

**Course Name: Antennas and Radiating Systems**

**Course Code: ECM-201**

**Course Type: PC**

**(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

Basic Knowledge of Electromagnetic Theory and RF Microwave Engineering are required.

**2. Course Learning Objectives:**

- i. Explain the fundamental parameters for antennas and the radiation field from an antenna using potential functions and discuss about different antenna and array antenna design.
- ii. This course describes the understanding of the components of a radar system and their relationship to overall system performance.
- iii. To become familiar with design, operation, and applications of various types of radar systems.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name: Antennas and Radiating Systems**

**Course Code: ECM-201**

**Hours per Week: 3L: 0T: 0P**

**Credits: 3**

Module	Topics	40L
1.	<b>Fundamental Concepts-</b> Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals, and auxiliary potential functions.	6L
2.	<b>Radiation from Wires and Loops-</b> Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.  <b>Loop Antennas:</b> Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.	8L

<b>Module</b>	<b>Topics</b>	<b>40L</b>
3.	<b>Antenna Arrays</b> -Linear Arrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, planar array, and Design consideration.	8L
4.	<b>Aperture Antennas</b> : Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture. Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.	6L
5.	<b>Micro strip Antennas</b> : Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.	6L
6.	<b>Reflector Antennas</b> : Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.	6L

**5. References:**

**Text Books:**

- C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
- J.D. Kraus, Antennas, McGraw Hill, 1988.

**Reference Books:**

- R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985

**\*\*\* End of Syllabus\*\*\***

**Course Name: Adaptive Signal Processing**

**Course Code: ECM-202**

**Course Type: PC  
(Semester –II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

Subject knowledge of Linear Algebra  
Signals and System  
Digital Signal Processing required

**2. Course Learning Objectives:**

- i. This course introduces the concepts about adaptive filter and their applications.
- ii. Students will also learn to design and analyse of impulse response and transfer function of unknown LTV System.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** Adaptive Signal Processing

**Course Code:** ECM-202

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	36L
1.	<b>Introduction to Adaptive Filters:</b> Definitions, Characteristics, Adaptive filter structures, Applications, Examples of adaptive systems. Adaptive linear combiner: General Description, Desired Response and Error, the performance function, gradient and minimum mean square error, and alternative expression of gradient.	5L
2.	<b>Wiener filter, Search methods and the LMS algorithm:</b> Wiener FIR filter (real case), Newton's type algorithm, steepest descent search and the LMS algorithm, Extension of optimal filtering to complex valued input, Complex LMS algorithm (FXLMS).	8L
3.	<b>Convergence and Stability Analyses:</b> Convergence analysis of the gradient search algorithms, learning curve and mean square error behavior, Weight error correlation matrix, Dynamics of the steady state mean square error (MSE), Mis-adjustment and stability of excess MSE.	5L

4.	<b>Variants of the LMS algorithm:</b> The sign LMS family. Normalized LMS algorithm, block LMS and FFT based realization. Sparse Adaptive Filtering Technique: Proportionate Normalized LMS (PNLMS), Improved PNLMS (IPNLMS), Zero-Attracting NLMS (ZA-NLMS) and ZA-PNLMS algorithms, Block Sparse PNLMS (BS-PNLMS) algorithm, frequency domain adaptive filters, Sub-band adaptive filtering.	6L
5.	<b>Adaptive Recursive Filters and Structures:</b> Least square (LS) estimation, pseudo-inverse of a data matrix, optimality of LS estimation, adaptive recursive filters, RLS algorithm, and convergence analysis of RLS algorithm, Application of RLS algorithm, Lattice structures and adaptive lattice filters the adaptive Lattice Predictor.	6L
6.	<b>Application of Adaptive Filters:</b> Echo cancellation, Equalization of data communication channels, Linear predictive coding and Noise cancellation, Adaptive control systems: Adaptive Model control, Adaptive inverse Control. Introduction of adaptive array and adaptive beam forming, Recent advances in adaptive filtering	6L

**5. Reference:**

**Text Books:**

- S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
- C. Widrow and S.D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

**Reference Book:**

- Behrouz Farhang-Boroujeny Adaptive Filters: Theory and Applications” Second Edition.

