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

Department of Electronics and Telecommunication Engineering
Third Year B. Tech Syllabus 2026-27 (As per NEP 2020)
(2024 Pattern)

Preamble

The Department of Electronics and Telecommunication Engineering at Vidya Pratishthan's Kamalnayan Bajaj Institute of Engineering & Technology stands as a vibrant crucible of innovation, knowledge creation, and academic excellence. Since its inception over two decades ago, the department has consistently embodied a multifaceted commitment—fostering intellectual growth, nurturing technical acumen, and shaping a dynamic pool of engineers who contribute meaningfully across diverse sectors of society.

Guided by a progressive vision, the department places paramount emphasis on the holistic development of its students, instilling in them a spirit of lifelong learning, ethical responsibility, and societal consciousness. Backed by a team of highly experienced and dedicated faculty, the academic environment is thoughtfully curated to inspire curiosity, critical thinking, and innovation.

The department prides itself on a periodically enriched curriculum that seamlessly integrates foundational knowledge with contemporary technological advancements. This is further reinforced through state-of-the-art laboratories and an application-oriented learning ecosystem that bridges theory with practice. Students are actively encouraged to engage in technical forums such as paper presentations, workshops, and seminars, while also participating in cultural and co-curricular pursuits that ensure a well-rounded educational experience.

With a strong legacy of academic distinction and industry alignment, the department has earned the confidence of leading organizations for campus recruitment and consistently witnesses commendable success in competitive examinations like GATE. As it continues its journey of excellence, the Department of E&TC Engineering remains steadfast in its mission to empower future engineers who are not only technically proficient but also socially responsible and globally competent.

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.

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

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 stakeholders 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.

Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology
Board of Studies: E&TC Engineering
Syllabus: Third Year (B. Tech.) E&TC Engineering
2024 Pattern T.Y. Sem V — A.Y. 2026–27

Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	ET24301TH	Digital Signal Processing	3	–	–	10	30	60	–	–	–	100	3	–	–	3
PCC	ET24301PR	Digital Signal Processing Practical	–	2	–	–	–	–	–	30	–	30	–	1	–	1
PCC	ET24302TH	Embedded System & RTOS	3	–	–	10	30	60	–	–	–	100	3	–	–	3
PCC	ET24302PR	Embedded System & RTOS Practical	–	2	–	–	–	–	–	30	–	30	–	1	–	1
PCC	ET24303TH	Electromagnetic Field Theory	2	–	–	10	–	60	–	–	–	70	2	–	–	2
PCC	ET24303TUT	Electromagnetic Field Theory Tutorial	–	–	1	–	–	–	–	–	30	30	–	–	1	1
PEC	ET24304XTH	Programmable Electronic Course I	3	–	–	10	30	60	–	–	–	100	3	–	–	3
PEC	ET24304XPR	Programmable Electronic Course I	–	2	–	–	–	–	–	–	30	30	–	1	–	1
MDM	XXXXXXXTH	Multi-disciplinary Minor	3	–	–	10	30	60	–	–	–	100	3	–	–	3
MDM	XXXXXXXPR	Multi-disciplinary Minor	–	2	–	–	–	–	30	–	–	30	–	1	–	1
VSEC	ET24305TH	Electronic Product Design and Development	1	–	–	40	–	–	–	–	–	40	1	–	–	1
VSEC	ET24305PR	Electronic Product Design and Development	–	2	–	–	–	–	–	–	30	30	–	1	–	1
AC	HS24301	Constitution of India	1	–	–	–	–	–	–	–	–	–	–	–	–	–
		Total	**16**	**10**	**1**	**90**	**120**	**300**	**30**	**60**	**90**	**690**	**15**	**5**	**1**	**21**

List of Electives, Multi-Disciplinary Minor and Open Elective

Code	Program Elective-I	Code	Multi-Disciplinary Minor	Code	Open Elective
ET24304A	Antennas and Wave Propagation	ME24052	Introduction to Robotics and Automation		
ET24304B	Fundamentals of Image Processing	AI25053	Generative AI (Sem V+)		
ET24304C	Software Defined Radio	CO25051	Cloud Computing		
ET24304D	Computer Communication Networks (CCN)	CO25052	High-Performance Computing (Sem V+)		

