-	-	50	-	-	-	**50**	2	-	-	2
ET23314	VSC- Skill Development	-	4	-	10	-	-	30	-	30	**70**	-	2	-	2
HS23312	Audit Course - Democracy, Election, and Governance	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**16**	**12**	-	**70**	**110**	**340**	**50**	**60**	**60**	**690**	**15**	**5**	**1**	**21**

SD Biradar — Autonomy Coord.

Dr. JS Rangole — HOD-E&TC

Dr. SM Bhosle — Dean Academics

Dr. SB Lande — Principal

VPKBIET BARAMATI Affiliated to S.P.P.U. Pune Id No.:(PU)/PN/Engg./152/2000 PUNE (MS.)

Bucket of Multidisciplinary Minor Courses

Multidisciplinary Minor Subjects	
Subject Code	**Subject Name**
AI23051	AI & Machine Learning
AI23052	Data Science
AI23053	Generative AI (Sem V+)
CO23051	Cloud Computing
CO23052	High Performance Computing (Sem V+)
CO23053	Computer Graphics & Gaming
IT23051	Cyber security
IT23052	Full Stack Development
ET23051	Embedded Systems
ET23052	Drone Technology
ET23053	Internet of Things
ET23054	Microprocessor and Microcontroller
CE23051	Waste Management
CE23052	Green building & smart cities
ME23051	3-D Printing
ME23052	Robotics & Automation
EL23051	Solar Technology
EL23052	Industrial Automation
GS23051	Nanotechnology
GS23052	Linear Algebra and Statistics

Bucket of Open Electives

Open Elective Subjects	
Subject Code	**Subject Name**
OE23001	Digital Marketing
OE23002	Professional Leadership
OE23003	Organizational Behaviour
OE23004	Industrial Management
OE23005	Disaster Management
OE23006	Energy Economics & Management
OE23007	Operations Research
OE23008	Intellectual Property Rights
OE23009	Cyber Laws
OE23010	Bioinformatics
OE23011	Biotechnology
OE23012	International Relations
OE23013	Universal Human Values
OE23014	Education Technology
OE23015	Design Thinking
OE23016	Accounting & Finance
OE23017	Sustainability & Climate Change
OE23018	Agriculture Technology
OE23019	Architectural Technology

HONORS DEGREE (only for students having CGPA >= 7.5)
Honor: Computational Intelligence
Honor: Cloud Computing and Virtualization, Data Science
Honor: Data Science
Honor: Artificial Intelligence
Honor: Cyber security
Honor: VLSI Design Technology
Honor: Advanced Communication Systems
Honor: Advances in Construction Technology
Honor: Advanced Structural Engg.
Honor: Robotics and Automation
Honor: Refrigeration & Air-conditioning
Honor: Renewable Energy and E- mobility

DOUBLE MINOR DEGREE (only for students having CGPA >= 7.5)
Double Minor: Artificial Intelligence and Data Science
Double Minor: Cloud Computing and Virtualization
Double Minor: Full Stack Development
Double Minor: Embedded Systems and Real-Time OS
Double Minor: Municipal or Urban Engineering
Double Minor: Enterprise Resource Planning
Double Minor: Digital Mfg. and Robotics
Double Minor: Renewable Energy

Code	Programme Elective Course 1
ET23303(A)	Antennas and Wave Propagation
ET23303(B)	Fundamentals of Image Processing
ET23303(C)	Software Defined Radio
ET23303(D)	Computer Communication Networks (CCN)

Code	Programme Elective Course 2
ET23312(A)	Power Electronics
ET23312(B)	Computer Vision
ET23312(C)	Machine Learning
ET23312(D)	Smart Antenna

Code	Programme Elective Course 3
ET23313(A)	Internet of Things
ET23313(B)	Cyber Security
ET23313(C)	PLC SCADA & Automation
ET23313(D)	Remote Sensing

ET23301: Digital Signal Processing

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem:60 Marks Practical: 30 Marks

Prerequisite Courses, if any: Signals & Systems

Course Objectives:

The course is aimed to:

1. To study discrete-time Signals and systems and Z transform
2. Fourier transform (DTFT), the concepts of frequency response characteristics of discrete-time systems, DFT and its fast computation.
3. To make the students able to design digital filters (FIR and IIR) and implement them in various forms.
4. To study and understand the concept of multirate DSP systems and applications of DSP

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Interpret and process discrete/ digital signals and represent the DSP system.
CO2: Analyze the digital systems using the Z-transform techniques.
CO3: Analyze discrete-time signals and systems using DFT and FFT.
CO4: Design and implement digital infinite impulse response (IIR) filters.
CO5: Design and implement digital finite impulse response (FIR) filters.
CO6: Apply signal processing algorithms for real-time applications

Course Contents

Unit I: Fundamentals of DSP

Discretization of Analog Signals: Sampling theorem in time domain, recovery of analog signals, and analytical treatment with examples, mapping between analog frequencies to digital frequency, Basic elements of DSP and its requirements, Discrete-Time Signals: Sequences and their Properties, Linear Time-Invariant (LTI) Systems, Convolution and its Properties, advantages of Digital over Analog signal processing, Introduction to DSP processor (TMS 320 XX 6713).

Unit II: Z Transform

Need for Z-transform, relation between Laplace transform and Z transform, relation between Fourier transform and Z transform, Concept of ROC and Properties of ROC, Relation between pole locations and time domain behavior, causality and stability considerations for LTI systems, Solution of difference equations using Z transform.

Unit III: Transforms (DFT-FFT)

Frequency domain sampling, DFT, Properties of DFT, circular convolution, Computation of linear convolution using circular convolution, FFT, decimation in time (DIT) and decimation in frequency (DIF) using Radix-2 FFT algorithm for 4 point and 8 point sequences, DFT & FFT computation complexity for

4 point and 8 point sequences, Linear filtering (Block convolution or Long sequence convolution) using overlap add and overlap save method.

Unit IV: IIR Filter Design

Concept of analog filter design, IIR filter design by approximation of derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters, Chebyshev filters and elliptic filters, IIR filter realization using direct form, cascade form and parallel form

Unit V: FIR Filter Design

Windowing techniques: Gibbs phenomenon, characteristics and comparison of different window functions, Linear phase conditions: impulse and phase and group delays, Design of linear phase FIR filter using windows: Rect, Hanning, Hamming, Blackmann & Kaiser, Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters, FIR filter realization using Direct Form, Cascade and linear phase structure.

Unit VI: Advanced DSP Concepts and Applications

Effect of finite word length, Introduction to multirate signal processing, Concept of Interpolation and decimation in signal processing,

Speech: Basics of speech signal and its features, identification of voiced and unvoiced speech and noise removal

Biomedical Signal: Basics of ECG and its features, Spectral Analysis using FFT,

Application of DSP to Radar signal processing.

Text Books:

1. Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis 5th Edition, 2022, Pearson
2. Digital Signal Processing: Theory and Practice by Maurice Bellanger, 10th Edition, 2024, Wiley
3. A.V.Oppenheim & R.W.Schafer, "Discrete-Time Signal Processing", Third Edition, Pearson Education.2010

Reference Books:

1. S.K. Mitra, "Digital Signal Processing: A computer-based approach", TMH.
2. L.R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall.
3. J.R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall.

MOOC / NPTEL Courses:

1. NPTEL Course on "Digital Signal Processing"
Link: https://nptel.ac.in/courses/117/102/117102060/
2. NPTEL Course on "Digital Signal Processing"
Link: https://nptel.ac.in/courses/108/105/108105055/

Practical Syllabus

Group A (All compulsory)

1. Verify the sampling theorem and aliasing effects with various sampling frequencies. Also, implement the sampling theorem using VLAB.
2. Find the z-transform of a given difference equation, compute its pole zero plot and comment on its

stability.

3. Compute DFT and IDFT { e.g. x(n) = {1,2,3,4} using N=4 and N= 8}

4. Find N-point circular convolution using the formula and verify its results. Implement linear filtering using circular convolution.

5 Implement IIR structures using Direct form I/ II/ Cascade form. Implement FIR structures using Direct Form/Cascade/Linear phase structures.

6. Study the windowing effect (time and frequency) for rectangular, hamming, hanning, blackmann and Kaiser window.

Group B (Any Two)

7 Design a Butterworth filter using Bilinear Transformation, for the following conditions: 0.8≤| ⟦H(e⟧ ^jw)| ≤1 0≤ ≤0.2π | ⟦H(e⟧ ^jw)≤|≤0.2 0.6≤ ≤π

OR

Design a Second order band-pass Digital Butterworth filter with a pass band of 200 Hz to 300 Hz and sampling frequency of 2000Hz using Bilinear Transformation.

OR

Evaluate the order and the poles of a Butterworth filter which has a 3dB bandwidth of 1000Hz and an attenuation of 20dB at 2000 Hz. Determine the system function H(z) by Bilinear Transformation using T=1/10000.

8. Design the symmetric FIR low pass filter for which desired frequency response is expressed as Hd (w)={(e^(-jwτ for|w|≤ wc) and 0 elsewhere The length of the filter should be M = 7 and Wc=1 radians/sample. Make use of the Rectangular/ Hamming/ Hanning/Blackman/ Kaiser window.

9. Verify the Sampling Theorem in frequency domain using FFT for under sampled, Nyquist and oversampled signals.

10. Compute the DFT by writing a function for the N>32 sequence. Calculate the computational complexity. Compare the time required by DFT & FFT functions.

Group C (Any two)

11. Implement the Block Convolution algorithms: a) Overlap-add b) Overlap-save.

12. Find the pitch frequency of the given speech signal using the autocorrelation method.

13. Implement the following ECG Signal Processing operations: a) Suppression of motion artifacts in ECG using N point moving average filters. b) Peak detection of ECG signal by using Band-limiting digital filters.

HOD E&TC	Dean Autonomy	Dean Academics	Principal
Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande

ET23302: Embedded System and RTOS

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem:60 Marks Practical: 30 Marks

Prerequisite Courses, if any: --

Course Objectives:

The course is aimed to:

1. To describe key characteristics of embedded systems and address the design issues.
2. To learn and implement real-time operating system concepts.
3. To understand the Embedded Linux environment.
4. To develop real-time embedded applications and learn testing processes.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Apply design metrics of Embedded systems to design real time applications to match recent trends in technology.
CO2: Apply real-time systems concepts.
CO3: Evaluate the µCOS II operating system and its services.
CO4: Apply Embedded Linux Development Environment and testing tools.
CO5: Analyze the Linux operating system and device drivers.
CO6: Analyze the hardware – software co design issues for testing of real time Embedded system.

Course Contents

Unit I: Introduction to Embedded Systems (06 Hrs.)

Introduction to Embedded Systems, Architecture, Classification and Characteristics of Embedded System, Design Process, Design Metrics and Optimization of various parameters of embedded system. ARM9 Based Microcontroller LPC2148: Features, Architecture (Block Diagram & Its Description), System Control, Clock & Power Control, GPIO, and Pin Connect Block.

Unit II: Real-Time Systems Concepts (06 Hrs.)

Foreground/ Background systems, Critical section of code, Resource, Shared resource, multitasking, Task, Context switch, Kernel, Scheduler, Non-Preemptive Kernel, Preemptive Kernel, Reentrancy, Round robin scheduling, Task Priorities, Static & Dynamic Priority, Priority Inversion, Assigning task priorities, Mutual Exclusion, Deadlock, Clock Tick, Memory requirements, Advantages & disadvantages of real-time kernels.

Unit III: µCOS II (06 Hrs.)

Features of µCOS II. Kernel structure. µCOS II RTOS services: Task management, Time management, Intertask Communication and Synchronization.

Unit IV: Embedded Linux Development Environment (06 Hrs.)

Need of Linux, Embedded Linux Today, Open Source and the GPL, BIOS Versus Boot loader, Anatomy of an Embedded System, Storage Considerations, Embedded Linux Distributions. Embedded Development Environment, Cross-Development Environment, Host System Requirements, Hosting Target Boards. Development Tools, GNU Debugger, Tracing and Profiling Tools, Binary Utilities

Unit V: Linux Kernel Construction (06 Hrs.)

Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration. Role of a Bootloader, Bootloader Challenges. A Universal Bootloader: Das UBoot. Porting U-Boot. Device Driver Concepts, Module Utilities, Driver Methods. Linux File System & Concepts.

Unit VI: Embedded Software Development, Testing Process and Tools (06 Hrs.)

Embedded Software development process and tools, Host and Target Machines, linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware- Software Design and Co-design. Testing on Host Machine, Simulators, and Laboratory Tools. Case study of an Embedded system like Automatic Chocolate Vending Machine.

Text Books:

1. Jean J.Labrosse, "MicroC OS II, The Real-Time Kernel", 2nd edition, CMP Books.
2. Christopher Hallinan, "Embedded Linux Primer –A Practical, Real-World Approach" 2nd edition, Prentice Hall.