**\*\*\* End of Syllabus\*\*\***

**Course Name: GIS & Satellite Communication**

**Course Code: ECM-203**

**Course Type: PE**

**(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

A solid understanding of electromagnetic theory, basic communication systems, antenna design, and digital communication

**2. Course Learning Objectives:**

- i. To introduce basic principles of GIS and satellite communication systems.
- ii. To enable the student to become familiar with satellites and satellite services.
- iii. To study of satellite orbits and launching.
- iv. To study of earth segment and space segment components.
- v. To study of satellite access by various users.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

**Evaluation System-**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** GIS & Satellite Communication

**Course Code:** ECM-203

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	32L
1.	Definition, Philosophy & Historical evolution of GIS, Components of GIS, Function of GIS, GIS Operations, Use and applications of GIS, Basic Concepts about Spatial Information, Spatial vs. Non-spatial data, Spatial data models – Raster and Vector.	6L
2.	Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks	6L

Module	Topics	32L
3.	Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day.	6L
4.	Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.	6L
5.	Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.	4L
6.	Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.	4L

**5. References:**

**Text Books:**

- Timothy Pratt and Jeremy Allnutt: "Satellite Communications": Ed 3, 2021. Wiley India.
- S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011. 3.
- Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.

**Reference Books:**

- Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.
- Varsha Agrawal, Anil K. Maini, "Satellite Communications" Wiley India 2010.

**\*\*\* End of Syllabus\*\*\***

**Course Name: Internet of Things**

**Course Code: ECM-204**

**Course Type: PE  
(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

A foundational knowledge of programming (like C, C++, and Python), electronics and hardware (microcontrollers, sensors, and processors), and computer networking (wireless protocols, TCP/IP, and cloud technology)

**2. Course Learning Objectives:**

- i. Understand what IOT technologies are used for today and what is required in certain scenarios.
- ii. Understand the types of technologies that are available and in use today and can be utilized to implement IOT solutions.
- iii. Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** Internet of Things

**Course Code:** ECM-204

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	35L
1.	Smart cities and IOT revolution, Fractal cities, From IT to IOT, M2M and peer networking concepts, Ipv4 and IPV6.	6L
2.	Software Defined Networks SDN, From Cloud to Fog and MIST networking for IOT communications, Principles of Edge/P2P networking, Protocols to support IOT communications, modular design and abstraction, security and privacy in fog.	7L
3.	Wireless sensor networks, introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client-side control and configuration.	6L

<b>Module</b>	<b>Topics</b>	<b>35L</b>
4.	Smart objects as building blocks for IOT, Open-source hardware and Embedded systems platforms for IOT, Edge/gateway, IO drivers, C Programming, multithreading concepts.	6L
5.	Operating systems requirement of IOT environment, study of mbed, RIOT, and Contiki operating systems, introductory concepts of big data for IOT applications.	6L
6.	Applications of IOT, connected cars IOT Transportation, Smart Grid and Healthcare sectors using IOT, Security and legal considerations, IT Act 2000 and scope for IOT legislation.	4L

## **5. References:**

### **Text Books:**

- A Bahaga, V. Madiseti, "Internet of Things- Hands on approach", VPT publisher, 2014.
- A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.

### **Reference Books:**

- Cuno Pfister, "Getting started with Internet of Things", Maker Media, 1st edition, 2011
- Samuel Greenguard, "Internet of things", MIT Press, 2015.

**\*\*\* End of Syllabus\*\*\***

**Course Name: Voice and Data Networks**

**Course Code: ECM-205**

**Course Type: PE**

**(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

A basic understanding of computer hardware, operating systems, and core computer networking fundamentals.

