# ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

**Syllabus (Effective from 2023-24)**

**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

**Abbreviation used:**

| | | | | | |
|---|---|---|---|---|---|
| AC | Audit course | LC | Lab Course | PA | Practical Assessment |
| PC | Professional Core | PR | Project/ Practical/ Internship | L | Lecture |
| PE | Professional Elective | SE | Seminar/ Expert Lecture/ Etc. | T | Tutorial |
| OE | Open Elective | IA* | Internal Assessment | P | Practical |
| MC | Mandatory/ Common Course | EA | End-Semester Assessment | | |

**Subject Code Format:**

| A1 | A2 | B3 | C4 | C5 | C6 |
|---|---|---|---|---|---|
| **School/ Dept. (Offering)**<br>**BH:** Basic Sciences and Humanities<br>**CS:** Computer Sciences<br>**EE:** Electrical Sciences<br>**EI:** Electronic Sciences<br>**IP:** Infrastructure and Planning<br>**MS:** Mechanical Sciences<br>**BT:** Biotechnology<br>**TE:** Textile Engineering | | **Level**<br>**1:** UG/ Int. Msc. (1st Year)<br>**2:** UG/ Int. Msc. (2nd Year)<br>**3:** UG/ Int. Msc. (3rd Year)<br>**4:** UG/ Int. Msc. (4th Year)<br>**5:** UG/ Int. Msc. (5th Year)<br>**6:** PG (1st Year)<br>**7:** PG (2nd Year)<br>**8:** Ph.D. | **0:** AC<br>**1:** PC<br>**2:** PE<br>**3:** OE<br>**4:** MC<br>**5:** LC<br>**6:** PR<br>**7:** SE<br>**8:**<br>**9:** | **Serial Number (01 to 99)**<br>01/ 03/…/ 19: Odd Sem. (ECE)<br>21/ 23/…/ 39: Odd Sem. (ICE)<br>41/ 43/…/ 59: Odd Sem. (VLSI)<br>61/ 63/…/ 79: Odd Sem. (Prog-4)<br>81/ 83/…/ 99: Odd Sem. (Prog-5)<br>02/ 04/…/ 20: Even Sem. (ECE)<br>22/ 24/…/ 40: Even Sem. (ICE)<br>42/ 44/…/ 60: Even Sem. (VLSI)<br>62/ 64/…/ 80: Even Sem. (Prog-4)<br>82/ 84/…/ 98: Even Sem. (Prog-5) | |

## 1st Semester

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours | | | Credit | Maximum Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | PC 1 | EI6101 | Advanced Communication Techniques | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| 2 | PC 2 | EI6103 | Wireless Communication | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| 3 | PE 1 (Any One) | EI6201 | Satellite Communication System | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| | | EI6203 | Cognitive Radio | | | | | | | | |
| | | EI6205 | Advanced Communication Networks | | | | | | | | |
| | | EI6207 | Sensor Networks and IoT | | | | | | | | |
| 4 | MC 1 | BH6401 | Mathematical Methods in Engineering | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| 5 | MC 2 | MS6403 | Research Methodology and IPR | 2 | 0 | 0 | 2 | 40 | 60 | - | 100 |
| 6 | LC 1 | EI6501 | Advanced Communication Lab - I | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| 7 | LC 2 | EI6503 | Wireless Communication Lab | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| 8 | AC 1 | Any One from the List of AC 1 (Appendix-I) | | 2 | 0 | 0 | 0 | 40 | 60 | - | 100 |
| | | | **Total** | **16** | **0** | **8** | **18** | **240** | **360** | **200** | **800** |

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## 2nd Semester

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours | | | Credit | Maximum Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | PC 3 | EI6102 | Information Theory and Coding Techniques | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| 2 | PC 4 | EI6104 | Optical Communication | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| 3 | PE 2 (Any One) | EI6202 | RF and Microwave Circuit Design | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| | | EI6204 | VLSI Signal Processing | | | | | | | | |
| | | EI6206 | Advanced Digital Signal Processing | | | | | | | | |
| 4 | PE 3 (Any One) | EI6208 | Adaptive Signal Processing | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| | | EI6210 | Antennas and Radiating Systems | | | | | | | | |
| | | EI6212 | Optical Networks | | | | | | | | |
| | | EI6214 | Advanced Radar System Engg | | | | | | | | |
| 5 | OE 1 | Any One from the List of OE 1 (Appendix-I) | | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| 6 | PR 1 | EI6602 | Project (Specialization Related) | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| 7 | LC 3 | EI6502 | Advanced Communication Lab – II | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| 8 | AC 2 | Any One from the List of AC 2 (Appendix-I) | | 2 | 0 | 0 | 0 | 40 | 60 | - | 100 |
| | | | **Total** | **17** | **0** | **8** | **19** | **240** | **360** | **200** | **800** |

## 3rd Semester

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours | | | Credit | Maximum Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | PE 4* (Any One) | EI7201 | Multimedia Signal Processing | 3 | 0 | 0 | 3 | 40 | 60 | - | 100 |
| | | EI7203 | Mobile Computing | | | | | | | | |
| | | EI7205 | Emerging Trends in Communication | | | | | | | | |
| | | EI7207 | Network Security and Cryptography | | | | | | | | |
| 2 | PR 2 | EI7601 | Dissertation (Phase-I) | 0 | 0 | 24 | 12 | - | - | 100 | 100 |
| | | | **Total** | **3** | **0** | **24** | **15** | **40** | **60** | **100** | **200** |

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

## 4th Semester

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours | | | Credit | Maximum Marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | PR 3 | EI7602 | Dissertation (Phase-II) | 0 | 0 | 32 | 16 | - | - | 100 | 100 |
| | | | **Total** | **0** | **0** | **32** | **16** | **-** | **-** | **100** | **100** |

## Credits and Maximum Marks

| Sl. No. | Semester | Credits | Maximum Marks |
|---|---|---|---|
| 1 | 1st | 18 | 800 |
| 2 | 2nd | 19 | 800 |
| 3 | 3rd | 15 | 200 |
| 4 | 4th | 16 | 100 |
| | Total | 68 | 1900 |

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## 1st SEMESTER

| | | | | | | |
|---|---|---|---|---|---|---|
| PC 1 | EI6101 | Advanced Communication Techniques | 3 | 0 | 0 | 3 |

**Prerequisite:** Probability and Statistics
**Course Outcomes:**
At the end of the course students will be able to,

1. Calculate orthogonal components of a given signal.
2. Compute various statistical averages of probability density function.
3. Evaluate BER of a given modulation scheme over an AWGN channel.
4. Evaluate and analyze the spectrum of a given modulation scheme.