Reference Books:

1. Raj Kamal, "Embedded Systems – Architecture, Programming and Design" 2nd edition, McGraw Hill.
2. Frank Vahid and Tony Givargis, "Embedded System Design – A Unified Hardware/ Software Introduction" 3rd edition, Wiley.

Practical Syllabus (Perform any 8 Experiments)

1. Multitasking in µCOS II RTOS using a minimum of 3 tasks on ARM7/ ARM Cortex- M3.
2. Semaphore as signaling & Synchronizing on ARM7/ ARM Cortex- M3.
3. Mailbox implementation for message passing on ARM7/ ARM Cortex- M3.
4. Queue implementation for message passing on ARM7/ ARM Cortex- M3.
5. Implementation of MUTEX using a minimum of 3 tasks on ARM7/ ARM Cortex- M3.
6. Download pre-configured Kernel Image, File System, boot loader to target device- ARM9.
7. Writing simple applications using embedded Linux on ARM9.
8. Writing "Hello World" Device Driver. Loading into & removing from Kernel on ARM9 board.
9. Write a program for I2C based RTC using embedded Linux on ARM9.
10. Using the Device driver for GPIO, write a program to blink the LED on ARM9.
11. Write a program for external interrupt on ARM9.

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ET23303(A): Antennas and Wave Propagation (Programme Elective Course 1)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem:60 Marks Term work: 30 Marks

Course Objectives:

The course is aimed to:

1. To able to apply Maxwell's equations and wave theory to analyze uniform plane waves in different media and determine their properties.
2. To gain an understanding of wave propagation in various environments and be able to calculate parameters like attenuation, multipath effects, and the influence of the Earth's atmosphere.
3. To acquire the ability to analyze and characterize different antenna types and understand key antenna parameters and their implications.
4. To able to perform detailed analyses of wire antennas, including the derivation of their radiation patterns and performance characteristics.
5. To develop the ability to design and analyze antenna arrays, optimizing configurations for specific radiation patterns and performance requirements.
6. To gain hands-on knowledge of practical antenna designs, including their structural details, applications, and the specific use cases for different antenna types.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Provide an in-depth understanding of Maxwell's equations, wave propagation, and polarization in various media including free space, dielectrics, and conductors.

Co2: Examine the fundamental principles of wave propagation in different environments, including free space, ionospheric conditions, and wireless channels.

CO3: Introduce the basic concepts of antennas, including their types, radiation mechanisms, and key parameters such as gain, directivity, and efficiency.

CO4: Explore the theory and analysis of wire antennas, including various types such as infinitesimal dipoles, small dipoles, and finite-length dipoles.

CO5: Understand the design and analysis of antenna arrays, including linear arrays, broadside, end-fire, and other configurations.

CO6: Study the structural details, dimensions, and applications of various types of antennas, with a focus on practical designs and real-world implementations.

Course Contents

Unit-1: Uniform Plane Waves (08 Hrs.)

Maxwell Equations in phasor form, Wave Equation, Uniform Plane wave in Homogeneous, free space, dielectric, conducting medium. Polarization: Linear, circular & Elliptical polarization, unpolarized wave. Reflection of plane waves, Normal incidence, oblique incidence, Electromagnetic Power and

Poynting theorem and vector

Unit-2: Wave Propagation (08 Hrs.)

Fundamental equations for free space propagation, Friis Transmission equation. Attenuation over reflecting surface, and the Effect of the earth's curvature. Ground, sky & space wave propagations. Structure of the atmosphere. Characteristics of ionized regions. Effects of Earth's magnetic field. Virtual height, MUF, Skip distance. Ionospheric abnormalities. Multi-hop propagation. Space link geometry. Characteristics of Wireless Channel: Fading, Multipath delay spread, Coherence Bandwidth, and Coherence Time.

Unit-3: Antenna Fundamentals (06 Hrs.)

Introduction, Types of Antennas, Radiation Mechanism. Antenna Terminology: Radiation pattern, radiation power density, radiation intensity, directivity, gain, antenna efficiency, half power beam width, bandwidth, antenna polarization, input impedance, antenna radiation efficiency, effective length, effective area, reciprocity. Radiation Integrals: Vector potentials A, J, F, M, Electric and magnetic fields electric and magnetic current sources, solution of inhomogeneous vector potential wave equation, far-field radiation.

Unit-4: Wire Antennas (06 Hrs.)

Analysis of Linear and Loop Antennas: Infinitesimal dipole, small dipole, finite length dipole half-wavelength dipole, small circular loop antenna. Complete Analytical treatment of all these elements.

Unit-5: Antenna Arrays (06 Hrs.)

Antenna Arrays: Two-element array, pattern multiplication N-element linear array, uniform amplitude and spacing, broadside and end-fire array, N-element array: Uniform spacing, non-uniform amplitude, array factor, binomial and DolphTchebyshev array. Planar Array, Circular Array, Log Periodic Antenna, YagiUda Antenna Array.

Unit -6: Antennas and Applications (06 Hrs.)

Structural details, dimensions, radiation pattern, specifications, features and applications of the following Antennas: Hertz & Marconi antennas, V- Antenna, Rhombic antenna. TW antennas. Loop antenna, Whip antenna, Biconical, Helical, Horn, Slot, Microstrip, Turnstile, Super turnstile & Lens antennas. Antennas with parabolic reflectors.

Text Books:

1. C. A. Balanis, "Antenna Theory - Analysis and Design", John Wiley.
2. Mathew N O Sadiku, "Elements of Electromagnetics" 3rd edition, Oxford University Press.

Reference Books:

1. John D Kraus, Ronald J Marhefka, Ahmad S Khan, Antennas for All Applications, 3rd Edition, the McGraw Hill Companies.
2. K. D. Prasad, "Antenna & Wave Propagation", Satya Prakashan, New Delhi.
3. John D Kraus, "Antenna& Wave Propagation", 4th Edition, McGraw Hill.
4. Vijay K Garg, Wireless Communications and Networking, Morgan Kaufmann Publishers, an Imprint of Elsevier.

Practical Syllabus

Group A

- To Measure Radiation Pattern, Return Loss, Impedance, Gain, and Beam width for the following antennas (Any Four)

1. Dipole antenna
2. Folded Dipole
3. Yagi-Uda
4. Horn
5. Parabolic Reflector
6. Microstrip Antennas

- Plot Standing Wave pattern and Measure SWR for open, short and matched termination

Group B (Any 6)

MATLAB/C/Scilab Simulation of following antenna arrays (Plotting radiation pattern)

1. Broadside linear array with uniform spacing and amplitude
2. End fire linear array with uniform spacing and amplitude
3. Binomial array
4. Dolph-Tchebyshev
5. Design and simulation of wire half-wave dipole antenna.
6. Design and simulate planer n element array
7. Design and simulate Log periodic antenna array
8. Design and simulate a broadside array
9. Design and simulate a helical antenna and Loop antenna
10. Design and simulate a Microstrip patch antenna and simulate a Slotted antenna

HOD E&TC	Dean Autonomy	Dean Academics	Principal
Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande

ET23203(B): Fundamentals of Image Processing
(Programme Elective Course 1)

Teaching Scheme: **Theory: 03 Hours/Week** **Practical: 02 Hours/Week**	**Credits: 04**	**Examination Scheme:** **CAA: 10 Marks** **In Sem: 30 Marks** **End Sem: 60 Marks** **Term work: 30 Marks**

Prerequisites:

1. Signals and Systems

Course Objectives:

1. To get acquainted with the fundamental principles of digital image processing, including image formation, representation, and the role of image processing in various applications.
2. To explore techniques for improving image quality through contrast enhancement, noise reduction, and filtering methods.
3. To focus on techniques for restoring degraded images and mitigating noise using various filtering techniques.
4. To introduce techniques for partitioning an image into meaningful regions and detecting key features.
5. To familiarize techniques to reduce image size for efficient storage and transmission while maintaining perceptual quality.
6. To introduce object recognition methodologies and explore emerging trends in digital image processing.

Course Outcomes:

Upon successful completion of this course, students will be able to:

CO1: Understand and implement fundamental image processing techniques.

CO2: Apply image enhancement, filtering, and restoration methods to real-world scenarios.

CO3: Perform segmentation, feature extraction, and object recognition in digital images.

CO4: Utilize image compression techniques for storage and transmission efficiency.

CO5: Apply machine learning and deep learning methods for image classification and analysis.

CO6: Develop and implement digital image processing algorithms using MATLAB or Python.

Course Contents

Unit 1: Introduction to Digital Image Processing (6 Lectures)

- Digital Image Fundamentals: Introduction to digital imaging, applications in medical imaging, remote sensing, machine vision, and robotics.
- Image Formation and Acquisition: Image sensors, scanning techniques, and image digitization.
- Sampling and Quantization: Nyquist theorem, aliasing, resolution, and bit-depth.

- Pixel Relationships: Adjacency, connectivity, distance metrics, and neighbourhood operations.
- Color Image Representation: RGB, HSV, CMYK, and other color models; chromaticity diagrams.

Unit 2: Image Enhancement in Spatial and Frequency Domains (7 Lectures)

- Spatial Domain Enhancement: Intensity transformations: Logarithmic, power-law, and piecewise-linear transformations. Histogram processing: Equalization, matching, and specification.
- Spatial Filtering: Smoothing filters: Mean, median, Gaussian, and bilateral filtering. Sharpening filters: Gradient operators (Sobel, Prewitt, Roberts) and high-boost filtering.
- Frequency Domain Enhancement: Introduction to the Fourier Transform and its properties. Low-pass, high-pass, and band-pass filtering. Homomorphic filtering for illumination normalization.

Unit 3: Image Restoration and Noise Reduction (6 Lectures)

- Image Degradation Model: Causes of image degradation, system modelling, and degradation function.
- Noise Models: Gaussian, salt-and-pepper, Poisson, and speckle noise.
- Restoration Techniques: Spatial domain filtering: Averaging, adaptive, and Wiener filters. Frequency domain filtering: Inverse and Wiener filtering.
- Blind Image Restoration: Least-squares filtering and constrained deconvolution.
- Motion Blur Restoration: Estimating and inverting motion blur kernels.

Unit 4: Image Segmentation and Feature Detection (7 Lectures)

- Edge Detection: First order and second-order derivative methods, Canny edge detection.
- Thresholding Techniques: Global and adaptive thresholding methods and Otsu's method for optimal threshold selection.
- Region-Based Segmentation: Region growing, region splitting and merging, and watershed segmentation.
- Morphological Image Processing: Dilation, erosion, opening, and closing. Hit-or-miss transform and morphological gradient.

Unit 5: Image Compression and Representation (7 Lectures)

- Image Compression Fundamentals: Compression models: Lossless vs. lossy compression. Entropy and redundancy in images.
- Lossless Compression Techniques: Huffman coding, Arithmetic coding, and Run-Length Encoding (RLE).
- Lossy Compression Techniques: Transform-based compression: Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT). JPEG and their applications.
- Quality Metrics in Compression: Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM).

Unit 6: Object Recognition and Emerging Applications in Image Processing (6 Lectures)

- Feature Extraction Techniques: Scale-Invariant Feature Transform (SIFT),

- Speeded-Up Robust Features (SURF), and Histogram of Oriented Gradients (HOG).
- Pattern Recognition and Classification: Supervised and unsupervised learning techniques in image analysis.
- Deep Learning in Image Processing: Basics of Convolutional Neural Networks (CNNs) for image classification and object detection.
- Applications in Industry: Medical imaging, biometrics (face, fingerprint recognition), remote sensing, and autonomous navigation.

Text/Reference Books:

1. R.C. Gonzalez, R.E.Woods, Digital image processing, Pearson Education India, Third Edition, 2002.
2. Anil K. Jain, Fundamentals of digital image processing, Prentice Hall of India.
3. Murat Tekalp, "Video Processing" 2nd Ed. Pearson Publications.

Lab Assignments

1. Image Representation and Basic Operations.

Objective: Load, display, and manipulate digital images in MATLAB.

2. Image Histogram and Contrast Enhancement.

Objective: Enhance image contrast using histogram processing.

3. Spatial Filtering for Smoothing and Sharpening.

Objective: Apply spatial domain filtering for image enhancement.

4. Frequency Domain Filtering Using Fourier Transform.

Objective: Perform image filtering using Fourier Transform.

5. Noise Removal and Image Restoration.

Objective: Reduce noise in images using different filtering techniques.

6. Edge Detection and Feature Extraction.

Objective: Detect edges using different edge detection techniques.

7. Image Segmentation Using Thresholding and Region-Based Methods.

Objective: Segment an image into meaningful regions.

8. Image Compression Using DCT and Wavelet Transform.

Objective: Compress images using transform-based techniques.

9. Feature Detection for Object Recognition.

Objective: Extract and match key features in an image.

10. Face Detection Using Machine Learning Techniques.

Objective: Detect faces in an image using machine learning.