HOD E&TC
Dr. J. S. Rangole

Dean Academics
Dr. S. M. Bhosle

Controller of Examination
Dr. A. H. Kolekar

Principal
Dr. S. B. Lande

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING
VPKBIET, BARAMATI

Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology
Board of Studies: E&TC Engineering
Syllabus: Honor / Double Minor Program
2024 Pattern T.Y. Sem V A.Y. 2026-27

Semester	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
V	ET24381TH	System Verilog for Design and Verification	3	-	-	10	30	60	-	-	-	100	3	-	-	4
	ET24381PR	System Verilog for Design and Verification	-	2	-	-	-	-	-	30	-	30	-	1	-	
	Total		3	2	-	10	30	60	-	30	-	130	3	1	-	4

HOD E&TC
Dr. J. S. Rangole

Dean Academics
Dr. S. M. Bhosle

Controller of Examination
Dr. A. H. Kolekar

Principal
Dr. S. B. Lande

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING
VPKBIET, BARAMATI

Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology
Board of Studies: E&TC Engineering
Syllabus: Third Year (B. Tech.) E&TC Engineering
2024 Pattern T.Y.Sem VI A.Y. 2026-27
SEMESTER-VI

Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	ET24311TH	Mobile communication and Networks	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PCC	ET24311PR	Mobile communication and Networks	-	-	1	-	-	-	-	-	30	30	-	1	-	
PCC	ET24312TH	Power Electronics	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PCC	ET24312PR	Power Electronics	-	2	-	-	-	-	-	30	-	30	-	1	-	
PEC	ET24313TH	Programme Elective course 2	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PEC	ET24313PR	Programme Elective course 2	-	2	-	-	-	-	-	30	-	30	-	1		
PEC	ET24314TH	Programme Elective course 3	2	-	-	10	-	60	-	-	-	100	2	-	-	3
PEC	ET24314PR	Programme Elective course 3	-	2	-				30	-	-	30	-	1	-	
MDM	ET240XXTH	Multi-disciplinary minor	2	-	-	10		60	-	-	-	70	2	-	-	3
MDM	ET240XXPR	Multi-disciplinary minor	-	2	-	-	-	-	30	-		30	-	1	-	
OE	OE240XXTH	Open Elective	3	-	-	10	30	60	-	-	-	100	3	-	-	3
	Total		16	08	1	60	120	360	60	60	30	720	16	5	-	21

List of Electives, Multi-Disciplinary Minor and Open Elective

Code	Program Elective Course 2	Code	Multi-Disciplinary Minor	Code	Open Elective
ET24313A	Computer Vision	ME24051	Introduction to 3D Printing Technologies	OE24008	Intellectual Property Rights
ET24313B	Machine Learning	CE25051	Waste Management	OE25011	Biotechnology
ET24313C	Smart Antenna	CE25052	Green building & smart cities	OE25012	International Relations
				OE25013	Universal Human Values
Code	**Program Elective Course 3**				
ET24314A	Internet of Things				
ET24314B	Cyber Security				
ET24314C	PLC SCADA & Automation				
ET24314D	Remote Sensing				

HOD E&TC
Dr. J. S. Rangole

Dean Academics
Dr. S. M. Bhosle

Controller of Examination
Dr. A. H. Kolekar

Principal
Dr. S. B. Lande

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING
VPKBIET, BARAMATI

Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology
Board of Studies: E&TC Engineering
Syllabus: Honor / Double Minor Program
2024 Pattern T.Y. Sem VI A.Y. 2026-27

Semester	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
VI	ET24391TH	Advanced Verification Methodologies and scripting	3	-	-	10	30	60	-	-	-	**100**	3	-	-	4
	ET24391PR	Advanced Verification Methodologies and scripting	-	2	-	-	-	-		30	-	30	-	1	-	
	Total		3	2	-	10	30	60		30	-	130	3	1	-	4