**2. Course Learning Objectives:**

- i. Explain the fundamental concepts of voice and data communication systems, including signaling, switching, multiplexing, and digital transmission principles.
- ii. Analyze the architectures and protocols used in voice and data networks such as PSTN, VoIP, ISDN, cellular networks, and packet-switched data networks.
- iii. Apply techniques of encoding, compression, digitization, and QoS mechanisms to support reliable voice and multimedia communication over data networks.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** Voice and Data Networks

**Course Code:** ECM-205

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	35L
1.	Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.	6L
2.	Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.	7L
3.	Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.	6L
4.	Queuing Models of Networks, Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols, Aloha System, Carrier Sensing, Examples of Local area networks.	6L

<b>Module</b>	<b>Topics</b>	<b>35L</b>
5.	Inter-networking, Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR) , IP address lookup , Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery.	6L
6.	Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.	4L

## **5. References:**

### **Text Books:**

- D. Bertsekas and R. Gallager, "Data Networks", 2nd Edition, Prentice Hall, 1992.
- L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan Kaufman, 2011.
- Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", 1st Edition, Morgan Kaufman, 2004.

### **Reference Books:**

- Walrand, "Communications Network: A First Course", 2nd Edition, McGraw Hill, 2002.
- Leonard Kleinrock, "Queueing Systems, Volume I: Theory", 1st Edition, John Wiley and Sons, 1975.
- Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, 1993.
- Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGraw Hill, 1987.

**\*\*\* End of Syllabus\*\*\***

**Course Name: MIMO System**

**Course Code: ECM-208**

**Course Type: PE**

**(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

Foundational courses in **communication systems, signals and systems, and relevant mathematical concepts like linear algebra and probability.**

**2. Course Learning Objectives:**

- i. Understand channel modeling and propagation, MIMO Capacity, space-time coding, MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.
- ii. Understand cooperative and coordinated multi-cell MIMO, introduction to MIMO in 4G (LTE, LTE-Advanced, WiMAX).
- iii. Perform Mathematical modeling and analysis of MIMO systems.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** MIMO System

**Course Code:** ECM-208

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	36L
1.	Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi antenna systems.	5L
2.	Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation.	8L
3.	The generic MIMO problem, Singular Value Decomposition, Eigen values and eigenvectors, Equalizing MIMO systems, Disadvantages of equalizing MIMO systems, Predistortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of pre coding and combining, Channel state information.	7L

<b>Module</b>	<b>Topics</b>	<b>36L</b>
4.	Codebooks for MIMO, Beam forming, Beam forming principles, increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrowband beam former, Wideband beam former.	6L
5.	Case study: MIMO in LTE, Code words to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beam forming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models.	6L
6.	Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.	4L

## 5. References:

### Text Book:

- Claude O Estges, Bruno Clerckx , "MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design", Academic Press, 1st edition, 2010.

### Reference Book:

- Mohinder Janakiraman, "Space - Time Codes and MIMO Systems", Artech House Publishers, 2004.

**\*\*\* End of Syllabus\*\*\***

**Course Name: Markov Chain and Queuing System**

**Course Code: ECM-209**

**Course Type: PE**

**(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

A solid foundation in calculus and probability theory.

**2. Course Learning Objectives:**

- i. Understand Markov Chains and regenerative processes used in modeling a wide variety of systems and phenomena.
- ii. Model a system as queuing system with some aspect of the queue governed by a random process.
- iii. Understand telecommunication systems modeling using Markov chains with special emphasis on developing queuing models

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** Markov Chain and Queuing System

**Course Code:** ECM-209

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	35L
1.	<b>Introduction:</b> Review of basic probability, properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem.	5L
2.	<b>Renewal Processes:</b> Basic definitions, recurrence times, rewards and renewal reward theorem, point processes, Poisson process, Wolds equation, Blackwell's theorem.	8L
3.	<b>Discrete time Markov chains:</b> definitions and properties, matrix representation, Perron-Frobenius theory.	7L
4.	<b>Continuous time Markov chains:</b> basic definitions, Q-matrix, birth-death processes, quasi birth death processes; Embedded Markov processes, semi Markov processes, reversible Markov chains, Random walks.	6L