ET23303(C): Software Defined Radio (Programme Elective Course 1)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem:60 Marks Term work: 30 Marks

Course Objectives:

The course is aimed at:

1. Demonstrate an understanding of SDR principles, its architecture, and differences from analog radio systems.
2. Analyze and design SDR systems, evaluating components like RF front ends, ADC/DAC, and FPGA/CPU/GPU trade-offs.
3. Implement multi-rate signal processing techniques, including DSP algorithms and OFDM, in SDR applications.
4. Design smart/MIMO antenna systems, applying SDR concepts to antenna arrays and MIMO techniques.
5. Implement cognitive radio functionalities using SDR, focusing on spectrum management and dynamic access.
6. Evaluate and apply SDR in real-world scenarios such as public safety communication, network interoperability, and embedded SDR systems.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand the fundamentals of Software Defined Radio (SDR) and its differences from analog radio systems.

CO2: Analyze the architecture of SDR, including hardware and software platforms, and the role of components like ADC/DAC, RF front end, and FPGA.

CO3: Apply multi-rate signal processing techniques to SDR systems, including algorithms for timing, frequency offset, and channel estimation.

CO4: Design and implement smart/MIMO antenna systems using SDR principles, including beam forming and space-time coding.

CO5: Explore the concepts of Cognitive Radio (CR), dynamic spectrum access, and spectrum sensing within the SDR framework.

CO6: Study real-world applications of SDR in advanced communication systems, including public safety, network interoperability, and embedded SDR platforms.

Course Contents

Unit I: Introduction to SDR and RF Implementation (7 Hrs.)

Introduction to SDR, Need of SDR, Principles of SDR, Basic Principle and Difference in Analog

radio and SDR, SDR characteristics, required hardware specifications, Software/Hardware platform, GNU radio -What is GNU radio, GNU Radio Architecture, Hardware Block of GNU, GNU software, MATLAB in SDR, Radio Frequency Implementation issues, Purpose of RF Front End, Dynamic Range, RF receiver Front End topologies, Flexibility of RF chain with software radio, Duplexer, Diplexer, RF filter, LNA, Image reject filters, IF filters, RF Mixers Local Oscillator, AGC, Transmitter Architecture and their issues, Sampling theorem in ADC, Noise and distortion in RF
chain, Pre-distortion

Unit II: SDR Architecture (7 Hrs.)

The architecture of SDR-Open Architecture, Software Communication Architecture, Transmitter Receiver Homodyne/heterodyne architecture, RF Front End, ADC, DAC, DAC/ADC Noise Budget, ADC and DAC Distortion, Role of FPGA/CPU/GPU in SDR, Applications of FPGA in SDR, Design Principles using FPGA, Trade-offs in using DSP, FPGA and ASIC, Power Management Issues in DSP, ASIC, FPGA

Unit III: Multi Rate Signal Processing (6 Hrs.)

Sample timing algorithms, Frequency offset estimation and correction, Channel Estimation, Basics of Multi-Rate, Multi-Rate DSP, Multi-Rate Algorithm, DSP techniques in SDR, OFDM in SDR.

Unit IV: Smart/MIMO Antennas using Software Radio (6 Hrs.)

Smart Antenna Architecture, Vector Channel Modelling, Benefits of Smart Antenna Phased Antenna Array Theory, Adaptive Arrays, DOA Arrays, Applying Software Radio Principles to Antenna Systems, Beam forming for systems multiple Fixed Beam Antenna Array, Fully Adaptive Array, Relative Benefits and Trade-offs OF Switched Beam and Adaptive Array, Smart Antenna Algorithms, Hardware Implementation of Smart Antennas, MIMO -frequency, time, sample synchronization, Space-time block coding-Space Time Filtering, Space-Time Trellis Coding.
Case Study: Principles of MIMO-OFDM.

Unit V: Cognitive Radio (6 Hrs.)

Cognitive Radio Architecture, Dynamic Access Spectrum, Spectrum Efficiency, Spectrum Efficiency gain in SDR and CR, Spectrum Usage, SDR as a platform for CR, OFDM as PHY layer, OFDM Modulator, OFDM Demodulator, OFDM Bandwidth, Benefits of OFDM in CR, Spectrum Sensing in
CR, CR Network.

Unit VI: Applications of SDR (6 Hrs.)

Application of SDR in advanced communication System-Case Study, Challenges and Issues, Implementation, Parameter Estimation –Environment, Location, other factors, Vertical Handoff, Network Interoperability.
Case Study: 1)CR for Public Safety –PSCR, Modes of PSCR, Architecture of PSCR 2)Beagle board-based SDR 3)Embedded PCSR using GNU radio

Text Books:

1. Jeffrey. H. Reed, Software Radio: A Modern Approach to Radio Engineering, Pearson LPE.
2. Markus Dillinge, Kambiz Madani, Nancy Alonistioti, Software Defined Radio: Architectures, Systems and Functions, Wiley.

Reference Books:

1. Tony. J. Rouphael, RF and DSP for SDR, Elsevier Newness Press, 2008
2. Dr. Taj Struman, Evaluation of SDR –Main Document
3. SDR –Handbook, 8th Edition, PENTEK
4. Bruce A. Fette, Cognitive Radio Technology, Newness, Elsevier

Practical Syllabus (Perform any 10)

1. Introduction to GNU Radio
2. Introduction to Software-Defined Radio Systems
3. Implementation of AM using SDR
4. Implementation of FM using SDR with applications such as transfer of files
5. Implementation of M-PSK transmitter using SDR
6. Implementation of M-PSK receiver using SDR
7. Implementation of M-QAM transmitter using SDR
8. Implementation of M-QAM receiver using SDR
9. Implementation of Transmission of files on Wireless media using SDR
10. Implementation of OFDM using SDR
11. Implementation of Cognitive radio using SDR

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ET23303(D): Computer Communication Networks (CCN)
(Programme Elective Course 1)

Teaching Scheme:	Credits	Examination Scheme:
Theory: 03 Hours/Week	04	CAA: 10 Marks
Practical: 02 Hours/Week		In Sem: 30 Marks
		End Sem:60 Marks
		Termwork: 30 Marks

Course Objectives:

The course is aimed to:

1. Understand the layering architecture of the OSI reference and TCP/IP model.
2. Elaborate the background concepts and functionalities of the application, transport, and network layers.
3. Study and analyze the flow and error control schemes.
4. Present ample details about the protocols, technologies, algorithms and standards that are used by each layer as it relates to the internet.
5. Overview of LAN concept, link layer, connecting LANs and connecting devices.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand the fundamental underlying principles of computer networking

CO2: Describe and analyze the hardware, software, and components of a network and their interrelations.

CO3: Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies

CO4: Have a basic knowledge of installing and configuring networking applications.

CO5: Specify and identify deficiencies in existing protocols and then go on to select new and better protocols.

CO6: Have a basic knowledge of the use of cryptography and network security.

Course Contents

Unit I: Introduction to computer networks and the Internet

Types of networks, Network topologies, Design issues for Layers, Network models, Introduction to Data Networks and ISO-OSI protocol, Fundamentals of the Physical Layer and different modes of data communication.

Unit II: Link layer

ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing, Ethernet, Hubs, and Switches. Data link control, Framing, Flow and error control, HDLC, point-to-point-to-point protocol, Media Access Control: Random Access, Controlled Access- Reservation, Channelization protocols.

Unit III: Switching in networks

Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Crossbar switch and evaluation of blocking probability, 2-stage, 3-stage and n-stage

networks, Packet switching, Blocking in packet switches, Three generations of packet switches, switch fabric, Buffering, Multicasting, Statistical Multiplexing.

Unit IV: Network layer

Introduction to Network Layer: Network-Layer Services, Circuit switching, Packet Switching, Network-Layer Performance, IPv4 Addresses, Forwarding of IP Packets, Network Layer Protocols: Internet Protocol (IP), ICMPv4, Next Generation IP: IPv6 Addressing, The IPv6 Protocol, The ICMPv6 Protocol, Transition from IPv4 to IPv6. Virtual circuit and Datagram networks, Routing algorithms, Broadcast and Multicast routing.

Unit V: Transport layer

Connectionless transport - User Datagram Protocol, Connection-oriented transport – Transmission Control Protocol, Remote Procedure Call. Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.

Unit VI: Application layer

Principles of network applications, Standard Client Server Protocols: World Wide Web and HTTP, Telnet, FTP, Email, SMTP, IMAP, POP, DNS, BOOTP, DHCP.

Text Books:

1. Behrouz A. Forouzan, "Data Communications and Networking" MacGraw Hill, 5th edition
2. James F. Kurouse& W. Rouse, "Computer Networking: A Top-down Approach", 6th Edition, Pearson Education.

Reference Books:

1. Andrew S. Tannenbaum, "Computer Networks", Pearson Education, Fourth Edition,2003
2. Wayne Tomasi, "Introduction to Data Communication and Networking", Pearson Education
3. Natalia Olifer, Victor Olifer, "Computer Networks" Wiley Student Edition

Practical Syllabus (Perform any 10)

1. Implementation of LAN using a suitable multi-user Windows operating System and demonstrating client-server and peer-to-peer mode of configuration.
2. Installation and configuration of Web server, and FTP Server.
3. Installation and configuration of Telnet server for Telnet communication.
4. Installation and configuration of the Proxy server.
5. Installation and configuration of the DHCP server.
6. Study of IP Addresses subnetting and CIDR
7. Study of Network Protocol Analyzer tool/software.
8. Study of network monitoring tool/software.
9. Simulating LAN or WAN using a suitable network simulator.
10. Write a program for Encryption and Decryption
11. Study of HTTPS, IPSec and SSH using Wireshark.

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HS23301: Universal Human Values and Professional Ethics

Teaching Scheme: Theory: 02 Hours/Week	Credits 02	Examination Scheme: CAA: 10 Marks End Sem: 60 Marks

Course Objectives:

This course is intended to:

- To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and the movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour, and mutually enriching interaction with Nature.
- This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Course outcome (Course Skill Set)

At the end of the course, students will be able to become more aware of themselves, aspirations in life, happiness and prosperity.

CO1: To handle problems with sustainable solutions while keeping human relationships and human nature in mind.

CO2: To become sensitive to their commitment towards what they have understood (human values, human relationships and human society).

CO3: To develop harmony with nature.

CO4: To apply what they have learnt to their self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Co5: To follow professional Ethical human conduct.

Unit-1: Introduction to Value Education (5 Hrs.)

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations

Unit II: Harmony in the Human Being (5 Hrs.)

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the

Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health

Unit III: Harmony in the Family and Society (5 Hrs.)

Harmony in the Family is a basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationships, 'Respect' – for the Right Evaluation and other Feelings, Justice in Human Relationships, Understanding Harmony in Society, and a Vision for the Universal Human Order.

Unit IV: Harmony in the Nature/Existence (5 Hrs.)

Understanding Harmony in Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, and The Holistic Perception of Harmony in Existence.

Unit V: Implications of the Holistic Understanding – a Look at Professional Ethics (6 Hrs.)

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Text Book and Teachers Manual

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
2. The Teacher"s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G
3. Professional Ethics and Human Values, Premvir Kapoor, Khanna Book Publishing

Reference Books :

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Rediscovering India - by Dharampal
9. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
10. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972
11. Limits to Growth – Club of Rome's report, Universe Books.
12. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
13. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
14. A N Tripathy, 2003, Human Values, New Age International Publishers.
15. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.

16. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press.
17. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
18. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
19. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e-Resources):

Value Education websites,

- https://www.uhv.org.in/uhv-ii,
- http://uhv.ac.in,
- http://www.uptu.ac.in
- Story of Stuff,
- http://www.storyofstuff.com
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- https://fdp-si.aicte-india.org/8dayUHV_download.php
- https://www.youtube.com/watch?v=8ovkLRYXIjE
- https://www.youtube.com/watch?v=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM
- Al Gore, An Inconvenient Truth, Paramount Classics, USA
- Charlie Chaplin, Modern Times, United Artists, USA
- IIT Delhi, Modern Technology – the Untold Story
- Gandhi A., Right Here Right Now, Cyclewala Productions

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HS23302: Constitution of India (Audit Course)

Teaching Scheme: Theory: 01 Hour/Week	Credits: --	Examination Scheme: CAA: -- End Sem: --

Course objectives:

This course is intended to:

- Familiarize students with the salient features, structure, and significance of the Constitution, including the principles enshrined in the Preamble.
- Provide an understanding of fundamental rights and duties, their scope, significance, and role in ensuring justice, equality, and freedom in a democratic society
- Explain the concept of Directive Principles of State Policy (DPSP) and their role in governance, emphasizing their interrelationship with Fundamental Rights.
- Analyze emergency provisions and constitutional amendments, discussing their implications on Indian democracy and governance.
- Encourage a comparative understanding of the Indian Constitution with other constitutions worldwide, fostering awareness of global governance models.

Course outcome (Course Skill Set)

At the end of the course, students will be able to become more aware of themselves, aspirations in life, happiness and prosperity.