HOD E&TC
Dr. J. S. Rangole

Dean Academics
Dr. S. M. Bhosle

Controller of Examination
Dr. A. H. Kolekar

Principal
Dr. S. B. Lande

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING
VPKBIET, BARAMATI

Bucket of Multidisciplinary Minor Courses

Multidisciplinary Minor Subjects	
Subject Code	**Subject Name**
AI24051	AI & Machine Learning
AI24052	Data Science
AI24053	Generative AI (Sem V+)
CO24051	Cloud Computing
CO24052	High Performance Computing (Sem V+)
CO24053	Computer Graphics & Gaming
IT24051	Cyber security
IT24052	Full Stack Development
ET24051	Embedded Systems
ET24052	Drone Technology
ET24053	Internet of Things
ET24054	Microprocessor and Microcontroller
CE24051	Waste Management
CE24052	Green building & smart cities
ME24051	3-D Printing
ME24052	Robotics & Automation
EL24051	Solar Technology
EL24052	Industrial Automation
GS24051	Nanotechnology
GS24052	Linear Algebra and Statistics

Bucket of Open Electives

Open Elective Subjects	
Subject Code	**Subject Name**
OE24001	Digital Marketing
OE24002	Professional Leadership
OE24003	Organizational Behaviour
OE24004	Industrial Management
OE24005	Disaster Management
OE24006	Energy Economics & Management
OE24007	Operations Research
OE24008	Intellectual Property Rights
OE24009	Cyber Laws
OE24010	Bioinformatics
OE24011	Biotechnology
OE24012	International Relations
OE24013	Universal Human Values
OE24014	Education Technology
OE24015	Design Thinking
OE24016	Accounting & Finance
OE24017	Sustainability & Climate Change
OE24018	Agriculture Technology
OE24019	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

ET24301: Digital Signal Processing

Teaching Scheme:	Credits	Examination Scheme:
Theory: 03 Hours/Week **Practical: 02 Hours/Week**	**04**	**CAA: 10 Marks** **In Semester: 30 Marks** **End Semester: 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 g 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 undersampled, 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.

ET24302: Embedded Systems and RTOS

Teaching Scheme:	Credits	Examination Scheme:
Theory: 03 Hours/Week **Practical: 02 Hours/Week**	**04**	**CAA: 10 Marks** **In Semester: 30 Marks** **End Semester: 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, and boot loader to the target device- ARM9.
7. Writing simple applications using embedded Linux on ARM9.
8. Writing "Hello World" Device Driver. Loading into & removing from the Kernel on the 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.

ET24303:- Electromagnetic Field Theory

Teaching Scheme:	Credits	Examination Scheme:
Theory: 02 Hours/Week Tutorial: 01 Hour/Week	03	Activity:10 Marks End Sem:60 Marks Oral:30 Marks

Prior knowledge of

1. Vectors, Vector Calculus
2. Coordinate Geometry, Cartesian, Cylindrical, Spherical

is essential.

Course Objectives:

- Provide the foundation and rudiments of Electromagnetic theory essential to subsequent courses of radiation, microwave and wireless communications.
- Expose the students to basic laws of electro statics, magneto statics leading to the Maxwell Equations for static and dynamic fields.
- Extend these laws to Uniform Plane waves, transmission line theory and some of the case studies of applications of engineering electromagnetic field theory.
- The main focus will be on the physical interpretation of all the mathematical formulations and extend these concepts to real time applications in the field Electronics and Telecommunication Engineering.

Course Outcomes:

After completion of this course students will be able to,

CO1: Apply the basic electromagnetic principles and determine the fields (E & H) due to the given source.

CO2: Apply boundary conditions to the boundaries between various media to interpret behavior of the fields on either sides.

CO3: State, Identify and Apply Maxwell's equations (integral and differential forms) in both the forms (Static, time-varying or Time-harmonic field) for various sources, Calculate the time average power density using Poynting Theorem, Retarded magnetic vector potential.

CO4: Formulate, Interpret and solve simple uniform plane wave (Helmholtz Equations) equations, and analyze the incident/reflected/transmitted waves at normal incidence.

Course Contents

Unit I: Electrostatics (06 Hrs.)