**Module I**
Review of Fundamentals:
Bandpass and Low pass signals, Low pass equivalent of band pass signals, Energy Considerations, , Low pass equivalent of band pass systems, Vector Space Concepts, Signal Space Concepts, Orthogonal Expansion of Signals, Gram Schmidt Orthogonalization Procedure, Bandpass and Lowpass random processes, WSS random process, Sampling Theorem for Bandlimited random processes, Bounds on tail probability, Limit Theorems for sums of random variables

**Module II**
Digital Modulation Schemes:
Basic differences between analog and digital modulation schemes, Representation of Digitally Modulated Signals, Memoryless Modulation Methods, Pulse Amplitude Modulation, Quadrature Amplitude Modulation, Multidimensional Signaling, Signaling Schemes with memory, Continuous Phase Frequency Shift Keying, Power Spectrum of Digitally Modulated Signals, Power Spectral Density of Linearly Modulated Signals, Power Spectral Density of Digitally Modulated Signals with finite memory, Power Spectral Density of CPFSK and CPM signals
Optimum Receivers for AWGN Channels:
Waveform and vector channel models: Optimum Detection for a general vector channel, Waveform and Vector AWGN Channels; Optimal Detection for the Vector AWGN Channel, Implementation of the Optimal receiver for the AWGN channels, Optimal detection and error probability for ASK, PAM, PSK and QAM Signaling

**Module III**
Digital Communication through Bandlimited Channels:
Characterization of bandlimited channels, Signal Design for band limited channels, Design of band limited signals for no inter symbol interference, The Nyquist criterion, Zero forcing equalizer, the minimum mean square error (MMSE) equalizer
Spread Spectrum Signals for Digital Communication:
Pseudo noise sequence, Properties of PNS, Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum signals, Error rate performance of a decoder, Frequency hopped spread spectrum signals, Performance of FH-SS in AWGN

**Text Book:**
1. John G.Proakis and MasoudSalehi, " Digital Communication", McGraw Hill, 5thEdn.

**Reference Book:**
1. Simon Haykin, "Digital Communications", Willey 4th edition

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| | | | | | | |
|---|---|---|---|---|---|---|
| PC 2 | EI6103 | Wireless Communication | 3 | 0 | 0 | 3 |

**Prerequisite:** Probability and Statistics, Digital Communication

**Course Outcomes:**

At the end of the course, students will be able to,

1. Evaluate system capacity in a cellular network
2. Model a given wireless channel
3. Evaluate BER of a given modulation format in a given wireless channel
4. Analyze fading statistics
5. Compute the spectrum of a given modulation format
6. Analyze a given equalization scheme

**Module I**

Cellular concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3G cellular standards.

Signal propagation: Propagation mechanism, reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing.

**Module II**

Fading channels: multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

Multiple access schemes: FDMA, TDMA, CDMA and SDMA.

Modulation Schemes: MSK and GMSK, multicarrier modulation, OFDM.

**Module III**

Receiver structure: diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE, Maximum Likelihood Sequence Estimation (MLSE)

MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing trade off.

Performance measures: outage, average snr, average symbol/bit error rate.

System examples: GSM, EDGE, GPRS, CDMA 2000 and WCDMA.

**Text Books:**


1. T. S. Rappaport, Wireless digital communications: Principles and practice, 2ndEd.Prentice Hall India, 2007.
2. W. C. Y. Lee, Wireless and Cellular Telecommunications, 3rd Ed., MGH, 2006.
3. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.


**Reference Books:**


1. G. L. Stuber, Principles of mobile communications, 2nd Ed., Springer, 2007.
2. Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson education, 2005.

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| | | | | | | |
|---|---|---|---|---|---|---|
| PE 1 | EI6201 | Satellite Communication System | 3 | 0 | 0 | 3 |

**Prerequisites:** Basics of Analog and Digital Communication

**Course Outcomes:**

At the end of this course, students will be able to,

1. Define orbital mechanics and launching methodologies of satellites.
2. Analyze the satellite subsystems
3. Design link power budget for satellites.
4. Compare competitive satellite services

**Module I**

Architecture of Satellite Communication System: Principles and architecture of satellite Communication, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.
Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee andPerigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.

**Module II**

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.
Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions,

**Module III**

Modulation and Multiple Access Schemes (CDMA, TDMA, FDMA) used in satellite communication Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ISRO. GPS.

**Text Books:**


1. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.
2. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.


**Reference Books:**


1. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.
2. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.

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| | | | | | | |
|---|---|---|---|---|---|---|
| PE 1 | EI6203 | Cognitive Radio | 3 | 0 | 0 | 3 |

**Prerequisite:** Wireless Communication, Mobile Communication

**Course Outcomes:**
At the end of this course, students will be able to
1. Apply the fundamental concepts of Software defined Radios.
2. Implement the fundamental concepts of cognitive radio networks.
3. Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
4. Analyze technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
5. Interpret fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation.

**Module-I**
Introduction to Software Defined Radios (SDR):
Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications.
SDR Architecture:
Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules
**Module-II**
Introduction to Cognitive Radios: Cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio. Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).
**Module-III**
Dynamic Spectrum Access and Management:
Spectrum broker, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.
Spectrum Trading:
Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

**Text Books:**

1. Ekram Hossain, DusitNiyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Joseph Mitola III, "Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000.
3. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
4. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
5. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007
6. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
7. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

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| | | | | | | |
|---|---|---|---|---|---|---|
| PE 1 | EI6205 | Advanced Communication Networks | 3 | 0 | 0 | 3 |

**PREREQUISITE:** Introductory knowledge of communication networks.

**Course Outcomes:**

At the end of this course, students will be able to

1. Analyze tools and conceptual models used in network performance analysis, ipv6 protocol, and their main characteristics and functionality.
2. Recognize the need for service integration and its accomplishment.
3. Evaluate the current QoS architectures and mechanisms, and the QoS support challenges in future networks;
4. Analyze the design issues in transport services in face of applications and services requirements;
5. Visualize relevant management issues and devise adequate network management solutions;
6. Identify and assess possible research opportunities and difficulties within the course scope.