CO1: Describe the salient features and basic structure doctrine of the Constitution and Interpret the values enshrined in the Preamble

CO2: Comprehend Fundamental Rights and Duties of Indian Citizens

CO3: Analyze the Role of Directive Principles of State Policy (DPSP) in Governance

Unit-1: Introduction to the Constitution of India (5 Hrs.)

Historical Perspective and Making of the Indian Constitution, Salient Features of the Constitution, Preamble and its Significance, Basic Structure of the Constitution, Emergency Provisions in the Indian Constitution, Important Amendments to the Constitution

Unit II: Fundamental Rights and Duties (4 Hrs.)

Fundamental Rights: Meaning, Scope, and Significance, Right to Equality, Freedom, Protection from Exploitation, Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Fundamental Duties of Indian Citizens

Unit III: Directive Principles and Governance (4 Hrs.)

Directive Principles of State Policy: Meaning and Purpose, Relationship between Fundamental Rights and Directive Principles, Role of Directive Principles in Policy Formulation, Comparison with Other Constitutions.

Reference Books & Study Materials

1. **M. Laxmikanth**, *Indian Polity*, McGraw Hill Education, 6th Edition, 2020.
2. **D.D. Basu**, *Introduction to the Constitution of India*, LexisNexis, 25th Edition, 2021.
3. **Subhash Kashyap**, *Our Constitution: An Introduction to India's Constitution and Constitutional Law*, National Book Trust, 2019.
4. **J.N. Pandey**, *The Constitutional Law of India*, Central Law Agency, 2020.
5. **Bare Act**, *Constitution of India*, Government of India Publications.

Evaluation and Assessment

Since this is an audit course, there is a mandatory internal evaluation which can be based on the following:

- **Assignments & Reports**– Writing about a constitutional provision or case study.
- **Quiz/MCQs** – To test basic understanding of the Constitution.
- **Group Discussion/Presentation** – On relevant topics like Fundamental Rights or Constitutional Amendments.

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ET23311-: Mobile Communication and Networks

Teaching Scheme:	Credits	Examination Scheme:
Theory: 03 Hours/Week	04	CAA: 10 Marks
Practical: 02 Hours/Week		In Sem: 30 Marks
		End Sem:60 Marks
		Oral: 30 Marks

Prerequisite Courses, if any: Analog and Digital Communication

Course Objectives:

The course is aimed to:

1. Various techniques of wireless communication systems.
2. OFDM and MIMO technologies to explain modern wireless systems.
3. Various aspects of mobile communication systems.
4. Different Generations of Mobile Networks.
5. Diversified issues that can enhance Network Performance.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand the fundamentals of wireless and mobile communications.

CO2: Discuss and study OFDM and MIMO concepts.

CO3: Elaborate fundamentals of mobile communication.

CO4: Study Wireless Network Technologies.

CO5: Understand modern and futuristic wireless network architecture.

CO6: Summarize different issues in performance analysis.

Course Contents

Unit I: Wireless and Mobile Communication (7 Hrs.)

Introduction to Wireless Communication: Evolution of Wireless Communication, Overview of Mobile Communication Systems, Applications of Wireless Communication, Challenges in Wireless Communication.

Cellular Communication Concepts: Cellular System Architecture, Frequency Reuse and Channel Allocation, Handoff and Roaming, Interference and System Capacity

Unit II: Multiple Access Techniques and MIMO (7 Hrs.)

Introduction of Spread Spectrum Techniques (DSSS, FHSS), **Multiple Access Techniques**: FDMA, TDMA, OFDMA, OFDM example, bit error rate for OFDM.

Multiple-Input Multiple-Output Wireless Communications: Introduction to MIMO Wireless Communications, MIMO System Model and MIMO-OFDM.

Unit III: Wireless Propagation and Channel Models (6 Hrs.)

Introduction, Free Space Propagation Model, Ground-Reflection Scenario, Hata Model and Receiver-Noise Computation, Channel Estimation techniques and Diversity in wireless communications, Free Space Propagation Model, Path Loss, Fading, and Shadowing, Multipath Effects and Doppler Shift,

Large-Scale and Small-Scale Fading Models.

Unit IV: Wireless Network Technologies (6 Hrs.)

GSM Architecture and Protocols, GPRS and EDGE Evolution, CDMA and WCDMA, LTE and LTE-Advanced.

5G and Beyond Wireless Technologies: Overview of 4G vs. 5G Networks, mmWave Communications and Massive MIMO, Network Slicing and Edge Computing, IoT and Smart Connectivity.

Unit V: Wireless and Mobile Technologies and Protocols and their Performance Evaluation (6 Hrs.)

Introduction, Wireless and mobile technologies, LTE- advanced, 5G – Architecture, wireless local area network and Simulations of wireless networks.

Unit VI: Performance Analysis Issues (8 Hrs.)

Introduction to Network coding, basic hamming code and significance of Information Theory. Interference suppression and Power control. MAC layer scheduling and connection admission in mobile communication.

Text Books:

1. Rappaport, T. S., "Wireless Communications--Principles and Practice", Pearson, 2nd Edition.
2. Jagannatham, A. K., "Principles of Modern Wireless Communication Systems", McGraw-Hill Education.

Reference Books:

1. Cristopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications", Wiley, 2nd Edition.
2. E. Dahlman, J. Skold, and S. Parkvall, "4G, LTE-Advanced Pro and the Road to 5G", Academic Press, 3rd Edition.
3. B. P. Lathi, "Modern Digital and Analog Communications Systems". Oxford University Press, 2015, 4th Edition.
4. Obaidat, P. Nicopolitids, "Modeling and simulation of computer networks and systems: Methodologies and applications" Elsevier, 1st Edition.

MOOC / NPTEL Courses:

1. NPTEL Course "Introduction to Wireless & Cellular Communications" Link of the Course: https://nptel.ac.in/courses/106/106/106106167/
2. NPTEL Course "Advanced 3G and 4G Wireless Mobile Communications" Link of the Course: https://nptel.ac.in/courses/117/104/117104099/

Practical Syllabus

Group A (Expt. 1 is compulsory and any two from Expt. 2 to 4)

1. Compute and compare the median loss by employing Hata model for various distance for carrier frequencies of 2.1 GHz and 6 GHz. Assume transmit and receive antenna heights of 40 m and 2 m in a large city. Plot the graph of path loss vs distance.
2. Simulate BER performance over a Rayleigh fading wireless channel with BPSK transmission for SNR: 0 to 50 dB.

3. Simulate BER performance over a wireline AWGN channel with BPSK transmission for SNR: 0 to 50 dB.

4. Estimate fading channel coefficient in AWGN for given transmitted pilot symbols and received outputs across the standard Rayleigh fading wireless channel (Single Rx/Tx antenna).

5. Compute the RMS delay spread for a given Power profile and plot the graph of Power vs Delay.

Group B (Expt. 6 is compulsory and any two from Expt. 7 to 10)

6. Perform a Link-Budget analysis for a wireless communication system.

7. Simulate BER performance of multi-antenna Rayleigh channel for SNR varying from 0 to 60 dB.

8. Simulate and compute minimum spacing required between the antennas for independent fading channels against operating carrier frequency bands for every generation of mobile standards.

9. Estimate channel coefficient vector Multi-Antenna Systems.

10. Compute the Doppler shift of the received signal for different carrier frequencies of mobile generations by considering a vehicle is moving at 60 miles per hour at an angle of 30 degrees with the line joining the base station.

Group C (Expt. 11 is compulsory, and any two from Expt. 12 to 14)

11. Simulate a mobile environment to evaluate performance parameters using any open source Network Simulator tool.

12. Breadboard implementation to demonstrate and evaluate performance metrics of loss system

13. Program to implement OFDM and evaluate frame error rate against SNR

14. Program to understand Scheduling Mechanism for resource sharing

Virtual LAB Links:

1. Link of the Virtual Lab:

Fading Channels: http://www.vlab.co.in/as

2. Link of the Virtual Lab:

Mobile Communications: http://fcmcvlab.iitkgp.ac.in

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ET23312(A): Power Electronics (Programme Elective Course 2)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any:

Basics of semiconductor devices and analog circuits, Electrical machines, circuit analysis methods, and microcontrollers.

Course Objectives:

This course emphasizes the effective knowledge of power devices – SCR, IGBT and power MOSFET and their switching techniques. It also gives insights into different types of converters and their applications in DC and AC motor drives

Course Outcomes: On completion of the course, the learner will be able to

CO1: Explain different triggering/gate drive circuits for a power device.
CO2: Compare and analyze different controlled converters.
CO3: Elaborate on different DC to AC Converters
CO4: Apply the concept of choppers and AC voltage control in different applications.
CO5: Design the DC Motor drives for industrial Applications.
CO6: Design the AC Motor drives for industrial Applications.

Course Contents

Unit I: Power Devices (08 Hrs.)

Construction, Steady state characteristics & Switching characteristics of SCR, Construction, Steady state characteristics of Power MOSFET & IGBT. SCR ratings: IL, IH, VBO, VBR, dv/dt, di/dt, surge current & rated current. Gate characteristics, Gate drive requirements, Gate drive circuits for Power MOSFET & IGBT, opto-isolator driving circuits for SCR. Series and parallel operations of SCR's. Applications of the above power devices as a switch.

Unit II: AC-DC Power Converters (08 Hrs.)

Concept of line & forced commutation, Single phase Semi & Full converters for R, R-L loads, Performance parameters, Effect of freewheeling diode, Three phase Semi & Full converters for R load, effect of source inductance, Power factor improvement techniques, Single Phase dual converter with inductive load.

Unit III: DC-AC Converters (06 Hrs.)

Single phase bridge inverter for R and R-L load using MOSFET / IGBT, performance Parameters, single phase PWM inverters. Three-phase voltage source inverter for balanced star R load with 120 and 180 mode of operation, Device utilization factor.

Unit IV: Chopper & AC Voltage Controller (06 Hrs.)

Working Principle of step down chopper for R-L load (highly inductive), control strategies.

Performance parameters, Step up chopper, 2-quadrant & 4-quadrant choppers, Single-Phase full wave AC voltage controller by using IGBT with R load.

Unit V: DC Motor Drives (06 Hrs.)

Speed-torque characteristics, methods of speed control, Starting and braking methods for DC motor. Single phase separately excited DC motor drive, Chopper controlled drives for separately excited and series DC Motor operations. Closed loop speed control of DC motor below and above base speed. Criteria for selection of motor for drives. Case study of DC motor Drives application.

Unit IV: AC Motor Drives (06 Hrs.)

Speed torque relation of AC motors, Methods of speed control and braking for Induction motor and Synchronous motor. Variable voltage & variable frequency three phase induction motor drive. Case study of AC motor Drives application.

Text Books:

1. M. H. Rashid, –Power Electronics circuits devices and applications, PHI 3rd edition, New Delhi.
2. M. S. Jamil Asghar, "Power Electronics", PHI, New Delhi
3. G. K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House
4. N. K. De, P. K. Sen, "Electric Drives", Prentice Hall of India Eastern Economy Edition.

Reference Books:

1. Ned Mohan, T. Undeland& W. Robbins, –Power Electronics Converters Applications and Design" 2nd edition, John Willey & sons, Singapore, Oxford University Press, New Delhi.
2. P.C. Sen, –Modern Power Electronics", S Chand & Co New Delhi.
3. "GE SCR MANUAL" 6th edition, General Electric, New York, USA.
4. Dr. P. S. Bimbhra, –Power Electronics", Khanna Publishers, Delhi.

List of Experiments

1. To plot the Characteristics of SCR and find the latching and holding current.
2. To plot V-I Characteristics of MOSFET / IGBT.
3. To perform Single phase Semi / Full Converter with R & R-L load and calculate different performance parameters
4. To perform a Single-Phase PWM bridge inverter for R load and calculate different performance parameters.
5. To perform step-down dc chopper using power MOSFET / IGBT and calculate different performance parameters.
6. To perform a single-phase AC voltage controller using SCRs for R load and calculate output voltage for different firing angles.
7. To perform speed control of the DC motor and plot voltage v/s speed characteristics.
8. To perform speed control of AC motor and plot speed torque characteristics.
9. Assignment: A case study of any industrial automation system using AC or DC drives.

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Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande

ET23312(B): Computer Vision (Programme Elective Course 2)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any:

1. Digital Systems
2. Microcontrollers

Course Objectives:

1. To be able to design new algorithms to solve recent state-of-the-art computer vision problems.
2. To perform software experiments on computer vision problems and compare their performance with the state of the art.
3. To develop a broad knowledge base so as to easily relate to the existing literature.
4. To gather a basic understanding of the geometric relationships between 2D images and the 3D world.
5. To build a complete system to solve a computer vision problem.

Course Outcomes: On completion of the course, the learner will be able to

CO1: Apply mathematical modeling methods to solve low, intermediate, and high-level image processing tasks.

CO2: Design innovative algorithms to address contemporary computer vision challenges.

CO3: Conduct software experiments on computer vision problems and evaluate performance against state-of-the-art methods.

CO4: Build a broad knowledge base to effectively relate and integrate with existing literature in computer vision.

