Optical Communication

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-1-0, (4)	CORE	EC107101EC

[Pre-requisites: EC105101EC- Digital Communication]

Course Outcome

At the end of this course students will be able to

1. Describe fiber types and structure; analyze wave propagation, dispersion, losses; evaluate lasers and measuring instruments.
2. Classify modulation formats; interpret phasor representations; design effective photonic modulation schemes for transmission systems.
3. Examine receiver noise; calculate sensitivity and SNR; assess coherent and non-coherent optical detection techniques.
4. Differentiate coherent systems; apply homodyne and heterodyne detection; illustrate DPSK, OFDM, WDM modulation formats.

Course Content

UNIT-I

OPTICAL MEDIUM AND SOURCES: Optical fibers, Step and graded index fibers, Wave propagation, Dispersion in single mode fibers, Fiber losses, Nonlinear optical effects. Semiconductor laser, Laser characteristics, Direct modulation, and external modulation. Optical measuring instruments.

UNIT- II

PHOTONIC TRANSMITTERS: Optical modulators, Phase modulators, Intensity modulators, Return-to-zero optical pulses, CSRZ, RZ33 pulses and their phasor representation, Optical DPSK transmitter, OOK-RZ modulation, Discrete phase modulation NRZ formats, Continuous phase modulation (PM-NRZ) formats.

UNIT- III

OPTICAL RECEIVERS: Photonic and electronic noise at the receiver, Receiver sensitivity, Optical SNR, Performance of OOK receiver, Quantum limit of optical receivers under different modulation, Binary coherent optical receiver, Non-coherent detection of optical DPSK and MSK.

UNIT- IV

COHERENT OPTICAL TRANSMISSION: Optical heterodyne detection, PSK coherent system, Homodyne detection, Coherent and non-coherent transmission, Optical source and modulation, Filters and phase comparators, Coherent phase and differential phase shift keying, Optical multi-level modulation, Coherent OFDM. Introduction to WDM, SONET.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	2	2	-	-	-	-	-	-	1	-	3
CO-2	3	3	3	3	-	-	-	-	-	1	1	-	3
CO-3	3	3	3	2	-	-	-	-	-	-	2	1	3
CO-4	3	2	3	3	-	-	-	-	-	1	2	-	3
Average	3	2.75	2.75	2.50						1	1.5	1	3

Course Materials

Required Text: Text books

1. Digital Optical Communications, Le Nguyen Binh, CRC Press, Chennai, 2009.
2. Fiber-Optic Communication Systems, 4ed, G. P. Agrawal, John Wiley & Sons, NY, 2010.

Optional Materials: Reference Books

1. Advanced Optical and Wireless Communication Systems, Ivan B. Djordjevic, Springer, 2018.

2. Optical Wireless Communications: System and Channel Modeling with Matlab, Z. Ghassemlooy, W. Popoola, S. Rajbhandari, CRC Press, 2013.

5G Communication and Beyond

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-1-0, (4)	CORE	EC107102EC

[Pre-requisites: EC105101EC- Digital Communication,]

Course Outcome

At the end of this course students will be able to

1. Apply enabling technologies for enhanced Mobile Boardband (emBB) services in 5G networks.
2. Apply enabling technologies for Ultra-Reliable Low Latency communication (URLLC) services in 5G networks.
3. Apply enabling technologies for Massive Machine Type Communication (mMTC) services in 5G networks.
4. Analyze evolution and architecture of 5G network and use cases.

Course Content

UNIT-I

Mobile Communications Overview: Evolution from 1G to 5G, Analog voice systems in 1G, digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G (EDGE); IMT2000, 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates, IMT Advanced, 4G, LTE, VOLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+), IMT2020, enhancements in comparison to IMT Advanced,

UNIT-II

Introduction to 5G Communication: 5G potential and applications, Usage scenarios, enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications, Spectrum for 5G, spectrum access/sharing, millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity.

UNIT-III

5G Network: New Radio (NR), Standalone and non-standalone mode, non-orthogonal multiple access (NOMA), massive MIMO, beam formation, PHY API Specification, flexible frame structure, Service Dala Adaptation Protocol (SDAP), centralized RAN, open RAN, multi-access edge computing (MEC), Introduction to software defined networking (SDN), network function virtualization (NFV), network slicing; restful API for service-based interface, private networks.

UNIT-IV

Current state and Challenges ahead: 5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements, large cell usage, LMLC, possible solutions for connectivity in rural areas (Bharat Net, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul/backhaul solutions: LEOS, HAP/UAV, Limitations of 5G and road towards 6G.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	2	2	-	-	-	-	-	-	3	1	3
CO-2	3	3	2	2	-	-	-	-	-	-	3	1	3
CO-3	3	3	2	2	-	-	-	-	-	-	3	1	3
CO-4	3	3	2	2	-	-	-	-	-	-	3	1	3
Average	3	3	2	2							3	1	3

Course Materials

Required Text: Text books

1. Mobile Communications by Jochen Schiller Pub: Financial Times / Imprint of Pearson.
2. Afifosseiran, Jose F Monserrat, Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.