**Module I**

Overview of Internet-Concepts, challenges and history. Overview of -ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP. Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.; Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties.

**Module II**

Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

**Module III**

IP address lookup-challenges. Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms. Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework. IPV4, IPV6, IP tunneling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

**Text Books:**


1. Jean Wairand and PravinVaraiya, “High Performance Communications Networks”, 2nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, “Network Calculus A Theory of Deterministic Queueing Systems for the Internet”, Springer Veriag, 2001.


**Reference Books:**


1. Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.
2. Anurag Kumar, D. Manjunath and Joy Kuri, “Communication Networking: An Analytical Approach”, Morgan Kaufman Publishers, 2004.
3. George Kesidis, “ATM Network Performance”, Kluwer Academic, Research Papers, 2005.

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| | | | | | | |
|---|---|---|---|---|---|---|
| PE 1 | EI6207 | Sensor Networks and IoT | 3 | 0 | 0 | 3 |

**Prerequisite:** Basic programming knowledge

**Course Outcomes:**
At the end of this course, students will be able to
1. Identify requirements from emerging WSN applications on WSN platforms, communication systems, protocols and middleware.
2. Compare and evaluate communication and network protocols used in WSNs.
3. Analyze and evaluate mechanisms and algorithms for time synchronization and localization in WSNs.
4. Elaborate requirements for the design of security mechanisms and middleware systems to be used in WSNs.

**Module I**
Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security
IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.
Real-World Design Constraints- Introduction, Technical Design constraints hardware, Data representation and visualization, Interaction and remote control.

**Module II**
Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one-commercial building automation today, Case study: phase two-commercial building automation in the future.

**Module III**
Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases.
IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry, Interface and Programming & IOT Device, Recent trends in sensor network and IOT architecture, Automation in Industrial aspect of IOT

**Text Book:**

1. Mandler, B., Barja, J., MitreCampista, M.E., Cagá_ová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing.


**Reference Books:**

1. Arsheep Bahga, Vijay Madisatti "Internet of Things: A Hands-On Approach", Orient Blackswan Private Limited - New Delhi; First edition (2015)
2. AJ Jun Zheng, "Wireless Sensor Networks: A Networking Prospective" Wiley; 1 edition (2014)

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| | | | | | | |
|---|---|---|---|---|---|---|
| MC 1 | BH6401 | Mathematical Methods in Engineering | 3 | 0 | 0 | 3 |

**Refer Appendix-I for detailed Syllabus.**

| | | | | | | |
|---|---|---|---|---|---|---|
| MC 2 | MS6403 | Research Methodology and IPR | 2 | 0 | 0 | 2 |

**Refer Appendix-I for detailed Syllabus.**

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| | | | | | | |
|---|---|---|---|---|---|---|
| LC 1 | EI6501 | Advanced Communication Lab - I | 0 | 0 | 4 | 2 |

**Prerequisite:** Fundamentals of electrical communication

**Course Outcomes:**
1. To design and test various communication circuits using discrete components.
2. To design and test various circuits using FPAA.
3. Simulation of the circuits using Simulink.

**Group A**
1. Design a circuit to generate Pseudo Noise (PN) Sequence of length 15 with deadlock avoidance and perform Direct Sequence Spread Spectrum (DSSS) to information having baud rate of 1kbps.
2. To design and verify the operation of 4QAM modem at baseband.
3. To design and verify the operation of 8QAM modem at baseband.
4. Design a 3-bit/4-bit Analog to Digital Converter (ADC).
5. To design and verify the operation of Pulse Code Modulation.
6. Simulate the above experiments using Simulink/LabVIEW.

**Group B**
1. Design and verify the operation of Amplitude Shift Keying (ASK) modulator and demodulator.
2. Design and verify the operation of Frequency Shift Keying (FSK) modulator and demodulator.
3. Design and verify the operation of Binary Phase Shift Keying (BPSK) modulator and demodulator.
4. To design and demonstrate the working of Time Division Multiplexing (TDM) and recovery of two band limited signals of PAM signals.
5. To design and demonstrate the working of Frequency Division Multiplexing (FDM) for two band limited signals.
6. Simulate the above experiments using FPAA (Field Programmable Analog Array).

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| | | | | | | |
|---|---|---|---|---|---|---|
| LC 2 | EI6503 | Wireless Communication Lab | 0 | 0 | 4 | 2 |

**Prerequisite:** Students should have prior knowledge of fundamentals of analog & digital communication, wireless communication, satellite communication & mathematics for communication engineers.

**Course Outcomes:**
Acquire basic knowledge of MATLAB, ability to design different circuits & derive the mathematical equation for different model.

**List of Experiments:**
1. Generate a Pseudo Random Binary Sequence (PRBS)
2. Pre-emphasis & De-emphasis
3. Pulse amplitude modulation & demodulation
4. Pulse width modulator
5. Pulse position modulation & demodulation
6. Frequency division multiplexing & de-multiplexing.
7. Link budget for satellite communication.
8. Free space path loss model and determine the carrier to noise ratio.
9. Outdoor propagation- Okumura model.
10. Outdoor propagation – Hata model.
11. To study generation (spreading) & demodulation (De-spreading) of DSSS modulated signal.
12. To study GPS data like longitude, latitude using GPS receiver

**Books to be referred:**

1. Getting started with MATLAB: A quick introduction for scientist & engineers by Rudrapratap, oxford university press.
2. Wireless communication: Principles and practice by T.S Rappaport, PHI publication.
3. Mathematics for communication engineers by T. K Moon, TMH publication.

| | | | | | |
|---|---|---|---|---|---|
| AC 1 | Any One from the List of AC 1 (Appendix-I) | 2 | 0 | 0 | 0 |

**Refer Appendix-I for detailed Syllabus.**

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## 2nd Semester

| | | | | | | |
|---|---|---|---|---|---|---|
| PC 3 | EI6102 | Information Theory and Coding Techniques | 3 | 0 | 0 | 3 |

**Prerequisite:** Communication Engineering

**Course Outcomes**
At the end of this course, students will be able to
1. Determine the amount of information per symbol and information rate of a discrete memoryless source and can Design the channel performance.
2. Comprehend various error control code properties
3. Apply linear block codes for error detection and correction
4. Apply convolution codes for performance analysis & cyclic codes for error detection and correction.
5. Design BCH & RS codes for Channel performance improvement against burst errors.