CO5: Develop an understanding of the geometric relationships between 2D images and the 3D world.

CO6: Build end-to-end systems to solve complex computer vision problems.

Course Contents

Unit 1: Digital Image Formation Depth estimation and Multi-camera views

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc., Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

Unit 2: Feature Extraction

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, ScaleSpace Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Unit 3: Image Segmentation

Region Growing, Edge-Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Unit 4: Pattern Analysis

Basics of Probability and Statistics, Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Unit 5: Motion Analysis

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Shape from X: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation. Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Unit 6: Applications of Computer Vision

Real-world applications of Computer Vision for various industries: Manufacturing, Healthcare, Agriculture, Transportation, Sports using Gesture Recognition, Motion Estimation and Object Tracking.

Textbooks:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited.
2. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press.

Reference Books:

1. R. Bishop; Pattern Recognition and Machine Learning, Springer.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann.

NPTEL Courses:

1. Modern Computer Vision by Prof. A.N. Rajagopalan, IIT Madras
https://onlinecourses.nptel.ac.in/noc25_ee51/preview
2. Computer Vision And Image Processing - Fundamentals And Applications By Prof. M. K. Bhuyan IIT Guwahati
https://onlinecourses.nptel.ac.in/noc25_ee13/preview

List of Experiments (Perform any 10)

Write MATLAB/ Python/ OpenCV code to achieve the following objectives

1. Practical 1: Image Formation and Transformation

Objective: Learn the fundamentals of image formation, and apply geometric transformations like Orthogonal, Euclidean, Affine, and Projective.

2. Practical 2: Camera Calibration & Epipolar Geometry

Objective: Understand camera calibration and Epipolar geometry.

3. Practical 3: Binocular Stereopsis and 3D Reconstruction

Objective: Implement depth estimation using stereo images.

4. Practical 4: Homography and RANSAC for Outlier Removal

Objective: Implement homography estimation and use RANSAC for robust matching.

5. Practical 5: Hough Transform for Line Detection

Objective: Detect straight lines in an image using the Hough transform.

OR

6. Practical 6: Corner Detection (Harris and Hessian)

Objective: Apply Harris and Hessian corner detection methods.

7. Practical 7: Feature Extraction Using SIFT and SURF

Objective: Extract features using SIFT and SURF and match key points between images.

8. Practical 8: Region Growing and Edge-based Segmentation

Objective: Implement region-growing and edge-based segmentation techniques.

OR

9. Practical 09: Graph-Cut Image Segmentation

Objective: Segment an image using the Graph-Cut algorithm.

10. Practical 10: K-Means and K-Medoids Clustering

Objective: Perform K-Means and K-Medoids clustering for image segmentation.

OR

11. Practical 11: Principal Component Analysis (PCA) for Dimensionality Reduction

Objective: Use PCA for dimensionality reduction in a dataset.

12. Practical 12: Background Subtraction for Motion Detection

Objective: Implement background subtraction for detecting moving objects in a video.

OR

13. Practical 13: Optical Flow using the Lucas-Kanade Method

Objective: Implement optical flow estimation using the Lucas-Kanade method.

Micro Project: Gesture Recognition OR Object Tracking

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Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande

Programme Elective Course – 2

ET23312(C): MACHINE LEARNING

Teaching Scheme: **Theory: 03 Hours/Week** **Practical: 02 Hours/Week**	**Credits** **04**	**Examination Scheme:** **CAA:10 Marks** **In Sem:30 Marks** **End Sem:60 Marks** **Practical: 30 Marks**

Prior knowledge of

- Discrete Mathematics, Any Programming Knowledge (Python/Matlab).

Course Objectives:

The objectives of this course are to:

1. **Introduce fundamental concepts of Machine Learning** including learning paradigms, data representations, feature engineering, and bias–variance trade-offs.
2. **Develop mathematical and algorithmic understanding of regression techniques**, including optimization, regularization, and performance evaluation.
3. **Provide strong foundations in classification algorithms**, decision trees, and ensemble learning methods with appropriate evaluation metrics.
4. **Explain unsupervised learning techniques** such as clustering and dimensionality reduction for pattern discovery and data analysis.
5. **Familiarize students with Artificial Neural Networks**, learning mechanisms, and their applications in regression and classification tasks.
6. **Expose learners to deep learning concepts and Convolutional Neural Networks**, enabling understanding of modern AI applications in vision, speech, and video analytics.

Course Outcomes: On completion of the course, learner will be able to:

CO1: Explain core concepts of Machine Learning, learning paradigms, feature engineering, and analyze issues such as overfitting, underfitting, and bias–variance trade-off.

CO2: Apply regression techniques and optimization methods to model real-world problems and evaluate model performance using standard metrics.

CO3 :Design and implement classification models using supervised learning algorithms and assess their performance using appropriate evaluation metrics.

CO4: Analyze datasets using unsupervised learning methods such as clustering and dimensionality reduction to extract meaningful patterns.

CO5: Develop and train Artificial Neural Network models including perceptron and multilayer networks for regression and classification problems.

CO6: Demonstrate understanding of deep learning architectures, CNN components, and optimization techniques to solve image and signal processing problems.

Course Contents

Unit I: Introduction to Machine Learning (7 Hours)

Motivation and real-world applications of Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Semi-supervised, Reinforcement Learning; Learning framework: data, features, labels, model, loss function; Overfitting and under-fitting; Bias–variance trade-off; Feature Engineering.

Unit II: Regression Techniques (7 Hours)

Simple and Multiple Linear Regression; Non-linear regression; Gradient Descent optimization; Polynomial regression; Regularization techniques: Ridge, Lasso, Elastic Net; Bayesian Linear Regression; Evaluation metrics: MSE, RMSE, MAE, R^2; Multivariate Regression

Unit III: Classification Techniques (7 Hours)

Binary and multiclass classification problems; Logistic Regression; k-Nearest Neighbors (k-NN); Naïve Bayes Classifier; Discriminant Analysis: LDA and QDA; Decision Trees for classification; Ensemble methods (Introduction): Bagging, Boosting, Random Forest; Classification performance metrics: Confusion Matrix, Precision, Recall, F1-score, ROC.

Unit IV: Clustering and Dimensionality Reduction (6 Hours)

Unsupervised learning overview; Clustering techniques: k-Means clustering, Hierarchical clustering, Density-based clustering (DBSCAN – introduction), Gaussian Mixture Models (GMM) and EM algorithm; Dimensionality reduction techniques: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Curse of dimensionality.

Unit V: Artificial Neural Networks (6 Hours)

Biological inspiration and artificial neuron model; McCulloch–Pitts neuron; Bias, threshold, and activation functions; Learning paradigms; Error and gradient descent; Perceptron model and limitations; Multilayer Perceptron (MLP); Backpropagation algorithm; Applications of ANN in regression and classification.

Unit VI: Deep Learning and Convolutional Neural Networks (6 Hours)

Introduction to Deep Neural Networks; Challenges in deep learning: vanishing gradient, overfitting, computational complexity; Regularization techniques: Dropout, Batch Normalization; Optimization algorithms: SGD, Adam; Convolutional Neural Networks (CNN): Convolution layer, pooling layer, Padding and stride; CNN architectures overview (LeNet, AlexNet, VGG); Applications of CNNs in image, speech, and video analysis.

Text Books:

1. Christopher Bishop, – Pattern Recognition and Machine Learning, Springer, 2007.
2. Laurene Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education, Inc.

Reference Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, –The Elements of Statistical Learning, Springer.
3. Phil Kim, –MATLAB Deep Learning; With Machine Learning, Neural Networks and Artificial Intelligence, a Press 2017.
4. Ethem Alpaydin –Introduction to Machine Learning Second Edition the MIT Press.
5. Simon Haykin, Neural Networks: A comprehensive foundation, Prentice Hall International Inc.

MOOC / NPTEL Courses:

1. Deep Learning By P K Biswas, Link of the Course: https://nptel.ac.in/courses/106105215.
2. Deep Learning by IIT Ropar Prof. Sudarshan Iyengar, Link of the Course: https://nptel.ac.in/courses/106106184.
3. Deep Learning For Visual Computing, IIT Kharagpur Prof. Debdoot Sheet , Link of the Course: https://nptel.ac.in/courses/108105103

List of Practical's

Perform any 8 experiments.

1. Introduction to Python and Machine Learning libraries (NumPy, Pandas, Matplotlib, Scikit-learn)
2. Data pre-processing and exploratory data analysis

3. Implementation of Simple and Multiple Linear Regression
4. Polynomial Regression and Regularization Techniques
5. Logistic Regression for classification
6. Implementation of k-NN and Naïve Bayes classifiers
7. Decision Tree and Random Forest classifiers
8. Dimensionality reduction using PCA
9. Implementation of Artificial Neural Network using MLP.
10. Implementation of Convolutional Neural Network (CNN)
11. Mini Project using real-world Dataset (CAA Activity).

HOD E&TC	Dean Academics	Principal
Dr. J. S. Rangole	Dr. S. M. Bhosle	Dr. S. B. Lande

Head
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ET23312(D): Smart Antenna (Programme Elective Course 2)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any: Antennas and Wave Propagations

Course Objectives:

1. To understand the theory of reconfiguration antenna and smart antenna.
2. To learn DOA estimation techniques for smart antenna.
3. To understand beam forming and MIMO technology.
4. The main focus will be on the 4G, 5G and beyond needs of an antenna to improve the signal quality, power management and BW for higher data rates.

Course Outcomes: On completion of the course, the learner will be able to

CO1: Describe smart antenna systems and discuss the effects of beam steering and mutual coupling.
CO2: Classify microstrip and reconfigurable antennas and techniques.
CO3: Explain Directional arrival estimation Methods.
CO4: Explain different adaptive processing algorithms.
CO5: Classify and compare beam forming methods.
CO6: Explain the MIMO system and MIMO antenna.

Course Contents

Unit I: Smart antennas (06 Hrs.)

Introduction, Need for Smart Antennas, Overview: Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, beam steering, degree of freedom.

Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Mutual Coupling Effects, Applications.

Unit II: Microstrip and Reconfigurable Antennas (06 Hrs.)

Microstrip antenna: Introduction, feeding techniques, Fractal antenna and array.

Reconfigurable Antenna: Classification of reconfigurable antenna, reconfigurable techniques, and Multiple reconfigurable features in antenna.

Unit III: Direction Of Arrival Estimation (DOA) Methods (07 Hrs.)

Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, MUSIC algorithm – root music and cyclic music algorithm, the ESPRIT algorithm

Unit IV: Adaptive Processing (07 Hrs.)

Sample matrix inversion algorithm, unconstrained LMS algorithm, normalized LMS algorithm, Constrained LMS algorithm, Perturbation algorithms, Neural network approach, Adaptive beam space processing,

Implementation issues.

Unit V: Beam Forming Methods (08 Hrs.)

Classical Beam former, Statistically Optimum Beam-forming Weight Vectors, Maximum SNR Beam former, Multiple Side lobe Canceler and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beam forming

Unit VI: MIMO Antennas (06 Hrs.)

Introduction, Principles of MIMO systems: SISO, SIMO, MISO MIMO, Hybrid antenna array for mm Wave, massive MIMO: concept and applications.

Text Books:

1. C.A. Balanis "Antenna Theory: Analysis and Design", 4th Edition, John Wiley & Sons.
2. Lal Chand Godara, "Smart Antennas", CRC Press, LLC-20.
3. Ahmed El Zooghby, "Smart Antenna Engineering", ARTECH HOUSE, INC.

Reference Books:

1. C.A. Balanis, "Introduction to Smart Antennas", John Wiley & Sons.
2. Mohammod Ali, "Reconfigurable antenna Design and Analysis", Publisher: Artech House
3. George Tsoulos," MIMO system technology for wireless communications", CRC- Taylor & Francis.
4. Long Zhao, Hui Zhao, Kan Zheng, Wei Xiang, "Massive MIMO in 5G Networks: Selected Applications", Springer.
5. Jian Li and Petre Stoica, "Robust adaptive Beam forming", John Wiley.

List of Experiments

Design and simulate the antennas using EM simulation software HFSS/CST MW/ MATLAB or any other equivalent simulation software

1. Design and simulate the microstrip patch antenna.
2. Design and simulate the radiation pattern of the reconfigurable antenna.
3. Design and simulate polarization reconfigurable antenna.
4. Design and simulate linear n-element array antennas.
5. Design and simulate planar n element array antenna.
6. Design and simulate the MIMO antennas.
7. Simulation of Direction arrival estimation methods.
8. Simulation of beam forming algorithms of phase array antenna.
9. Simulation of adaptive processing algorithms.
10. Simulation of reflecting Intelligence surfaces.