Review of 3D Coordinate Geometry, Vector Calculus, Physical significance of Gradient, Divergence, Curl, Electric field intensity(E), Displacement Flux Density(D), Gauss's law, Electric potential(V), Potential Gradient, E/D/V due to uniform sources (point charge, infinite line charge, infinite surface charge) , Maxwell Equations for Electrostatics, Current, Current Density, physical interpretation.

Application Case Study: Electrostatic Discharge, Cathode Ray Oscilloscope.

Unit II: Magneto statics (06 Hrs.)

Lorentz force, magnetic field intensity (H), Magnetic Flux Density(B), – Biot–Savart's Law – Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Maxwell Equations for Magneto Statics, physical interpretation.

Application Case Study: Lightning, Magnetic Resonance Imaging (MRI).

Unit III: Boundary Conditions (06 Hrs.)

Electric Dipole, Dielectric Polarization, Properties of Conductors, Dielectric Materials, Boundary conditions (dielectric-dielectric, conductor –dielectric), significance and applications of Poisson's and Laplace's equations - Capacitance, Energy density. Magnetization, magnetic materials, Boundary conditions for Magnetic Fields, Magnetic force, Torque.

Application Case Study: RF MEMS, Magnetic Levitation, Electromagnetic Pump.

Unit IV: Time Varying Electromagnetic Fields: Maxwell Equations (06 Hrs.)

Scalar and Vector Magnetic Potential, Poisson's and Laplace Equations, Faraday's law, Translational and motional emf, Displacement current density, Continuity Equation, Time varying Maxwell's equations - point form, integral form, Power and Poynting theorem, concept of Retarded magnetic vector potential,

Text Books:

T1. M.N.O. Sadiku and S.V. Kulkarni, "Principles of Electromagnetics", Oxford University Press, India, 2015 (Asian adaptation of 'M.N.O. Sadiku, Elements of Electromagnetics, Sixth International Edition, Oxford University Press'), 6th Edition

T2. William H. Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill, 8th Revised Edition.

Reference Books:

1. Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, 5th Edition.
2. Jordan and Balmain, "Electromagnetic Waves and Radiating Systems", PHI, 1964.

MOOC/ NPTEL Course

1. NPTEL Course "Transmission Lines and EM Waves -Video course" Prof. R.K. Shevgaonkar
Link of the Course: https://nptel.ac.in/courses/117/101/117101056/

2. NPTEL Course on "Electromagnetic theory - Video course" Dr. Pradeep Kumar K
Link of the Course: https://nptel.ac.in/courses/108/104/108104087/

3. David Staelin. 6.013 Electromagnetics and Applications. Spring 2009. Massachusetts Institute of Technology: MIT Open Course Ware
Link: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-013-electromagnetics-and-applications-spring-2009/index.htm#

ET24304(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 Semester: 30 Marks End Semester: 60 Marks Oral: 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).
- Plot Standing Wave pattern and Measure SWR for open, short and matched termination

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

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

ET24304(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 Semester: 30 Marks** **End Semester: 60 Marks** **Oral: 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.

ET24304(C): Software Defined Radio (Programme Elective Course 1)

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

ET24304(D): Computer Communication Networks (CCN)
(Programme Elective Course 1)

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

ET24305: Electronic Product Design and Development (VSEC)

Teaching Scheme:		Examination Scheme
Theory: 01 Hr./week	Credits: 02	CAA: 40 Marks
PR: 02 Hrs./week		ORAL: 30 Marks

Course Objectives:

1. Familiarise the versatile MATLAB programming language
2. Apply the fundamental techniques through MATLAB Programming
3. Familiarise the versatile Arduino programming language
4. Apply the fundamental techniques through Arduino Programming

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

CO1: Be able to use MATLAB for interactive computations and apply the knowledge and techniques for the implementation of simple programs on MATLAB.

CO2: Understand the fundamentals of Arduino and apply the knowledge and techniques for the implementation of simple programs on Arduino.

Module I: MATLAB and SIMULINK (6 Hours)

MATLAB: Introduction to MATLAB, Data Types and Variables, Basic MATLAB Functions, Script Files, Arrays Operations, Graphics.