**Module I**
Entropy, Relative Entropy, and Mutual Information: Entropy, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information, Chain Rules, Data-Processing Inequality, Fano's Inequality
Typical Sequences and Asymptotic Equipartition Property: Asymptotic Equipartition Property Theorem, Consequences of the AEP: Data Compression, High-Probability Sets and the Typical Set

**Module II**
Source Coding and Data Compression: Kraft Inequality, Huffman Codes, Optimality of Huffman Codes, Shannon–Fano–Elias Coding, Competitive Optimality of the Shannon Code
Channel Coding Theorem, Zero-Error Codes, Fano's Inequality and the Converse to the Coding Theorem

**Module III**
Linear Binary Block Codes: Introduction, Generator and Parity-Check Matrices, Repetition and Single-Parity-Check Codes, Binary Hamming Codes, Error Detection with Linear Block Codes, Weight Distribution and Minimum Hamming Distance of a Linear Block Code, Hard-decision and Soft-decision Decoding of Linear Block Codes, Cyclic Codes, Parameters of BCH and RS Codes, Interleaved and Concatenated Codes.

**Text Books:**
1. Elements of Information Theory by Thomas Cover, Joy Thomas, second edition, A JOHN WILEY & SONS, INC., PUBLICATION
2. Channel Codes: Classical and Modern by William Ryan, Shu Lin, Cambridge University Press

**Reference Book:**
1. Information Theory and Reliable Communication by Robert Gallager, ISBN: 978-0-471-29048-3

# ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

**Syllabus (Effective from 2023-24)**

**School/ Department: School of Electronic Sciences**

**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PC 4 | EI6104 | Optical Communication | 3 | 0 | 0 | 3 |

**Prerequisites:** Basic Optical Laws, Wave propagation in circular waveguide

**Course Outcomes:**

At the end of this course, students will be able to

1. Distinguish various modes of operation of optical fibers.
2. Elaborate different types of losses in optical fiber and the pulse broadening resulting from the effect of dispersion.
3. Analyze the operation of optical receiver and various effects introducing noise in the system.
4. Elaborate the different elements of an optical fiber link.
5. Analyze the application areas of optical fiber amplifiers.

**Module I**

Elements of an Optical Fiber Communication link, Optical Fiber Modes and Configurations, Mode Theory for Circular Waveguides, Single-mode Fibers, and Graded-Index Fiber Structure.

Elementary ideas on Fiber Materials, Fiber Fabrication and Fiber Optic Cables.

Attenuation, Signal Distortion in Optical Waveguides, Pulse Broadening in Graded-Index Fiber guides, Design optimization of Single-Mode-Fibers (Elementary concepts).

**Module II**

Basic ideas of light sources and their principle of operation (LEDs and LASERS), Physical Principles of Photodetectors, Avalanche Photodiodes.

Optical Receiver Operation (Fundamentals), Receiver noises, Digital Transmission Systems.

Coherent Optical Fiber Communications; Definition and Classification of Coherent System, Fundamental Concepts; Homodyne Detection, Heterodyne Detection, Direct-Detection OOK, OOK Homodyne System, PSK Homodyne System, Heterodyne Detection Schemes.

**Module III**

Point-to-Point Links; Link Power Budget, Rise-Time Budget, Transmission Distance for Single-Mode Links. Wavelength Division Multiplexing, Optical Amplifiers; Type of Amplifiers with expression for gains and noise figure, Raman Amplifiers, Optical bandwidth, Photonic Switching Integrated Optical Switches.

**Text Books:**


1. Gerd Keiser, “Optical Fiber Communications, 4th Edition”, Mc Graw Hill.
2. C. K. Sarkar, D. C. Sarkar, “Opto Electronics and Fiber Optics Communication”, New Age International Publishers (p) Limited, Delhi.


**Reference Book:**


1. Max Ming-Kang Liu, “Principles and Applications of Optical Communications”, TATA Mc Graw-Hill Edition 2010

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**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 2 | EI6202 | RF and Microwave Circuit Design | 3 | 0 | 0 | 3 |

**Prerequisite:** Field Theory, Calculus

**Course Outcomes:**
At the end of this course, students will be able to,
1. Analyze the behavior of RF passive components and model active components.
2. Perform transmission line analysis.
3. Demonstrate use of Smith Chart for high frequency circuit design.
4. Justify the choice/selection of components from the design aspects.
5. Design different microwave device modeling.

**Module I**
Transmission Line Theory:
Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.
Microwave Network Analysis:
Impedance and equivalent voltage and current, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.

**Module II**
Microwave Components:
Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.
Microwave Semiconductor Devices and Modeling:
PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, MESFET, MOSFET, CMOS

**Module III**
Amplifiers Design:
Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators, Mixers design.

**Text Books:**

1. Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design", AuthorHouse, 2009.
2. D.M.Pozar, " Microwave engineering" ,Wiley, 4th edition, 2011.


**Reference Books:**

1. R.Ludwig and P.Bretchko, "R. F. Circuit Design", Pearson Education Inc, 2009.
2. G.D. Vendelin, A.M. Pavoi, U. L. Rohde, "Microwave Circuit Design Using Linear and Non Linear Techniques", John Wiley 1990.
3. S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.
4. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education, 2004

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**Syllabus (Effective from 2023-24)**

**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 2 | EI6204 | VLSI Signal Processing | 3 | 0 | 0 | 3 |

**Prerequisite:** Concepts of DSP systems and its architecture., Basic knowledge on DSP Concepts and FIR digital filters.