Module	Topics	35L
5.	<b>Fundamental queuing results:</b> Little's theorem, invariance of the mean delay, Conservation law. Markovian queues: Jackson and BCMP networks, numerical Algorithms. M/G/1 & G/M/1 queues and G/G/1 queues.	6L
6.	<b>Advanced queuing models:</b> priority, vacation and retrials in queues.	3L

**5. References:**

**Text Books:**

- Cliffs, "Stochastic Modeling and the Theory Queues", Prentice Hall, 1989.
- P. Bremaud, "Markov Chains", Springer-Verlag, 1999.

**Reference Books:**

- E. Seneta, "Non-Negative Matrices and Markov Chains", Springer Series in Statistics, Springer, 1981.
- R. Gallager, "Discrete Stochastic Processes", Kluwer Academic Press, 1996.
- L. Kleinrock, "Queuing Systems", vols I and II, John Wiley and Sons 1976.

**\*\*\* End of Syllabus\*\*\***

**Course Name: Remote Sensing & Radar Technology**

**Course Code: ECM-210**

**Course Type: PE**

**(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

The prerequisites for this class include a basic understanding of electromagnetic waves (Physics II), linear system theory including Fourier analysis and some basic understanding of statistics and/or probability.

**2. Course Learning Objectives:**

- i. Understand basic concepts, principles and applications of radar technology and remote sensing.
- ii. Provide examples of applications of principles to a variety of topics in radar technology and remote sensing, particularly related to data collection, radiation, resolution, and sampling.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** Remote Sensing & Radar Technology

**Course Code:** ECM-210

**Hours per Week:** 3L: 0T: 0P

**Credits:** 3

Module	Topics	40L
1.	<b>Radar fundamentals:</b> Radar basics; pulsed radar; target ranging; range ambiguity; pulse-to-pulse motion; signal, noise and loss; target detection; receiver components and processing; Doppler radar; Doppler velocity ambiguity.	4L
2.	<b>Radar sensitivity:</b> Radar power equation: derivation and application for point targets; radar power losses; radio and receiver noise: Radar Antenna: Directivity; gain; illumination; antenna patterns; aperture antennas; phased array antennas, Scattering Process, Radar Signals: Transmitter/signal generating characteristics; pulsed waveform; continuous waveform; pulse modulation and compression; digital filtering; Doppler spectrum	6L

Module	Topics	40L
3.	<b>Physics Of Remote Sensing:</b> Electro Magnetic Spectrum, Physics of Remote Sensing Effects of Atmosphere-Scattering–Different types–Absorption-Atmospheric window-Energy interaction with surface features –Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in Remote sensing.	6L
4.	<b>Data Acquisition:</b> Types of Platforms–different types of aircrafts-Manned and Unmanned spacecrafts–sun synchronous and geo synchronous satellites –Types and characteristics of different platforms – LANDSAT,SPOT,IRS,INSAT,IKONOS,QUICKBIRD etc.	6L
5.	<b>Photographic products:</b> B/W, color, color IR film and their characteristics – resolving power of lens and film -Optomechanical electro optical sensors – across track and along track scanners-multispectral scanners and thermal scanners–geometric characteristics of scanner imagery -calibration of thermal scanners.	6L
6.	<b>Thermal And Hyper Spectral Remote Sensing:</b> Sensors characteristics-principle of spectroscopy-imaging spectroscopy–field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing – thermal sensors, principles, thermal data processing, applications.	6L
7.	<b>Data Analysis:</b> Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics-visual and digital interpretation–Basic principles of data processing – Radiometric correction–Image enhancement–Image classification–Principles of LiDAR, Aerial Laser Terrain Mapping	6L