MATLAB SIMULINK: Basic Waveforms, Trigonometric Functions, Differential Equations.

Module II: Introduction of Arduino (6 Hours)

Introduction and Familiarization: Hardware Overview, Download and Install the Arduino IDE, Arduino IDE and Sketch Overview, Understanding Arduino Syntax.

Basics: Understanding and Using Variables, blinking an LED, digital Read () and Serial Port Communication, analog Read () and Serial Port Communications, Reading Analog Pins and Converting the Input to a Voltage, fade an LED with Pulse Width Modulation using analogWrite ().

Implementation: Blink an LED Without using the delay() Function, Using Buttons, State Change Detection and the Modulo Operator, Debouncing a Button, Analog I/O and Serial Communications

Study Resources:

1. MATLAB Onramp: Learn the basics of MATLAB through this introductory tutorial on commonly used features and workflows. Get started with the MATLAB language and environment so that you can analyze science and engineering data. https://MATLABacademy.mathworks.com/details/MATLAB-onramp/gettingstarted
2. MATLAB Fundamentals: Learn core MATLAB® functionality for data analysis, visualization, modelling, and programming. Implement a common data analysis workflow that can be applied to many science and engineering applications. https://MATLABacademy.mathworks.com/details/MATLAB-fundamentals/mlbe
3. "Internet of Things: Case Studies", Libelium Inc, White papers, Spain http://www.libelium.com/resources/case-studies

4. NPTEL Course on “Introduction to IoT”, by Prof. Sudip Misra, IIT Kharagpur Link of the Course: https://nptel.ac.in/courses/106105166

List of Practical

Group A: (Perform any FOUR)

1. Write a basic MATLAB program to declare variables, perform basic operations on variables and use the trigonometric function (Sine/Cosine) & plot the graph.
2. Write a MATLAB program to define an array & perform various operations. Create a matrix & perform the addition of two matrices.
3. Write MATLAB code to print the sum of the first 10 natural numbers using (For Loop).
4. Create a SIMULINK model to generate basic waveforms.
5. Create a SIMULINK model for a given differential equation.

Group B: (Perform any FOUR)

6. Interface LED with Arduino & write a program for LED Blinking with a delay function.
7. Interfacing various sensors like temperature, humidity, and buzzer with Arduino board.
8. Interface LED with Arduino & write a program to fade an LED with Pulse Width Modulation.
9. To study block-wise construction of an analog oscilloscope & function generator.
10. To study block-wise construction of a multi-meter & frequency counter.

HS24301: 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.

ET24311-: Mobile Communication and Networks

Teaching Scheme: Theory: 03 Hours/Week Tutorial: 01 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Semester: 30 Marks End Semester: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

ET24312: Power Electronics

Teaching Scheme: Theory: 03 Hours/Week Practical: 02 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks In Semester: 30 Marks End Semester: 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 Wiley & 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.

ET24313(A): Computer Vision (Programme Elective Course 2)

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

ET24313(B): Machine Learning (Programme Elective Course 2)

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

Prerequisite Courses, if any:
Discrete Mathematics, Any Programming Knowledge (Python/ Matlab /Java).

Course Objectives:

1. To gain the ability to identify and apply different machine learning paradigms, including supervised and unsupervised learning techniques.
2. To develop the skills to implement linear and probabilistic models for regression and classification, and evaluate their performance.
3. To understand the theory and application of clustering techniques, including dimensionality reduction and k-means clustering.
4. To design and implement basic artificial neural networks, utilizing activation functions, error correction, and learning paradigms.
5. To gain proficiency in using multilayer perceptrons (MLP), backpropagation, and advanced neural network structures like Self-Organizing Feature Maps.
6. To acquire the expertise to design, train, and optimize deep learning models, with a focus on convolutional neural networks for real-world applications.

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

CO1: Introduce the fundamental concepts and types of machine learning, including regression, classification, and dimensionality reduction techniques.

CO2: Provide a comprehensive understanding of regression and classification models, including Bayesian methods, multivariate data analysis, and kernel methods.