**Course Outcomes:**
At the end of this course, students will be able to,
1. Apply the various VLSI architectures and algorithms for digital signal processing.
2. Analyze the various pipelining and parallel processing techniques
3. Calibrate the techniques of critical path and Algorithmic Strength Reduction in the filter structures.
4. Describe the basic ideas of power Analysis in DSP systems.

**Module I**
DSP Concepts: Linear system theory, DFT, FFT, realization of digital filters. Typical DSP algorithms, DSP applications. Data flow graph representation of DSP algorithm.

**Module II**
Architectural Issues: Binary Adders, Binary multipliers, Multiply Accumulator (MAC) and Sum of Product (SOP).
Pipelining and Parallel Processing, Retiming, Unfolding, Folding and Systolic architecture design.
Fast Convolution: Cook-Toom algorithm, modified Cook-Toom algorithm, Winograd algorithm, modified Winograd algorithm

**Module III**
Algorithmic strength reduction in filters and transforms: DCT and inverse DCT, parallel FIR filters.
Power Analysis in DSP systems: Scaling versus power consumption, power analysis, power reduction techniques, power estimation techniques, low power IIR filter design, Low power CMOS lattice IIR filter.

**Text Books:**

1. Keshap K. Parhi, VLSI Digital Signal Processing Systems, Design and Implementation, John Wiley, 2007.
2. U. Meyer-Baese, Digital Signal processing with Field Programmable Arrays, Springer, 2007.


**Reference Books:**

1. V. K. Madisetti, VLSI Digital Signal Processors: An Introduction to Rapid Prototyping and Design Synthesis, IEEE Press, New York, 1995.
2. S. Y. Kung, H. J. Whitehouse, VLSI and Modern Signal Processing, Prentice Hall, 1985.

## School/ Department: School of Electronic Sciences
## Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 2 | EI6206 | Advanced Digital Signal Processing | 3 | 0 | 0 | 3 |

**Prerequisite:** Digital Signal Processing, basic knowledge of Undergraduate Mathematics

**Course Outcomes:**
At the end of this course, students will be able to,
1. Analyze the modern digital signal processing algorithms and applications.
2. Apply theory of multirate DSP and solve numerical problems and write algorithms
3. Analyze theory of prediction and solution of normal equations
4. Analyze the power spectrum estimation (4 or 5 methods).
5. Design digital systems in real time applications
6. Apply the algorithms for wide area of recent applications.

**Module I**
Multirate Digital Signal Processing
Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Implementation of Sampling Rate Conversion: Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion of Band-pass Signals, Sampling Rate Conversion by an Arbitrary Factor: Applications of Multirate Signal Processing, Digital Filter Banks.

**Module II**
Linear Prediction and Optimum Linear Filters
Random Signals, Correlation Functions, and Power Spectra, Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Properties of the Linear Prediction-Error Filters, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction

**Module III**
Power Spectrum Estimation
Estimation of Spectra from Finite-Duration Observations of Signals, Computation of the Energy Density Spectrum, Estimation of the Autocorrelation and Power Spectrum of Random Signals: The Period gram, The Use of the DFT in Power Spectrum Estimation, Nonparametric Methods for Power Spectrum Estimation: Parametric Methods for Power Spectrum Estimation.

**Text Books:**
1. John G. Proakis, Dimitris G. Manolakis Digital Signal Processing: Principles, Algorithms, and Applications,4th edition
2. Alan V. Oppenheim, Ronald W. Schafer Discrete-Time Signal Processing, 2011, Pearson Education India.

**Reference Book:**
1. Nagoorkani, Digital Signal Processing, Tata McGraw-Hill Education.

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**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 3 | EI6208 | Adaptive Signal Processing | 3 | 0 | 0 | 3 |

**Prerequisites:** Signals and Systems, DSP, linear algebra, random process

**Course Outcomes:**
At the end of the course, students will be able to
1. Comprehend design criteria and modelling adaptive systems.
2. Apply mathematical models for error performance and stability of adaptive systems.
3. Analyze gradient estimation based on performance surface in adaptive systems.
4. Implement LMS algorithm for signal processing applications.
5. Design Kalman filter for adaptive noise cancellation

**Module I**
Introduction to Adaptive Filters: Adaptive filter structures, issues and examples. Applications of adaptive filters, Channel equalization, active noise control. Echo cancellation, beamforming.
Discrete time stochastic processes: Re-visiting probability and random variables. Discrete time random processes, Power spectral density - properties. Autocorrelation and covariance structures of discrete time random processes.
Eigen-analysis of autocorrelation matrices.

**Module II**
Wiener filter, search methods and the LMS algorithm: Wiener FIR filter (real case). Steepest descent search and the LMS algorithm. Extension of optimal filtering to complex valued input. The Complex LMS algorithm. Convergence and Stability Analyses: Convergence analysis of the LMS algorithm. Learning curve and mean square error behavior. Weight error correlation matrix. Dynamics of the steady state mean square error (MSE).
Misadjustment and stability of excess MSE. Variants of the LMS Algorithm: The sign-LMS and the normalized LMS algorithm. Block LMS. Review of circular convolution. Overlap and save method, circular correlation. FFT based implementation of the block LMS Algorithm.

**Module III**
Vector space framework for optimal filtering: Axioms of a vector space, examples, subspace. Linear independence, basis, dimension, direct sum of subspaces. Linear transformation, examples. Range space and null space, rank and nullity of a linear operator. Inner product space, orthogonality, Gram-Schmidt orthogonalization. Orthogonal projection, orthogonal decomposition of subspaces. Vector space of random variables, optimal filtering as an orthogonal projection computation problem.
The lattice filter and estimator: Forward and backward linear prediction, signal subspace decomposition using forward and backward predictions. Order updating the prediction errors and prediction error variances, basic lattice section. Reflection coefficients, properties, updating predictor coefficients. Lattice filter as a joint process estimator. AR modeling and lattice filters. Gradient adaptive lattice.
RLS lattice filter: Least square (LS) estimation, pseudo-inverse of a data matrix, optimality of LS estimation. Vector space framework for LS estimation. Time and order updating of an orthogonal projection operator. Order updating prediction errors and prediction error power. Time updating PARCOR coefficients.