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Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande

ET23313(A): Internet of Things (IoT) (Programme Elective Course 3)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any:

1. Digital Systems
2. Microcontrollers

Course Objectives:

1. Understand IoT Fundamentals – Introduce the basic concepts, key components, and working principles of IoT, including sensors, actuators, and networking.
2. Analyze IoT Architecture – Explore architectural frameworks, design principles, and essential standards in IoT, including M2M communication and XaaS models.
3. Examine IoT Communication Protocols – Study wireless technologies and IP-based communication protocols that support IoT connectivity and interoperability.
4. Develop IoT Solutions – Provide hands-on experience with IoT boards, programming, sensor interfacing, and communication methods such as Bluetooth, WiFi, and USB.
5. Apply IoT in Industrial Settings – Investigate IIoT applications, industrial network design, and the role of legacy and modern communication protocols in the industry.
6. Explore IoT Applications and Cloud Integration – Understand real-world IoT applications in smart cities, home automation, and cloud-based IoT solutions.

Course Outcomes: On completion of the course, the learner will be able to

CO1: Explain fundamental IoT concepts, including sensors, actuators, and networking principles.

CO2: Analyze IoT architecture, design aspects, and M2M communication frameworks.

CO3: Compare and evaluate wireless communication protocols (Zigbee, BLE, MQTT, CoAP, etc.) for IoT applications.

CO4: Implement IoT-based solutions using microcontrollers, sensors, and communication modules.

CO5: Assess industrial IoT applications and design methodologies for low-power and legacy network protocols.

CO6: Develop IoT applications using cloud-based storage, data analytics, and management tools.

Course Contents

Unit I: Overview of IOT (06 Hrs.)

Definitions, Types of sensors, Types of Actuators, Example and Working, Networking Basics, RFID Principles and components, Wireless Sensor Networks, Definition, and characteristics of an IoT, Physical Design of an IoT, Logical design of IoT, Communication Models, Communication API's, What is the IoE? Difference between IoT and IoE, Pillars of the IoE, Connecting the Unconnected, Transitioning to the IoE, Bringing it all together.

Unit II: Architecture Design Aspects of IoT(06 Hrs.)

IoT-An- An Architectural Overview, building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Unit III: Wireless Technologies and IP-based protocols supporting IoT (06 Hrs.)

IEEE 802.15.4, Zigbee, Wireless HART, ZWave, Bluetooth Low Energy, RFID, RFID Protocols.

Zigbee & IoT Network Layer Protocols-IPv4, IPv6, 6LoWPAN, RPL, REST, AMPQ, CoAP, MQTT, comparison of Bluetooth and BLE, CoAP and MQTT.

Unit IV: Interfacing and Programming (06 Hrs.)

Introduction to IoT Boards, Interfacing with IoT Boards, IoT deployment for Raspberry Pi /Arduino/Equivalent platform – Reading from Sensors, Communication: Connecting microcontroller with mobile devices – communication through Bluetooth, WiFi and USB - Contiki OS- Cooja Simulator.

Unit V: Industrial IoT (07 Hrs.)

Introduction, Key IIOT technologies, Catalysts, and precursors of IIoT, Innovation and the IIoT, Applications of IIoT Examples: Healthcare, Oil and Gas Industry, Logistics and the Industrial Internet, Retail applications, IoT innovations and design methodologies, Industrial Internet Architecture Framework (IIAF): Control domain, operational domain and application domain, Three tier topology, Design of low power device network, legacy industrial protocols, Bluetooth, Zigbee IP, Z-wave, Wi-Fi backscatter in IIoT design.

Unit VI: Applications of IoT (08 Hrs.)

Home automation, smart cities, Various real-time applications of IOT- Connecting IOT to cloud – Cloud Storage for IOT, Data Analytics for IOT – Software & Management Tools for IOT. Industrial IOT.

Text Books:

1. Ovidiu Vermesan, Peter Fresiss, "Internet of Things" From research and innovation to market Deployment", River Publishers series in Communication, USA.
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley Publications.
3. **Reference Books:**
4. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication
5. Internet of Things: Case Studies, Libelium Inc, White papers, Spain http://www.libelium.com/resources/case-studies
6. Useful Links for IoT Applications and Use Cases:

- http://52.16.186.190/resources/case-studies/
- https://pressbooks.bccampus.ca/iotbook/chapter/iot-use-cases/
- https://research.aimultiple.com/iot-applications/
- https://www.jigsawacademy.com/101-applications-of-iot/
- https://www.youtube.com/watch?v=xmt6OCBeS94

List of Experiments

1. Study of Raspberry Pi, Beagle board, Arduino, and different operating systems for Raspberry Pi / Beagle board/Arduino. Understanding the process of OS installation on Raspberry Pi/Beagle board/Arduino
2. Open-source prototype platform- Raspberry Pi/Beagle board/Arduino -Simple program digital read/write using LED and Switch -Analog read/write using sensor and actuators.
3. Interfacing sensors and actuators with Arduino/Raspberry Pi.
4. IoT-based Stepper Motor/DC Motor Control with Arduino/Raspberry Pi.
5. Introduction to MQTT/ CoAP and sending sensor data to the cloud using Raspberry Pi/Beagle board/ Arduino.
6. Get the status of a bulb at a remote place (on the LAN) through the web.
7. Interfacing Arduino to Bluetooth Module.
8. Communicate between Arduino and Raspberry PI.
9. IoT-based small project implementation on the topics based on small problem statements of the fields like chatbot, smart home (Home Automation), social issues and environmental issues etc. This project can be built on any IoT simulation platform like Tinkercad, Cooja etc.

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Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande

ET23313(B): Cyber Security (Programme Elective Course 3)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any:--

Course Objectives:

1. Cyber Security Awareness: Students will be able to identify and explain key cyber security concepts, risks, and threats.
2. Cryptography Application: Students will apply symmetric and asymmetric cryptography techniques for securing communications.
3. Network Security Implementation: Students will implement security measures such as firewalls, VPNs, and intrusion detection systems.
4. Vulnerability and Risk Management: Students will identify and propose safeguards for common security vulnerabilities in systems and networks.
5. Malware Prevention and Analysis: Students will analyze and prevent malware using relevant security tools and techniques.
6. Security in Emerging Technologies: Students will secure mobile, IoT, and web applications, addressing modern security challenges.

Course Outcomes: On completion of the course, the learner will be able to

CO1: Understand fundamental cyber security concepts, including common cyber risks, breaches, attacks, and exploits, and learn about techniques like footprinting and scanning.

CO2: Gain proficiency in cryptography techniques, including symmetric and asymmetric key encryption, digital signatures, and their applications in securing communications.

CO3: Explore network security principles, including server and OS security, vulnerability management, and intrusion detection and prevention techniques.

CO4: Analyze cyber security vulnerabilities across platforms and networks, and identify safeguards for mitigating threats such as weak authentication, open access, and poor cyber security awareness.

CO5: Study different types of malware (e.g., viruses, worms, ransomware) and understand their impact on systems, along with techniques for prevention, analysis, and system hardening.

CO6: Investigate the evolving landscape of security challenges in mobile computing, IoT, and web services, with an emphasis on securing applications and identity management.

Course Contents

Unit I: Cyber Security Concepts

Cyber Risks, Breaches, attacks, Exploits, Social Engineering, footprinting, Scanning, etc.

Unit II: Cryptography and Cryptanalysis

Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security.

Unit III: Infrastructure and Network Security

Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Introduction to Intrusion Detection and Prevention Techniques, Host-based Intrusion Prevention Systems, Security Information Management,

Unit IV: Cyber Security Vulnerabilities & Safeguards

Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness.

Unit V: Malware

Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System Tuning Tools, Anti Phishing.

Unit VI: Security in Evolving Technology

Biometrics, Mobile Computing and Hardening on Android and iOS, IOT Security, Web server configuration and Security. Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST, etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, and Challenges.

Text Books/ Reference Books:

1. Jeeva Jose & Vijo Mathew, Introduction to Security of Cyber-Physical Systems, Khanna Book Publishing Company, 2023.
2. William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.
3. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
4. Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
5. Atul Kahate, "Cryptography and Network Security", McGraw Hill.
6. V.K. Pachghare, "Cryptography and Information Security", PHI Learning

MOOC / NPTEL Courses:

1. NPTEL Course on "Industrial Automation and Control" by Prof. S. Mukhopadhyay, IIT Kharagpur.
Link: https://nptel.ac.in/courses/108105088

List of Experiments

Lab 1: Cyber Security Tools Exploration

Objective: Familiarize students with tools for foot printing, scanning, and reconnaissance.

- Task: Use Nmap to scan a network and identify open ports and services.

Lab 2: Symmetric and Asymmetric Cryptography

Objective: Apply symmetric (AES) and asymmetric (RSA) encryption for secure communication.

- Task: Encrypt and decrypt messages using AES and RSA in Python.

Lab 3: Configuring Firewalls for Network Protection

Objective: Understand and configure firewalls to secure a network.

- Task: Set up basic firewall rules using iptables on a Linux system.

Lab 4: Network Security and Packet Sniffing

Objective: Learn network sniffing and security monitoring techniques.

- Task: Capture and analyze network traffic using Wireshark to identify suspicious packets.

Lab 5: Intrusion Detection and Prevention

Objective: Explore intrusion detection and prevention techniques.

- Task: Configure Snort IDS and analyze network traffic for potential attacks.

Lab 6: Malware Analysis and Detection

Objective: Analyze and detect various types of malware.

- Task: Use Cuckoo Sandbox to analyze a malware sample in a controlled environment.

Lab 7: Operating System and Server Hardening

Objective: Implement security measures to protect operating systems and servers.

- Task: Harden a Linux server by disabling unnecessary services and applying security patches.

Lab 8: Vulnerability Assessment and Penetration Testing

Objective: Perform vulnerability scanning and penetration testing on systems.

- Task: Use Nessus to scan a machine for vulnerabilities and generate a report.

Lab 9: Securing Web Applications

Objective: Secure web applications by implementing basic security measures.

- Task: Install an SSL certificate on an Apache web server and enable HTTPS.

Lab 10: IoT and Mobile Device Security

Objective: Secure IoT devices and mobile applications.

- Task: Secure an IoT device by configuring strong Wi-Fi encryption and firmware updates.

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ET23313(C): PLC SCADA and Automation (Programme Elective Course 3)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any:

1. Control Systems.
2. Power Devices and Circuits.

is essential.

Course Objectives:

1. Understanding and recognising industrial control problems.
2. Concept of PLCs and Its Importance in Industrial Automation.
3. Development of Ladder Programming in PLC and PLC Interface in real-time applications.
4. Overview of technology of advanced automation Systems such as SCADA, DCS Systems.
5. Learning of CNC fundamentals and Important Protocols in Industrial Automation.

Course Outcomes: On completion of the course, the learner will be able to

CO1: Understand and Recognize Industrial Control Problems.
CO2: Analyze & explain different hardware functions of PLC.
CO3: Develop Ladder Programming in PLC and PLC Interface in real-time applications.
CO4: Explore and interpret the functionality of SCADA.
CO5: Identify and interpret the functionality of Distributed Control Systems (DCS).
CO6: Define and explain CNC machines and Applications of Industrial Protocols.

Course Contents

Unit I: Elements of Process Control Automation (07 Hrs.)

Process control principles, Control System Evaluation, Analog control, Digital control, Architecture of Industrial Automation Systems (Automation Pyramid), Advantages and limitations of Automation, Concept and Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Concept of VFD, Energy conservation schemes through VFD.

Unit II: Fundamentals of PLC (06 Hrs.)

Architecture of PLC- Types of PLCs, Applications of PLC's, PC v/s PLC, Different Modules, Power Supply Unit etc. Need of PLC, Different Types of Sensors- Sinking, Sourcing. Operation and function. Monitoring of Process through Sensors- Connection Details. Analog Addressing, Continuous Process Monitoring and Control.

Unit III: Programming of Programmable Logic Controllers (07 Hrs.)

PLC programming, NO/ NC Concept, Ladder diagram: of logic gates, arithmetic instructions, multiplexer,

Ladder diagram for different logical conditions or logical equations or truth table. Timers: types of timer, Characteristics, Function of timer in PLC, Classification of a PLC timer, Ladder diagram using timer, PLC counter, Ladder diagram using counter. PLC Programming of Branded PLCs. Concept of P, PI, PD, PID w.r.t. PLC, Data File Handling- Forcing I/O.

Unit IV: Supervisory Control and Data Acquisition Systems (SCADA) (06 Hrs.)

Concept of SCADA, Architecture of SCADA, Components of SCADA Systems, MTU- functions of MTU, RTU- Functions of RTU, Directly interact with devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software. Working of SCADA, Applications of SCADA in Industrial Automation like Oil and gas, Power etc.

Unit V: Distributed Control Systems (DCS) (06 Hrs.)

Basic Concept of DCS, History and Hierarchy of DCS, Basic Components of DCS as Operator Station, Control Module, and I/O module, Types of DCS, Need of DCS, Functions of each level, Advantages and Disadvantages, Applications of DCS such as Water Treatment Plant, Comparison of PLC, DCS and SCADA.

Unit VI: CNC Machines and Industrial Protocols (06 Hrs.)