## 5. References:

### Text Books:

- Introduction to Radar Analysis, 2nd Edition, by Majafza
- Radar Principles, by Peyton Z. Peebles, Jr.
- Radar Handbook, by Skolink
- Introduction to Radar Systems, by Skolink
- Modern Radar System Analysis, by Marton
- Lilles and T.M., and Kiefer,R.W. Remote Sensing and Image interpretation, John Wiley & Sons-2000, 6thEdition

### Reference Books:

- John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 2nd Edition, 1995.
- John A.Richards, Springer –Verlag, Remote Sensing Digital Image Analysis, 1999.
- Paul Curran P.J. Principles of Remote Sensing, ELBS; 1995.

\*\*\* End of Syllabus\*\*\*

**Course Name: VLSI DSP**  
**Course Code: ECM-211**  
**Course Type: PE**  
**(Semester II)**  
**Course Broad Category: (Major)**

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**1. Course Prerequisite:**

Foundation of Digital Signal Processing (DSP)  
Digital Circuits  
Fundamentals of Digital VLSI

**2. Course Learning Objectives:**

- i. This course explains application of VLSI for Digital Signal Processing
- ii. Students will also learn about low-power VLSI design technique
- iii. Students will also understand FSM and multiplier for DSP

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name:** VLSI DSP

**Course Code:** ECM-211

**Hours per Week:** 3L: 0T:0P

**Credits:** 3

Module	Topics	36L
1.	<p><b>Module I: VLSI for DSP:</b></p> <p><b>I.A:</b> Working Principle of DSP System, Typical DSP Algorithms: Introduction to DSP FPGA Hardware; FPGA Fundamental Concepts, DSP Arithmetic Essentials, Signal Flow Graph (SFG) Techniques. Pipelined DSP architectures, examples, Parallel realization of DSP algorithms</p> <p><b>I.B:</b> Folding: Definition, Folding transformations, idea of unfolding, unfolding theorem, loop unfolding, register minimization techniques, Register minimization in folded architectures, Hardware minimization by folding, folding formula, examples from biquad digital filters;</p> <p><b>I.C:</b> Systolic Architecture Design: Introduction, Systolic array design methodology, FIR systolic arrays, Selection of scheduling vector, Matrix-Matrix multiplication and 2D systolic array design; Digital Filtering, Recursive DSP Retiming (IIR and LMS), Serial Filter Implementation, Multi-Channel Filter Implementation Frequency Domain Processing;</p> <p><b>I.D:</b> CORDIC based Implementations: CORDIC Techniques, Adaptive DSP Algorithms and Applications, Architecture, Implementation of FIR filter and FFT algorithm; FPGA Advantages for DSP, High end FPGA Architecture.</p>	12L

Module	Topics	36L
2.	<p><b>Module II: Low Power VLSI: II.A:</b> MOSFET fundamentals, Sources of power consumption, Power Reduction techniques: path balancing, Transistor Sizing and reordering, technology scaling, Retiming for low-power, Dynamic voltage and frequency scaling, multi-supply design, switching activity, MTCMOS technique, clock gating, power gating, adaptive body-biasing, reversible logic.</p> <p><b>II.B:</b> circuit styles: static CMOS, dynamic CMOS, PTL, DCVSL, CML etc, Pipelining and clocking, static and dynamic D-Latch, Two-phase clock generator, TSPC-Latch, clock-skew and clock distribution, Wave-pipelining: advantage, constraints, Implementation: NPCPL, delay balancing, power estimation.</p>	12L
3.	<p><b>Module-III: Logic Level Processing:</b></p> <p><b>III.A:</b> Finite State Machine (FSM): State Diagram, Moore Model, Mealy Model; FSM Examples: Serial Adder, Sequence Detector, Traffic Light Controller.</p> <p><b>III.B:</b> Multipliers for DSP: Array Multiplier, Wallace-Tree Multiplier, Repeated Addition Multiplier, Shift &amp; Add Multiplier.</p> <p><b>III.C:</b> Static Timing Analysis (STA): Setup Time and Hold Time of Flip-Flops, Data Arrival Time, Data Required Time, Slack, Critical Path, Maximum Operating Frequency, Input Delay, Output Delay; Calculation of Timing Violations in Circuits, Remedies of Timing Violations in Circuits.</p>	12L