**Text Book:**
1. S. Haykin, Prentice Hall, Englewood Cliffs, NJ "Adaptive Filter Theory", 1991

**Reference Book:**
1. B. Farhang - Boroujeny, John Wiley and Sons "Adaptive Filters Theory and Applications", 1999.

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## Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 3 | EI6210 | Antennas and Radiating Systems | 3 | 0 | 0 | 3 |

**Prerequisite:** Electromagnetic Field theory

**Course Outcomes:**

At the end of this course, students will be able to

1. Compute the far field distance, radiation pattern and gain of an antenna for given current distribution.
2. Estimate the input impedance, efficiency and ease of match for antennas.
3. Compute the array factor for an array of identical antennas.
4. Design antennas and antenna arrays for various desired radiation pattern characteristics.

**Module I**

Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects.

Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

**Module II**

Linear Arrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration.

Microstrip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.

**Module III**

Broadband Antennas: Broadband concept, Log-periodic antennas, frequency independent antennas, Yagi-Uda antennas

Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture.

**Text Books:**


1. Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons, 4th edition, 2016.
2. John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas for All Applications", Tata McGraw-Hill, 2002.


**Reference Books:**


1. R.C. Johnson and H. Jasik, "Antenna Engineering hand book", Mc-Graw Hill, 1984.
2. I.J. Bhal and P. Bhartia, "Micro-strip antennas", Artech house, 1980.

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## Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 3 | EI6212 | Optical Networks | 3 | 0 | 0 | 3 |

**Prerequisite:** Basic Optical Fiber Communication.

**Course Outcomes:**

At the end of this course, students will be able to,

1. Differentiate losses in optical fiber link and state transmission characteristics of optical fiber.
2. Design optical fiber communication links using appropriate optical fibers light sources, detectors.
3. Explore concept of designing and operating principles of modern optical systems and networks
4. Apply different network access schemes and packet switching in OFC systems.
5. Design and manage networks with appropriate consideration.

**Module I**

Introduction to Optical Network: - Optical Networks: multiplexing techniques, second generation optical networks. The optical layer, optical packet switching.

Transmission Basics: wavelength, frequencies and channel spacing, wavelength standards. Non-linear Effects: Effective length and area, stimulated brillouin scattering, stimulated Raman scattering, Propagation in a non-linear medium, self-phase modulation, cross phase modulation Four wave mixing. Components: Couplers: Principles of operation, Conservation of energy, Isolators and circulators: Principles of operation

**Module II**

Multiplexers and filters: Gratings, diffraction pattern, Bragg grating, Fiber gratings, Fabry-perot filters, multilayers dielectric thin – film filters,

Mach-Zehnder interferometers, Arrayed waveguide grating, Acousto-optic tunable filter, High channel count multiplexer Architecture.

Switching: large optical switches, Optical switch Technologies, large electronic switches wavelength converters: Optoelectronic Approach, optical grating, interferometric techniques wave mixing. Crosstalk: Intra-channel crosstalk, inter-channel crosstalk, crosstalk in Networks, Bidirectional system crosstalk reduction.

**Module III**

WDM Network Design Cost Trade-offs, Light path Topology Design, and Routing and wavelength assignment problems, Dimensioning Wavelength Routing Networks, Network Survivability, Basic Concepts, Protection in SONET/SDH, Protection in client layer, Optical Layer Protection, Different Schemes, Interworking between Layers, Access Networks, Network Architecture Overview, Enhanced HFC, FTTC, PON evolution.

Optical Switching, OTDM, Synchronization, Header Processing, Buffering, Burst Switching, Deployment Considerations- SONET/SDH core Network Optical Switching, OTDM, Synchronization, Header Processing, Buffering, Burst Switching, Deployment Considerations- SONET/SDH core Network

**Textbooks:**


1. R. Ramaswami, & K. N. Sivarajan, “Optical Networks a Practical perspective”, Morgan Kaufmann Publishers, 3rd Ed.
2. U. Black, “Optical Networks: Third Generation Transport Systems”/ Pearson Educations


**Reference Book:**


1. Biswanath Mukherjee “Optical WDM Networks” Springer Pub 2006.

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**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 3 | EI6214 | Advanced Radar System Engg | 3 | 0 | 0 | 3 |

**Prerequisite:** Fundamentals of electromagnetics, Probability

**Course Outcomes:**
At the end of this course, students should be able to:
1. Analyze the essential principles of operation of radar systems
2. Apply appropriate mathematical and computer models relevant to radar systems to calculate system performance, and assess the limitations of particular cases
3. Design simple radar systems and the associated signal processing, at block diagram level
4. Analyze the performance of simple tracking radar systems

**Module I**
Basics of Radar: Introduction, Maximum Unambiguous Range, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation, Illustrative Problems.
Radar Equation: SNR, Envelope Detector — False Alarm Time and Probability, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets – sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.

**Module II**
CW and Frequency Modulated Radar: Doppler Effect, CW Radar — Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. Illustrative Problems
FM-CW Radar: Range and Doppler Measurement, Block Diagram and Characteristics, FM-CW altimeter, Multiple Frequency CW Radar.

**Module III**
MTI and Pulse Doppler Radar: Introduction, Principle, MTI Radar with – Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancelers — Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters.
Tracking Radar: Tracking with Radar, Sequential Lobing, Conical Scan, Monopulse Tracking Radar — Amplitude Comparison Monopulse (one- and two- coordinates), Phase Comparison

**Text Books:**

1. Men* I. Skolnik, Introduction to Radar Systems, TMH Special Indian Edition, 2nd Ed. Mcgraw Higher Ed - 2017
2. Byron Edde, Radar Principles, Technology. Applications, Pearson Education, 2004.