Introduction of CNC Machines, Basics and need of CNC machines, NC, CNC and DNC (Direct NC) systems, Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines. Industrial Communication: Devicenet, Foundation Fieldbus, PROFIBUS, MODBUS, Ethernet, TCP/IP, Concept of Industry 4.0.

Text Books:

1. Curtis Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson Education.
2. Madhuchhanda Mitra, Samarjit Sen Gupta, "Programmable Logic Controllers and Industrial Automation", 2nd Edition, Penram International Publishing India Pvt. Ltd.

Reference Books:

1. Stuart A. Boyer, "SCADA Supervisory Control and Data Acquisition", 4th Edition, ISA Publication.
2. John W. Webb, Ronold A Reis, "Programmable Logic Controllers, Principles and Applications", 5th Edition, Prentice Hall of India Pvt. Ltd.
3. Kilian, "Modern control technology: components & systems", 2nd Edition, Delmar.
4. Bela G Liptak "Process Software and Digital Networks", 4th Edition, CRC Press
5. Pollack. Herman, W & Robinson., T. "Computer Numerical Control", Prentice Hall.
6. Pabla, B.S. &Adithan, M. "CNC Machines", New Age Publishers.
7. R.G. Jamkar, "Industrial Automation Using PLC SCADA & DCS" Global Education Limited

MOOC / NPTEL Courses:

1. NPTEL Course on "Industrial Automation and Control" by Prof. S. Mukhopadhyay, IIT Kharagpur. Link: https://nptel.ac.in/courses/108105088

List of Experiments

Lab 1: Introduction to Process Control Systems

Objective: Demonstrate analog and digital control systems. **Task:** Simulate and compare a temperature control loop using both systems.

Lab 2: Signal Standardization and Transmitters

Objective: Learn about signal standardization and transmitter configurations.

Task: Implement signal conversion between 4-20mA and 0-10V standards.

Lab 3: VFD and Energy Conservation

Objective: Understand VFD operation and its energy-saving capabilities.

Task: Control motor speed with a VFD and demonstrate energy conservation.

Lab 4: PLC Basics and Module Identification

Objective: Understand PLC architecture and types.

Task: Identify and explore different PLC components and modules.

Lab 5: PLC Sensors and Module Configuration

Objective: Learn sensor integration with PLC.

Task: Connect sinking and sourcing sensors and read PLC input/output.

Lab 6: Ladder Logic Programming

Objective: Create ladder logic programs for logical conditions.

Task: Implement ladder diagrams for AND, OR, NOT gates and truth tables.

Lab 7: Timers and Counters in PLC

Objective: Use timers and counters in PLC programming.

Task: Program timers (TON, TOF) and counters in a ladder logic.

Lab 8: SCADA System Simulation

Objective: Understand SCADA architecture and operation.

Task: Set up a SCADA system with HMI and RTU for process monitoring.

Lab 9: SCADA Applications in Industrial Automation

Objective: Explore SCADA applications in industrial processes.

Task: Implement a SCADA system for process control like water treatment.

Lab 10: DCS System Configuration

Objective: Learn DCS components and hierarchy.

Task: Set up a DCS system with operator stations and I/O modules for a simulated process.

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ET23313(D): Remote Sensing (Programme Elective Course 3)

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Sem: 30 Marks End Sem: 60 Marks Practical: 30 Marks

Prerequisite Courses, if any:

Course Objectives:

1. To introduce the basic principles of remote sensing.
2. To be familiar with Indian space missions and satellite sensor characteristics.
3. To know the different types of satellite data products, visual interpretation and basics of digital processing of satellite images.
4. To provide exposure of the global navigation satellite system and its application.
5. To understand the underlying concepts of microwave and lidar remote sensing

Course Outcomes: On completion of the course, the learner will be able to

CO1: Describe the concepts of remote sensing and electromagnetic radiation interaction.
CO2: Explain the sensor's characteristics and analyze its resolution.
CO3: Classify different types of satellite data products and design various color composites.
CO4: Describe the fundamentals of microwave remote sensing.
CO5: Analyze GNSS signal structure and augmentation systems.
CO6: Demonstrate and describe real-life applications of remote sensing.

Course Contents

Unit I: Principles of Remote Sensing (07 Hrs.)

Basic principles of Remote Sensing, Data and Information, Remote Sensing Data Collection, Types of Remote Sensing- Active and Passive remote sensing; Advantages and Limitations of Remote Sensing, Electromagnetic Energy- Electromagnetic Spectrum, Interaction of EMR: Interaction with Earth's Atmosphere and Atmospheric window, Spectral Signature: Interaction with Soil, Water and Vegetation.

Unit II: Satellite Sensors and Resolution (07 Hrs.)

Types of Remote Sensing Platforms, Types of Satellite Orbits - Geosynchronous and Geostationary, Polar and sun-synchronous orbit, low earth, medium earth, highly elliptical orbits, Recent Trends in Remote sensing Earth Observation data, Indian & Global Space Missions: Indian & Global Satellites and Sensors Characteristics, Satellite Resolution: Spatial, Temporal, Spectral, Radiometric; Differences between

Multispectral and Hyperspectral remote sensing.

Unit III: Satellite Data Products & Processing (07 Hrs.)

Satellite Data Analysis: Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections - Basic Principles of Visual Interpretation, Equipment for Visual Interpretation, Ground Truth; Color Composite: False and True Color Composite; Image enhancements; Classifications - Supervised and Unsupervised, Normalized satellite Indices - NDVI, NDWI, GDVI, NDSI etc. Remote Sensing Data Sources: USGS, Bhuvan, ESA, Sentinel etc.

Unit IV: Active Remote Sensing (06 Hrs.)

Microwave Remote Sensing: Active and Passive Systems, Advantages, Platforms and Sensors, Microwave Radiation and Simulation, Principles of Radar – Resolution, Range, Angular Measurements, Microwave Scattering, Imagery – characteristics and Interpretation; Definitions of LiDAR - Concepts and its applications.

Unit V: GNSS Technology (06 Hrs.)

Introduction of GNSS Technology: GNSS Signal Structures, GNSS Vulnerabilities, GNSS Applications, GNSS Market and Business, Indian Regional Navigation Satellite System (IRNSS), Ground Based Augmentation Systems, Space Based Augmentation Systems - GAGAN; Principles of satellite positioning - Principle of Satellite Positioning, GNSS Orbits, Navigation Message Details; Positioning Errors, Data Formats, Location-Based Services (LBS), Tools for GNSS data processing.

Unit IV: Applications of Remote Sensing (06 Hrs.)

Applications of Remote Sensing: Environmental and Disaster, Coastal and Near Shore, Forest and Agriculture, Water Resource, Urban Planning and Management, Land Use and Land Cover Analysis.

Text Books:

1. John A. Richards, "Remote Sensing Digital Image Analysis - An Introduction" 5th Edition, Springer-Verlag Berlin Heidelberg.
2. Joseph, G., "Fundamentals of Remote Sensing", Universities Press.
3. Roy. P.S., Dwivedi. R. S., "Remote Sensing Application", Published by NRSC ISRO Hyderabad.

Reference Books:

1. Liu, J.-G., & Mason, P.J. "Image Processing and GIS for Remote Sensing: Techniques and Applications", 2nd Edition, Wiley-Blackwell.
2. Sabins, F. F.,"Remote Sensing: Principles and Interpretation", 4th Edition, Waveland Pr. Inc.
3. Navalgund, R. R. Ray, S. S., "Hyperspectral Data, Analysis Techniques Application", Indian Society of Remote Sensing.
4. Lillesand, T. M., Kiefer, R. W., Chipman, J. W., "Remote Sensing and Image Interpretation", 7th Edition, John Wiley & Sons.
5. Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, Elmar Wasle, "GNSS - Global Navigation Satellite Systems: GPS, GLONASS, Galileo, and more", Springer.
6. Pinliang Dong, Qi Chen," LiDAR Remote Sensing and Applications", 1st Edition CRC Press.

MOOC / NPTEL Courses:

1. NPTEL Course "Remote Sensing: Principal and Application", by Prof. Eswar Rajasekaran, IIT Bombay Link of the Course: https://nptel.ac.in/courses/105101206
2. NPTEL Course "Remote Sensing Essentials", by Dr. Arun.K.Saraf, IIT Roorkee Link of the Course: https://nptel.ac.in/courses/105107201
3. NPTEL Course "Global Navigation Satellite Systems and Applications", by Dr. Arun.K.Saraf, IIT Roorkee Link of the Course: https://nptel.ac.in/courses/105107194

List of Experiments

Lab 1: Visualize the electromagnetic spectrum and spectral signatures of Earth surfaces using Python.

Lab 2: Simulate and visualize different satellite orbits and resolution effects on remote sensing data using MATLAB.

Lab 3: Import multispectral satellite images and create true and false color composites for visual interpretation using Python.

Lab 4: Perform radiometric correction and enhance satellite image contrast using MATLAB.

Lab 5: Calculate NDVI and perform supervised and unsupervised classification on satellite data using Python.

Lab 6: Simulate microwave scattering and radar backscatter with varying surface roughness using Python.

Lab 7: Process LiDAR point cloud data to generate a Digital Elevation Model (DEM) and visualize in 3D using MATLAB.

Lab 8: Simulate GNSS data with errors and compute position errors using Python.

Lab 9: Compare classified satellite images with ground truth data and compute the confusion matrix using MATLAB.

Lab 10: Analyze remote sensing data for land cover classification and urban planning applications using MATLAB.

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HS23311: Environmental Studies

Teaching Scheme: Theory: 02 Hours/Week	Credits 02	Examination Scheme: Activity: 10 Marks End sem: 60 Marks

Prerequisite Courses, if any:

Course Objectives:

The course is aimed to:

1. Understand the fundamental concepts of environmental science and its relevance to engineering.
2. Analyze the environmental impact of various engineering industries.
3. Learn about sustainable engineering practices, pollution control, and waste management.
4. Study environmental laws in India and global initiatives for environmental conservation.
5. Explore corrective measures and preventive technologies for mitigating environmental damage.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Gain an understanding of environmental issues related to engineering industries.

CO2: Analyze the impact of engineering industries on the environment

CO3: Learn sustainable engineering solutions for mitigating environmental damage.

CO4: Be aware of Indian and global initiatives for environmental protection

CO5: Develop a sense of responsibility towards environmental conservation in their professional field.

Course Contents

Unit I: Introduction to Environmental Studies (06 Hrs.)

Importance of Environmental Studies, Components of the Environment: Atmosphere, Hydrosphere, Lithosphere, and Biosphere, Ecosystems and Biodiversity: Types, Importance, and Conservation, Sustainable Development Goals (SDGs) and Role of Engineers in Sustainability, Renewable and Non-Renewable Resources, Water Resources: Overuse, Pollution, and Engineering Solutions, Energy Resources: Fossil Fuels, Nuclear Power, and Renewable Energy Alternatives, Land Resources: Soil Degradation, Deforestation, and Urbanization.

Unit II: Impact of Engineering Industries on Environment (07 Hrs.)

Manufacturing & Automobile Industry: Air pollution, Carbon emissions, Waste disposal, Chemical & Pharmaceutical Industry: Water and soil contamination, Hazardous waste, Construction & Infrastructure: Land degradation, Dust pollution, Waste generation, Electronics & IT Industry: E-waste, Energy consumption, Semiconductor waste, Power Generation (Thermal, Hydropower, Nuclear): Pollution, Waste heat, Radiation hazards, Causes and Effects of Climate Change, Global Warming and Greenhouse Effect.

Unit III: Engineering Solutions for Environmental Mitigation and Sustainable Practices (07 Hrs.)

Carbon Capture and Storage (CCS), Green Chemistry & Eco-friendly Materials, Sustainable Design & Life Cycle Assessment (LCA), Energy-efficient Technologies & Smart Grids, Case Studies on Successful

Pollution Reduction Waste Management Strategies: Solid Waste and Biomedical Waste Management, E-Waste: Sources, Impact, and Recycling, Hazardous Waste Handling and Treatment, Circular Economy and Zero-Waste Technologies Sustainable Engineering Practices: Renewable Energy Technologies (Solar, Wind, Biomass, Hydropower) Green Buildings and Sustainable Architecture, Electric Vehicles and Smart Transportation Systems, Sustainable Agriculture and Water Conservation Technologies.

Unit IV: Environmental Initiatives in India and Worldwide (06 Hrs.)

National Initiatives: Swachh Bharat Abhiyan, Namami Gange, National Green Tribunal (NGT), Corporate Social Responsibility (CSR) & Environmental Compliance, Environmental Activism and the Role of NGOs, Environmental Laws and Policies in India, The Environmental Protection Act, 1986, Role of Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCB), International Environmental Agreements (Kyoto Protocol, Paris Agreement, COP Summits), Global Initiatives: UNEP, IPCC, World Bank Environmental Policies.

Text Books:

1. Benny Joseph, Environmental Studies, McGraw Hill Education, 3rd Edition, 2021.
2. Anubha Kaushik & C.P. Kaushik, Environmental Studies, New Age International Publishers, 5th Edition, 2022.