## 5. References:

### Text Books:

- Keshab K. Parhi. *VLSI Digital Signal Processing Systems*, Wiley-Inter Sciences, 1999
- S. Brown and Z. Vranesic, *Fundamentals of Digital Logic with Verilog Design*, McGrawHil, 2007.

### Reference Book:

- Sneh Saurabh, *Introduction to VLSI Design Flow*, Cambridge University Press, 2023.

\*\*\* End of Syllabus\*\*\*

**Course Name: Personality Development through Life Enlightenment Skills**

**Course Code: ECM-281**

**Course Type: HM**

**(Semester – II)**

**Course Broad Category: (Skill Enhancement)**

**1. Course Prerequisite:**

Basic Knowledge of Electromagnetic Theory and RF Microwave Engineering are required.

**2. Course Learning Objectives:**

- i. To learn to achieve the highest goal happily.
- ii. To become a person with stable mind, pleasing personality and determination.
- iii. To awaken wisdom in students.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology** – Lectures and Presentations, Interactive Discussions and Case Studies.

**Evaluation System –**

- A. Continuous Internal Assessment I (40 Marks).
- B. Continuous Internal Assessment II (40 Marks).
- C. End-Semester Exam (60 Marks)

**4. Course Content:**

**Course Name: Personality Development through Life Enlightenment Skills**

**Course Code: ECM-281**

**Hours per Week: 2L: 0T: 0P**

**Credits: 1**

Module	Topics	24L
1.	<p><b>Neetisatakam-Holistic development of personality</b></p> <ul style="list-style-type: none"> <li>• Verses- 19,20,21,22 (wisdom)</li> <li>• Verses- 29,31,32 (pride &amp; heroism)</li> <li>• Verses- 26,28,63,65 (virtue)</li> <li>• Verses- 52,53,59 (dont's)</li> <li>• Verses- 71,73,75,78 (do's)</li> </ul>	8L
2.	<p><b>Approach to day to day work and duties.</b></p> <p><b>Shrimad Bhagwad Geeta :</b></p> <ul style="list-style-type: none"> <li>• Chapter 2-Verses 41, 47,48,</li> <li>• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17,23, 35,</li> <li>• Chapter 18-Verses 45, 46, 48.</li> </ul>	8L

Module	Topics	24L
3.	<b>Shrimad Bhagwad Geeta:</b> <ul style="list-style-type: none"> <li>• Chapter2-Verses 56, 62, 68</li> <li>• Chapter 12 -Verses 13, 14, 15, 16,17, 18</li> </ul> <b>Personality of Role model. Shrimad Bhagwad Geeta:</b> <ul style="list-style-type: none"> <li>• Chapter2-Verses 17, Chapter 3-Verses 36,37,42,</li> <li>• Chapter 4-Verses 18, 38,39</li> <li>• Chapter18 – Verses 37,38,63</li> </ul>	8L

**5. References:**

**Text Book:**

- "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.

**Reference Book:**

- Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

**\*\*\* End of Syllabus\*\*\***

**Course Name: Antennas and Radiating Systems Laboratory**

**Course Code: ECM-213**

**Course Type: PC  
(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

Knowledge of EM Wave and Transmission line Laboratory  
Microwave Circuit Lab.

**2. Course Learning Objectives:**

- i. Expose students to experimental skills on electronic circuit design and analysis.
- ii. To gain practical knowledge by applying experimental methods to correlate with the basic electronic theory.
- iii. To apply the analytical techniques and graphical analysis to the experimental data.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology: Instruction:** This method recognizes that students have different learning styles, abilities, and backgrounds, and aims to create a learning environment that accommodates these differences.