**Reference Books:**

1. Peebles. Jr., P.Z. Wiley., Radar Principles New York, 1998.
2. A. Rkhards, James A. Scheer, William A. HoIm. Principles of Modem Radar: Basic Principles – Mark Yesdee, 2013

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**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

| | | | | | |
|---|---|---|---|---|---|
| OE 1 | Any One from the List of OE 1 (Appendix-I) | 3 | 0 | 0 | 3 |

**Refer Appendix-I for detailed Syllabus.**

| | | | | | | |
|---|---|---|---|---|---|---|
| PR 1 | EI6602 | Project (Specialization Related) | 0 | 0 | 4 | 2 |

## School/ Department: School of Electronic Sciences
## Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)

| | | | | | | |
|---|---|---|---|---|---|---|
| LC 3 | EI6502 | Advanced Communication Lab – II | 0 | 0 | 4 | 2 |

**Prerequisite:** Basic working knowledge of MATLAB, Simulink, LabVIEW

**Course Outcomes:** At the end of the course, students will be able to

1. Simulation and subsequent verification of different digital communication systems in different channel conditions

**List of Experiments:**

(Following experiments should be carried out using MATLAB/Simulink/LabVIEW)

1. Check whether the given sequence as a PN sequence or not (by verifying different properties Balance Property, Run length Property and Autocorrelation property of PN sequence.
2. To generate different mobile channels and verify their properties (impulse response/ frequency response, Plot histogram of channels.)
3. Generation and detection of ASK, FSK and PSK using Simulink.
4. Plot the Bit Error Rate (BER) curve of BPSK in AWGN channel and Rayleigh channel.
5. Plot the BER curve of BFSK in AWGN channel and Rayleigh channel use coherent/non-coherent detection method to demodulate it.
6. Compare the BER curve of QPSK and 4QAM in AWGN channel and Rayleigh channel.
7. Plot the BER curve of MSK in AWGN channel and Rayleigh channel.
8. Plot the BER curve of Hamming code in AWGN channel and Rayleigh channel.
9. Record a real time audio signal and perform its spectral analysis.
10. Perform BPSK modulation on an image and its subsequent recovery in the presence of noise.
11. Use of 16QAM to transmit and receive an image.

| | | | | | |
|---|---|---|---|---|---|
| AC 2 | Any One from the List of AC 2 (Appendix-I) | 2 | 0 | 0 | 0 |

**Refer Appendix-I for detailed Syllabus.**

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**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

## 3rd Semester

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 4 | EI7201 | Multimedia Signal Processing | 2 | 0 | 0 | 0 |

**Prerequisite:** Digital signal processing.

**Course Outcomes:**
At the end of the course, students will be able to,
1. Implement text, audio and video processing technique.
2. Observe the effect of various properties and operations of different kind signals (ie 1D and 2D).
3. Identify areas of knowledge which are required, select an appropriate approach to a given signal processing task, and critically evaluate and benchmark the performance of alternative techniques for a given problem by simulation using, e.g., Matlab;
4. Design and create practical solutions to a range of common signal processing problems and to critically assess the results of their solutions, including shortcomings

**Module I**
Basic Signal transform: Fourier Transform, Short-Time Fourier Transform, Wavelet Transform-Continuous Wavelet Transform, Wavelet Transform with Discrete Wavelet Functions, Haar Wavelet, Multiresolution Analysis, Filter Banks, Digital Audio signal: Effects of Sampling and Quantization on the Quality of Audio Signal, Speech and Music Decomposition Algorithm, Audio Compression-Lossless Compressions, Lossy Compressions, MPEG Compression

**Module II**
Image Processing: Fundamentals of Digital Image Processing; Elementary Algebraic Operations with Images; Image Enhancement: Histogram modification, Histogram equalization, Smoothing, Filtering, Sharpening, Homomorphic filtering. Color Models; Filtering- Filtering in the Spatial Domain, Filtering in the Frequency Domain, Image Sharpening, Wiener Filtering, Edge Detection, Introduction to Mathematical morphology and its application, Morphological Operations, Dilation, Erosion, Opening, Closing, JPEG Image Compression

**Module III**
Digital Video Processing: Digital Video Standards, Motion Estimation, Digital Video Compression-MPEG-1, MPEG-2, MPEG-4, H.264/MPEG4-AVC

**Text Books:**

1. SrdjanStankovic, Irena Orovic Ervin Sejdic, Multimedia Signals and Systems Basic and Advanced Algorithms for Signal Processing, Second Edition, Springer International Publishing Switzerland 2016


**Reference Books:**

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education. 3rd Edition,2016.
2. A. Bovik, Handbook of Image & Video Processing, 2nd edition, Academic Press, 2005
3. A. M. Tekalp, Digital Video Processing, Prentice-Hall, 2nd edition, 2015

**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 4 | EI7203 | Mobile Computing | 2 | 0 | 0 | 0 |

**Prerequisite:** Wireless communication

**Course Outcomes:**
At the end of this course, students will be able to,
1. Analyze wireless and mobile communications systems and be able to choose an appropriate mobile system from a set of requirements.
2. Describe the important issues and concerns on security and privacy.
3. Interface a mobile computing system to hardware and networks.
4. Analyze the positioning techniques and location based services and applications.

**Module I**
Mobile Communication-Mobile Computing-Mobile Computing Architecture-Mobile Devices-Mobile System Networks – Data dissemination – Mobile management security
GSM – services and architectures – Radio interfaces – Protocols – Localization – Calling – Handover – Security – New data services – General packet radio service High speed circuit switched data – DECT.

**Module II**
Medium Access Control – Introduction to CDMA –based Systems – Spread spectrum in CDMA Systems – coding methods in CDMA – IS-95 CDMAOne System – IMT – 2000 – I-mode – OFDM
IP and mobile Network layers – Packet Delivery and Handover Management – Location management – Registration – Tunneling and Encapsulation - Route Optimization - Dynamic Host Configuration Protocol. Conventional TCP/IP Transport Layer Protocols – Indirect TCP – Snooping TCP – Mobile TCP – Other methods of mobile TCP – layer transmission – TCP over 2.5G/3G Mobile networks

**Module III**
Mobile agent – Application server – Gateways – Portals -Service Discovery – Device management – Mobile file Systems-Security.
Wireless LAN(Wi-Fi) Architecture and Protocol layers- WAP 1.1 and WAP 2.0 Architecture - Bluetooth enabled devices network – layers in Bluetooth protocol- security in Bluetooth protocol- IrDA – ZigBees

**Text Books:**
1. Raj Kamal, "Mobile Computing",Oxford Higher education, Second Edition, 2007
2. J.Schiller, "Mobile Communication", Addison Wesley, 2000.
3. William Stallings, "Wireless Communication and Networks", Pearson Education,2003.