Reference Books:

1. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 3rd Edition, 2021.
2. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, University Press, 3rd Edition, 2021.
3. Suresh K. Dhameja, Environmental Science and Engineering, S.K. Kataria & Sons, 2nd Edition, 2020.

Additional Reports & Resources:

1. Government of India - Ministry of Environment, Forest & Climate Change (MoEFCC) Reports (Website)
2. United Nations Environment Programme (UNEP) Reports (Website)
3. IPCC Climate Change Reports (Website)
4. Central Pollution Control Board (CPCB) Reports (Website)

List of Activities

Unit 1: Introduction to Environmental Studies

- Ecosystem Study Report – Visit a local park, water body, or forested area and document its ecosystem components (flora, fauna, and food chains).
- Sustainability Case Study – Choose one of the Sustainable Development Goals (SDGs) and prepare a report on its implementation in India.
- Renewable vs. Non-Renewable Resources – Prepare a comparative chart listing sources, usage, and sustainability factors.
- Water Conservation Survey – Conduct a survey in your neighborhood or campus to assess water consumption and suggest conservation strategies

Unit 2: Impact of Engineering Industries on Environment

- Industrial Impact Assessment – Select an engineering industry (automobile, chemical, IT, etc.) and analyze its environmental impact
- Carbon Footprint Calculation – Calculate the carbon footprint of your daily activities (electricity, transportation, food, etc.) and suggest ways to reduce it.
- Climate Change Awareness Video – Create a short video (2–3 min) explaining global warming and its impact.
- Case Study on Pollution Control Failures – Research a real-world incident of industrial pollution (e.g., Bhopal Gas Tragedy, Minamata Disease) and analyze the causes and consequences

Unit 3: Engineering Solutions for Environmental Mitigation and Sustainable Practices

- Waste Management Audit – Conduct a waste audit in your college or home, classify the waste generated, and propose a waste management plan.
- E-Waste Collection Drive – Organize a drive to collect and safely dispose of e-waste in your locality. Submit a report on the amount collected and its disposal method.
- Renewable Energy Model – Create a working or conceptual model of a solar panel, wind turbine, or biomass plant.
- Green Building Analysis – Identify a green building in your city (or college) and analyze its energy-efficient features.

Unit 4: Environmental Initiatives in India and Worldwide

- Report on National Environmental Policies – Summarize key environmental laws in India and their effectiveness.
- International Climate Agreements Presentation – Prepare a presentation on major agreements like the Paris Agreement, Kyoto Protocol, and their impact on India.
- NGO/CSR Initiative Study – Research an NGO or corporate social responsibility (CSR) initiative focused on environmental protection and prepare a report.
- Swachh Bharat Implementation Review – Visit a local area, document cleanliness conditions, and suggest improvements under Swachh Bharat Abhiyan

Evaluation Criteria (10 Marks Total)

1. Depth of Research & Analysis (3 Marks)
2. Presentation & Clarity (3 Marks)
3. Creativity & Practical Application (2 Marks)
4. Timely Submission (2 Mark)

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ET23314: Skill Development

Teaching Scheme:	Credits	Examination Scheme:
Practical: 04 Hours/Week	02	Activity: 10 Marks Term work: 30 Marks Oral: 30 Marks

Prerequisite Courses, if any:

1. Basics of Electronics Components
2. Working of Operational amplifier
3. Basics of Electronics measurement

is essential.

Course Objectives:

The course is aimed to:

1. To build and upgrade the practical knowledge of an individual.
2. To make students Employable with the required skill set.
3. To promote youth work to assist the "Make in India" initiative.
4. To grow and build confidence among students on specific skill sets.
5. To cultivate an Entrepreneurial mindset after getting the required experience.
6. To improve professional skills such as morals/ethics/teamwork/communication skills/lifelong learning etc.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Students should recognize the need to engage in independent and life-long learning in required skill sets

CO2: Student needs to experience the impact of industries on society by visiting different industries and understanding the importance of industrial products for analog and digital circuits and systems.

CO3: The student has to make use of modern electronic and IT Engineering Tools and Technologies for solving electronic engineering problems.

CO4: Students would be able to communicate effectively at different technical and administrative levels.

CO5: Students will exhibit leadership skills both as an individual and as a member of a team in a multidisciplinary environment.

List of Laboratory Experiments

Group A (Any Three)

1. Testing /Measurement/Calibration/Troubleshooting/Maintenance/Installation

Case studies on Study, Testing and maintenance of Batteries.

A. Apply skill sets mentioned in #Group A Skills 1 and may be covered as per availability of lab or

equipment's.

OR

B. Apply Skill sets mentioned in #Group A Skills 1 may be covered by visiting any Automobile service centers/Battery maintenance service centers or related industries.

Note: Batteries of e-Vehicle & Technology Involved (Lithium Batteries, etc.)

2. **Case study on Automotive Electronics. (Sensors, Clusters, Controls, Semiconductor devices etc.)**

A. Apply the Skill set mentioned in #Group A Skills 1 and Group A Skills 2, which is related to automotive electronics may be covered as per the availability of lab or equipment.

OR

B. Apply Skill sets mentioned in #Group A Skills 1 may be covered by visiting any Automobile service centers or related industry.

3. **Case Study on Biomedical Instrumentation**

   A. Apply the Skillset mentioned in #Group A Skills 3, which is related to automotive electronics may be covered as per the availability of lab or equipment.

   OR

   B. Visit biomedical instrument maintenance service centers.

   OR

   C. Visit Hospitals or related industries.

Note: Students are expected to know about sensor technology / Interface/maintenance/ calibration of electronic instrumentation of some of this equipment.

4. **Troubleshooting and maintenance of PCB Boards &Controllers**
5. **Troubleshooting and maintenance of Power supply**

Group B (Any Two)

Software / Hardware Design

1. **Design and simulate DC-DC boost converter for battery-based applications**

   Design a conventional DC-DC boost converter to step up the battery voltage of 5 V to 10 V. Draw the circuit diagram and find the required value of duty ratio. Implement the circuit in open-source TINA software. Plot the graphs of output voltage and PWM signal with respect to time.

2. **Design a web page(s)**

   A. Using different text formatting tags

   B. With links to different pages and allow navigation between pages

   C. With Images, tables and frames

   D. Using style sheets to maintain a uniform style for all web pages

   E. Using a form that uses all types of controls.

   F. Validate all the controls placed on the form using JavaScript.

   Note: Use maximum above points while designing Web page.

3. **SMPS Design**

   A. Design and Simulate of SMPS of 24 V @ 1A.

   OR

   B. Design, simulate and Implement buck converter using ICs like LM3842 / LM 3524 and measure performance parameters like

      1. Load regulation
      2. Line regulation
      3. Ripple rejection
      4. Output impedance and
      5. Dropout voltage.
      6. Note: Hardware-based assignments:

   Note: EDA tool (NI Multisim/ORCAD/PSPICE / Altium Designer suite, etc.)

4. **Design and simulate DC-DC boost converter for battery-based applications.**

Design a conventional DC-DC boost converter to step up the battery voltage of 5 V to 10 V. Draw the circuit diagram and find the required value of duty ratio. Implement the circuit in open-source TINA software. Plot the graphs of output voltage and PWM signal with respect to time.

5. **Design and Simulate PID Controller based on OP-AMP.**

Design an analog PID controller to track a reference voltage of 5 V in a circuit. Draw the circuit diagram of the controller and implement the circuit in open-source TINA software. Change the reference voltage to 10 V and show that the circuit can still track this changed reference voltage. Show the effect of 3 controller gains viz. proportional gain, integral gain and derivative gain on the output response.

Group C (Compulsory)

Industrial Visit (Practical Visit)

1. Industrial visit to Maintenance /Calibration/ service department of Electronics industry /Hospitals /Service centers etc. Students should visit related fields and submit reports in a predefined format.
2. Industrial visit to the software industry to understand the different processes and skills required as a software professional engineer

Group D (Compulsory)

Documentation/Specification /Manual

1. Study of documentation/specification /Manual/SOP

Note: Based on the group B assignment, students need to prepare a user manual / SOP and make an effective presentation.

Reference Books:

1. Ron Lenk, "Practical design of Power Supplies", John Wiley & Sons, 2005.
2. Abraham I. Pressman," Switching Power Supply Design", McGraw-Hill, 3rd Edition, 2009.
3. Khandpur R.S., "Biomedical Instrumentation", TMH, 3rd Edition.
4. W Bosshart, "Printed Circuit Boards - Design & Technology", Tata McGraw Hill, 1st Edition.
5. D.Patranabis, "Principles of Industrial Instrumentation", TMH Publishing Co., 2nd Edition, 2008
6. R.K. Jain, "Mechanical and Industrial Measurement", Khanna Publishers, New Delhi, 11th Edition.
7. L.D. Goettsche, "Maintenance of Instruments and systems – Practical guides for measurement and control", International Society for Automation, 2nd Edition.
8. Henry W. Ott, "Noise Reduction Techniques in Electronic Systems", John Wiley & Sons, USA, 2nd Edition.
9. Kim R Fowler, "Electronic Instrument Design", Oxford University Press, 1st Edition.
10. Jiuchun Jiang, And Caiping Zhang, "Fundamentals and Applications of Lithium-Ion Batteries In Electric Drive Vehicles", Wiley Publication, 1st Edition.
11. Web Technologies: Black Book, 2018, Dreamtech Press (1 January 2018), ISBN-10: 9386052490, ISBN-13: 978-9386052490
12. Jennifer Robbins, "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", Shroff/O'Reilly, 5th Edition.
13. Thomas Powell, "Web Design: The complete Reference", Tata McGraw Hill, 2nd Edition.

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HS23312: Democracy, Election, and Governance (Audit Course)

Teaching Scheme: Theory: 01 Hour/Week	Credits: --	Examination Scheme: CAA: -- End Sem: --

Course objectives:

This course is intended to:

- Analyze the structure and role of democratic institutions
- Understand the electoral process and the role of the Election Commission of India,
- Study the framework of governance in India, covering the executive, legislative, and judicial branches at both central and state levels.

Course outcome (Course Skill Set)

Upon completion of this course, students will be able to:

CO1: Explain the evolution and significance of democracy in India, its core principles, and its role in nation-building.

CO2: Describe the composition, powers, and functions of the Election Commission of India and understand the electoral process.

CO3: Interprete the governance structures at the Union and State levels, covering executive, legislative, and judicial functions.

Unit I: Democracy in India

Evolution of Democracy, Dimensions of Democracy: Social, Economic and Political, Decentralisation: Grassroots Level Democracy, Challenges before Democracy: women and marginalized sections of the society

Unit II: Election

Election Commission of India- composition, powers and functions, and electoral process. Types of emergency grounds, procedure, duration, and effects. Amendment of the constitution- meaning, procedure, and limitations.

Unit III: Governance

Union Executive- President, Vice-president, Prime Minister, Council of Ministers. Union Legislature-Parliament and Parliamentary proceedings. Union Judiciary- Supreme Court of India – composition and powers and functions.

Unit IV: State Executive

Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary- High court. Local Government-Panchayatraj system Challenges of caste, gender, class, democracy and ethnicity.

References:

1. Banerjee-Dube, I. (2014). A history of modern India. Cambridge University Press.
2. Bhargava, R. (2008). Political theory: An introduction. Pearson Education India.
3. Bhargava, R., Vanaik, A. (2010) Understanding Contemporary India: Critical Perspective. New Delhi: Orient Blackswan.
4. Chandhoke. N., Proyadardhi.P, (ed) (2009), 'Contemporary India: Economy, Society, Politics', Pearson India Education Services Pvt. Ltd, ISBN 978-81- 317-1929-9.
5. Chandra, B., "Essays on contemporary India", Har-Anand Publications.
6. Chaterjee, P., "State and Politics in India".
7. Dasgupta. S., (ed) (2011), 'Political Sociology', Dorling Kindersley (India) Pvt. Ltd., Licensees of Pearson Education in south Asia. ISBN: 978-317-6027- 7.
8. Deshpande, S. (2003). Contemporary India: A Sociological View, New Delhi: Viking Publication.
9. Guha, R. (2007). India After Gandhi: The History of the World's Largest. Democracy, HarperCollins Publishers, New York.
10. Guha, R. (2013). Gandhi before India. Penguin UK.
11. Jayal. N.G. (2001). Democracy in India.New Delhi: Oxford University Press.
12. Kohli, A., "Democracy and discontent: India's growing crisis of governability", Cambridge University Press.
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Evaluation and Assessment

Since this is an audit course, evaluation will be based on active participation, understanding of concepts, and analytical skills:

- **Assignments & Reports**– Writing about a constitutional provision or case study.
- **Quiz/MCQs** – To test basic understanding of the Constitution.
- **Group Discussion/Presentation** – On relevant topics like Fundamental Rights or Constitutional Amendments.

HOD E&TC	Dean Autonomy	Dean Academics	Principal
Dr BH Patil	Dr CB Nayak	Dr SM Bhosle	Dr SB Lande