**Evaluation System –**

- A. **Internal Assessment (60 Marks)**- Formative Continuous Assessment [Continuous Assessment; Note Book (30 Marks), Viva Voce (20 Marks), Attendance (10 Marks)]
- B. **End-Semester Exam (40 Marks)** - Summative Assessment.

**4. Course Content:**

**Course Name:** Antennas and Radiating Systems Laboratory

**Course Code:** ECM-213

**Hours per Week:** 0L: 0T: 2P

**Credits:** 1

Module	Topics	13L
1.	Simulation of half wave dipole antenna.	3L
2.	Simulation of change of the radius and length of dipole wire on frequency of resonance of antenna.	2L
3.	Simulation of monopole antenna with and without ground plane.	2L
4.	Simulation of a half wave dipole antenna array.	4L
5.	Simulation of Micro strip patch antenna (2.4GHz).	2L

## **5. References**

### **Textbooks**

- C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
- J.D. Kraus, Antennas, McGraw Hill, 1988.

### **Reference Books**

- R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985

**\*\*\* End of Syllabus\*\*\***

**Course Name: Adaptive Signal processing laboratory**

**Course Code: ECM-291**

**Course Type: PC  
(Semester – II)**

**Course Broad Category: (Major)**

**1. Course Prerequisite:**

Subject knowledge of Signals and System and DSP required.

**2. Course Learning Objectives:**

- (i) This course introduces the concepts about adaptive filter and their applications.
- (ii) Students will also learn to design and analyze of impulse response and transfer function of unknown LTV System.

**3. Teaching methodology and evaluation system for the course:**

**Teaching methodology: Instruction:** This method recognizes that students have different learning styles, abilities, and backgrounds, and aims to create a learning environment that accommodates these differences.

**Evaluation System –**

- A. **Internal Assessment (60 Marks)-** Formative Continuous Assessment [Continuous Assessment; Note Book (30 Marks), Viva Voce (20 Marks), Attendance (10 Marks)]
- B. **End-Semester Exam (40 Marks)-** Summative Assessment.

**4. Course Content:**

**Course Name:** Adaptive Signal Processing laboratory

**Course Code:** ECM-291

**Hours per Week:** OL: OT: 3P

**Credits:** 1

Module	Topics	10P
1.	<b>Convolution and Correlation</b>  i. MATLAB implementation of discrete-time convolution sum ii. Auto-correlation and cross-correlation of signals.	2P
2.	<b>Eigenvalue and Eigenvector Computation</b>  i. MATLAB code to compute eigenvalues and eigenvectors of a matrix	1P
3.	<b>System Identification Using Adaptive Filtering</b>  ii. Implementation of the <b>Least Mean Squares (LMS) Algorithm</b> iii. Implementation of the <b>Normalized LMS (NLMS) Algorithm</b>	2P

<b>Module</b>	<b>Topics</b>	<b>10P</b>
4.	<b>Sparse System Identification Techniques</b> <ol style="list-style-type: none"> <li>i. Implementation of <b>Proportionate NLMS (PNLMS) Algorithm</b></li> <li>ii. Implementation of <b>Improved PNLMS (IPNLMS) Algorithm</b></li> <li>iii. Implementation of <b>Zero-Attracting NLMS (ZA-NLMS) Algorithm</b></li> <li>iv. Implementation of <b>Zero-Attracting PNLMS (ZA-PNLMS) Algorithm</b></li> </ol>	4P
5.	<b>Block Sparse System Identification</b> <ol style="list-style-type: none"> <li>i. MATLAB implementation of <b>Block Sparse PNLMS (BS-PNLMS) Algorithm</b></li> </ol>	1P

## 5. References

### Text Books

- S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
- C.Widrow and S.D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

### Reference Book

- Behrouz Farhang- Boroujeny Adaptive Filters: Theory and Applications” Second Edition.

**\*\*\* End of Syllabus\*\*\***