**Reference Books:**
1. Singhal, "WAP-Wireless Application Protocol", Pearson Education, 2003.
2. Lother Merk, Martin. S. Nicklaus and Thomas Stober, "Principle of Mobile Computing", Second Edition, Springer, 2003.
3. William C. Y. Lee, "Mobile Communication Design Fundamentals", John Wiley,1993.

# ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

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**Syllabus (Effective from 2023-24)**

## School/ Department: School of Electronic Sciences
## Course: M. Tech., Programme: Electronics and Communication Engineering (ECE), Duration: 2 years (Four Semesters)

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 4 | EI7205 | Emerging Trends in Communication | 2 | 0 | 0 | 0 |

**Prerequisite:** Wireless Communication, mobile computing, Signal Processing

**Course Outcomes:**

At the end of the course, students will be able to,

1. Demonstrate the fundamentals of 2G and 3G cellular systems and GSM and GPRS architecture
2. Classify 2G,3G,4G and 5G network
3. Identify evolution of LTE Technology to Beyond 4G
4. Illustrate 5G architecture and usage of small cells in 5G mobile network
5. Incorporate Device to Device communication in 5G network
6. Conduct research work in 5G communication, Device to Device communication

**Module I**

Introduction —2G AND 3G CELLULAR SYSTEMS -GSM Architecture – Air interface – Protocols and Signalling - GPRS Architecture– Mobility and location management

Historical trend of wireless communication -Evolution of LTE Technology to Beyond 4G.THE 5G INTERNET – Internet of Things and context – Awareness – Network Reconfiguration and Virtualization support – Mobility – quality of Service Control – Emerging approach for resource over provisioning

**Module II**

SMALL CELLS FOR 5G MOBILE NETWORKS- Introduction – Small Cells – Capacity limits and Achievable gains with densification – Mobile data demand – Demand vs Capacity – small cell challenges. CO-OPERATION FOR NEXT GENERATION WIRELESS NETWORKS – Introduction – cooperative diversity and relaying strategies – PHY Layer Impact – MAC protocol analysis.

**Module III**

5G ARCHITECTURE – Introduction – High level requirements for 5G architecture – Fundamentals architecture and 5G flexibility – Physical Architecture and 5G deployment. DEVICE TO DEVICE D2D COMMUNICATION – D2D: from 4G to 5G – Radio resource management for mobile brand D2D – Multihop D2D communications for proximity and emergency services – Multi-operator D2D communications.

**Text Books:**


1. Fundamentals of 5G mobile Networks, edited by Jonathan Rodis Quez and Wiley 5G Mobile and Wireless Communications Technology by Afif Osseiran (ed.); Jose F. Monserrat (ed.); Patrick Marsch (ed.); Mischa Dohler (other); Takehiro Nakamura (other) June 2016.
2. Iti Saha Misra, “Wireless Communication and Networks – 3G and Beyond”, Mc Graw Hill Education, Second Edition, 2013.
3. William Stallings, “Wireless Communication and Networks”, Pearson Education,2003.


**Reference Books:**


1. William C.Y. Lee, “Mobile Communication Design Fundamentals”, John Wiley,1993
2. Roy Blake, “Wireless Communication Technology”, India edition, Cengage learning. 2010.
3. Upena Dalal “Wireless Communication”, Oxford Higher education, First Edition, 2009.
4. J. Schiller, “Mobile Communication”, Addison Wesley, 2000.

# ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

**Syllabus (Effective from 2023-24)**

**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

| | | | | | | |
|---|---|---|---|---|---|---|
| PE 4 | EI7207 | Network Security and Cryptography | 2 | 0 | 0 | 0 |

**Prerequisite:** Communication Engineering, Computer Network

**Course Outcomes:**
At the end of the course, students will be able to:
1. Identify and utilize different forms of cryptography techniques.
2. classify the symmetric encryption techniques and
3. Illustrate various Public Key Cryptography techniques
4. Incorporate authentication and security in the network applications.
5. Summarize the intrusion detection and its solutions to overcome the attacks.

**Module I**
Security - Need, security services, Attacks, OSI Security Architecture, one time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques.
Private-Key (Symmetric) Cryptography - Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Triple DES, RC5, IDEA, Linear and Differential Cryptanalysis.

**Module II**
Public-Key (Asymmetric) Cryptography - RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms: MD4 MD5, Secure Hash algorithm, RIPEMD-160, HMAC.

**Module III**
Authentication - IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos, IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction.
System Security - Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Firewall Design Principles, Trusted Systems.

**Text Book:**

1. William Stallings, "Cryptography and Network Security, Principles and Practices", Pearson Education, 6th Edition.


**Reference Books:**

1. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security, Private Communication in a Public World", Prentice Hall, 2nd Edition
2. Christopher M. King, Ertem Osmanoglu, Curtis Dalton, "Security Architecture, Design Deployment and Operations", RSA Pres,
3. Stephen Northcutt, Leny Zeltser, Scott Winters, Karen Kent, and Ronald W. Ritchey, "Inside Network Perimeter Security", Pearson Education, 2nd Edition
4. Richard Bejtlich, "The Practice of Network Security Monitoring: Understanding Incident Detection and Response", William Pollock Publisher, 2013

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| | | | | | | |
|---|---|---|---|---|---|---|
| PR 2 | EI7601 | Dissertation (Phase-I) | 0 | 0 | 24 | 12 |

**School/ Department: School of Electronic Sciences**
**Course: M. Tech., Programme: Electronics and Communication Engineering (ECE),**
**Duration: 2 years (Four Semesters)**

## 4th Semester

| | | | | | | |
|---|---|---|---|---|---|---|
| PR 3 | EI7602 | Dissertation (Phase-II) | 0 | 0 | 32 | 16 |