Optional Materials: Reference Books

1. Mobile Cellular Telecommunications: Analog and Digital Systems by William Lee, Pub: McGraw Hill Education
2. Mobile Communications Design Fundamentals by William Lee, Pub: Wiley India Pvt. Ltd.
3. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson
4. Saad Z. Asif, “5G Mobile Communications Concepts and Technologies”, CRC Press, Taylor & Francis Group, First Edition, 2018.
5. HarriHolma, Antti Toskala, Takehiro Nakamura, “5G Technology 3GPP NEW RADIO”, John Wiley & Sons First Edition,2020.
6. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.
7. Athanasios G. Kanatos, Konstantina S. Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
8. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
9. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Springer Series in Wireless Technology.

Introduction to Deep Learning

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	ELECTIVE	EC107201EC

[Pre-requisites: NA]

Course Outcome

At the end of this course students will be able to

1. To apply back-propagation and activation functions to train a multilayer perceptron for tasks like XOR classification.
2. To apply regularization techniques (e.g., dropout, data augmentation) to reduce overfitting in deep neural networks.
3. To evaluate the impact of parameter initialization strategies on training stability and model performance.
4. To analyze structural differences between convolutional architectures (e.g., LeNet vs. VGGNet) to justify their use in tasks like object recognition.
5. To implement a Long Short-Term Memory (LSTM) network to model sequential data (e.g., text prediction).
6. To design an encoder-decoder model using RNNs for tasks like machine translation.

Course Content

UNIT-I

Deep Feedforward Networks: Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms.

Unit- II

Regularization for Deep Learning: Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Early Stopping, Parameter Tying and Parameter Sharing, DropoutOptimization for Training Deep Models: How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates.

Unit- III

Convolutional Networks: The Convolution Operation, Pooling, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Convolutional Networks, and the History of Deep Learning: LeNet, AlexNet, VGGNet.

Unit- IV

Sequence Modeling: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Deep Recurrent Networks, The Challenge of Long-Term Dependencies, The Long Short-Term Memory and Other Gated RNNs.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	3	2	3	-	-	-	-	-	-	2	1
CO-2	3	2	2	-	3	-	-	-	-	-	-	2	2
CO-3	3	-	-	1	3	-	-	-	-	-	-	2	1
CO-4	3	3	3	2	3	-	-	-	-	-	-	2	2
CO-5	3	2	3	1	3	-	-	-	-	-	-	2	1
CO-6	3	3	3	2	3	-	-	-	-	-	-	1	2
Average	3	2.6	2.8	1.6	3							1.83	1.5

Course Materials

Required Text: Text books

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Optional Materials: Reference Books

1. Neural Networks: A Systematic Introduction, Raul Rojas, 1996
2. Pattern Recognition and Machine Learning, C.M. Bishop, Springer, 2006.

Satellite and Space Systems

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	ELECTIVE	EC107202EC

[Pre-requisites: EC104101EC-Electromagnetic field theory]

Course Outcome

At the end of this course students will be able to

1. Analyze orbital mechanics and GEO operations; compute orbital elements, look angles, visibility, and assess perturbation/drag, eclipse, and outage impacts.
2. Explain and evaluate space and earth segment subsystems (power, AOCS, station-keeping, TT&C, transponders, antennas); configure links and decode NOAA APT/Meteor M2 data.
3. Derive and use GPS/NavIC observables (pseudorange, carrier phase), model errors, and implement sequential/Kalman estimation for accurate navigation solutions.
4. Process GPS data using single/double differencing and wide-lane combinations; detect/fix cycle slips and perform kinematic positioning via programmed workflows.

Course Content

UNIT-I:

Orbital Mechanics: Kepler's laws, orbital elements, apogee and perigee heights, Coordinate transformations, Time, orbit perturbations, effects of a non-spherical earth, atmospheric drag. Geostationary orbit: introduction, antenna look angles, the polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage, launching orbits.

Unit- II:

Satellite systems: Space Segment, Power Supply, Attitude Control, Spinning satellite stabilization, Momentum wheel stabilization, Station Keeping, Thermal Control, TT&C Subsystem, Transponders, The wideband receiver, power amplifier, Antenna Subsystem. Earth Segment: Receive-Only Systems, Transmit-Receive Earth Stations. Case study: Decoding of NOAA APT or Meteor M2 data from the received signal.

Unit- III:

Satellite based navigation systems: Introduction to GPS or NavIC; GPS observables: pseudo ranges, carrier phase, SA/AS, format of data; Estimation procedures: Stochastic and mathematical models, sequential estimation, Kalman filtering.