CO3: Explore advanced clustering techniques, including dimensionality reduction methods and clustering algorithms like k-means and Gaussian mixtures.

CO4: Delve into the architecture and operation of artificial neural networks, including biological and artificial neuron models, and key learning paradigms.

CO5: Examine the implementation of multilayer perceptrons (MLP) and backpropagation algorithms for classification tasks, along with advanced learning mechanisms like self-organizing maps.

CO6: Study deep learning techniques, particularly Convolutional Neural Networks (CNNs), and explore their applications, challenges, and optimizations.

Course Contents

Unit I: Introduction to Machine Learning (7 Hrs.)

Why Machine learning? Types of machine learning, basic concepts in machine learning like parametric and non-parametric modelling, linear and nonlinear regression, over-fitting and dimensionality reduction. Decision trees, Feature reduction.

Unit II: Models for Regression and Classification (7 Hrs.)

Linear Models for Regression: Least Squares and Nearest Neighbors, Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison Linear Models for Classification: Discriminant Functions. Probabilistic Discriminative Models Multivariate Data, Parameter Estimation, Multivariate Classification, Multivariate Regression Kernel Methods: Support Vector machines and Relevance Vector Machines

Unit III: Clustering (6 Hrs.)

Dimensionality Reduction: Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis, Clustering: k-Means Clustering, Mixtures of Gaussians.

Unit IV: Artificial Neural Networks (6 Hrs.)

Biological neuron, Artificial neuron model, the concept of bias and threshold, Activation functions, McCulloch-Pits Neuron Model, learning paradigms, the concept of error energy, gradient descent algorithm and application of linear neuron for linear regression, Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations.

Unit V: Artificial Neural Networks (6 Hrs.)

Multilayer perceptron (MLP) and backpropagation algorithm, Application of MLP for classification, Self-Organizing Feature Maps, Learning vector quantization Radial Basis Function networks.

Unit VI: Deep Learning and Convolution Neural Networks (6 Hrs.)

Improvement of the Deep Neural Network: Vanishing Gradient, Overfitting, Computational Load, ReLU Function, Dropout Architecture of ConvNet, Convolution Layer, Pooling Layer, Applications of CNN's

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.

List of Experiments

1. Implement a simple logic network using the MP neuron model.
2. Implement a simple linear regressor with a single-neuron model.
3. Implement and test MLP trained with a back-propagation algorithm.
4. Implement and test the RBF network.
5. Implement SOFM for character recognition.
6. Implement SVM classifier for the classification of data into two classes. Students can use datasets such as flower classification etc.
7. Implement and test the Multiclass SVM classifier.
8. Implement and test CNN for object recognition.

ET24313(C): Smart Antenna (Programme Elective Course 2)

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

Prerequisite Courses, if any: Antennas and Wave Propagation

Course Objectives:

1. To understand the theory of reconfiguration antenna and smart antenna.
2. To learn DOA estimation techniques for a 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.

ET24314(A): Internet of Things (IoT) (Programme Elective Course 3)

Teaching Scheme: Theory: 02 Hours/Week Practical: 02 Hours/Week	Credits 03	Examination Scheme: CAA: 10 Marks End Semester: 60 Marks TW: 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.

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.

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.

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.

ET24314(B): Cyber Security (Programme Elective Course 3)

Teaching Scheme: Theory: 02 Hours/Week Practical: 02 Hours/Week	Credits 03	Examination Scheme: CAA: 10 Marks End Semester: 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.

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.

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.

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.

ET24314(C): PLC SCADA and Automation (Programme Elective Course 3)

Teaching Scheme:	Credits	Examination Scheme:
Theory: 02 Hours/Week **Practical: 02 Hours/Week**	**03**	**CAA: 10 Marks** **End Semester: 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. .

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.

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.

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.

ET24314(D): Remote Sensing (Programme Elective Course 3)

Teaching Scheme: Theory: 02 Hours/Week Practical: 02 Hours/Week	Credits 03	Examination Scheme: CAA: 10 Marks End Semester: 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.

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.

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.

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.