Unit- IV:

Processing of GPS data: Mathematical model of GPS observables, Use of differencing, differential position, Wide-lanes and use in kinematic positioning, Cycle slip fixing/Bias resolution, Kinematic (moving receiver) GPS processing, Introduction to programming for processing GPS data and relevant software.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	3	3	-	-	-	-	-	-	2	-	3
CO-2	3	3	3	3	-	-	-	-	-	-	2	-	3
CO-3	3	3	3	3	-	-	-	-	-	-	1	-	3
CO-4	3	3	3	3	-	-	-	-	-	-	1	-	3
Average	3	3	3	3							1.5		3

Required Text: Text books

1. Satellite Communications, Dennis Roddy (Fourth edition), McGraw Hill.
2.GPS Theory and Practice, Hofmann-Wellenh , B. H. Lichtenegger, and J. Collins, Springer, 1994.

Optional Materials: Reference Books

1. Satellite Communication Systems Engineering, Wilbur L. Pritchard, Henri G. Suyderhoud, Robert A. Nelson (SecondEdition), Pearson
2.Satellite Communication, by Timothy Pratt, Charles Bostian, Jeremy Allnutt (Second Edition), John Wiley & Sons.
3.MIT Open courseware. Link: https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-540-principles-of-the-global-positioning-system-spring-2012

Digital Image Processing

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering [Pre-requisites: EC104102EC- Digital Signal Processing]	3-0-0, (3)	ELECTIVE	EC107203EC

Course Outcome

At the end of this course students will be able to

1. To apply basic digital image processing techniques to manipulate images for real-world applications.
2. To apply spatial domain techniques to enhance image quality.
3. To use frequency domain methods and pseudo-coloring to improve image contrast and feature extraction.
4. To Implement edge detection techniques and boundary descriptors to segment images.
5. To apply thresholding and region-based segmentation methods to partition images under varying illumination conditions.
6. To design and implement morphological operations, image compression algorithms, and color transformations to optimize image processing tasks.

Course Content

UNIT-I:

Introduction to image processing: Types of image processing, Applications and fields of image processing, Fundamental steps in Digital image processing, Elements of visual perception, Image sensing and acquisition, Basic Concepts in Sampling and Quantization, representing digital images, Some Basic Relationships Between Pixels.

Unit- II:

Image Enhancement in the Spatial Domain: Some basic gray level transformations, Histogram Processing, Histogram modification, Contrast Stretching, Log Transformation, Image subtraction, spatial filtering, Sharpening Spatial filters, use of first and second derivatives for enhancement.

Image Enhancement in the Frequency Domain, Gaussian filters, Homomorphic filtering Pseudo coloring: intensity slicing.

Unit- III:

Image Segmentation: - Some Basic Relationships between pixels, Point, Line and edge detection, Gradient operators, Canny edge detection, pyramid edge detection. Edge linking and boundary detection, Hough transform, Chain codes, boundary segments, skeletons, Boundary descriptors, Fourier descriptors.

Thresholding: The role of illumination, Global thresholding, Adaptive thresholding, Use of boundary characteristics for histogram improvement and local thresholding, Region based segmentation, Region growing, region splitting and merging.

Unit- IV:

Morphological Image Processing: Introductions, Dilation, Erosion, Opening, closing.

Image Compression: Data redundancies Elements of information, variable-length coding, predictive coding, Transform coding, Image compression standards; Color image processing: Color models, Pseudocolor image processing, Color transformations.

(COs)	**(POs)**											**(PSOs)**	
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO- 5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PSO- 1**	**PSO- 2**
CO-1	3	2	2	-	3	-	-	-	-	-	-	1	2
CO-2	3	2	3	-	3	-	-	-	-	-	-	2	2
CO-3	3	2	3	1	3	-	-	-	-	-	-	2	1
CO-4	3	3	3	-	3	-	-	-	-	-	-	2	1
CO-5	3	2	3	1	3	-	-	-	-	-	-	2	1
CO-6	3	2	3	-	3	-	-	-	-	-	-	2	1
Average	3	2	3	1	3							1.83	1.33

Course Materials

Required Text: Text books

1. Digital Image Processing, Gonzalez and Woods, 3rd Edition (DIP/3e), Prentice Hall, 2008
2. Fundamentals of Digital Image Processing, A.K. Jain, PHI, New Delhi, 2001

Optional Materials: Reference Books

1. Image Processing, Analysis and Machine Vision, Milan Sonka, Thomson Learning, 2001
2. Digital Image Processing, Pratt W.K, John Wiley & Sons, 2001

Low Power Circuit Design

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	ELECTIVE	EC107204EC

[Pre-requisites: EC103102EC- Microelectronic Devices and Circuits, EC103104EC- Digital logic design, EC106103EC-VLSI Design]

Course Outcome

At the end of this course students will be able to

1. Analyze sources of power dissipation and evaluate low-power design approaches at the system, circuit, and mask levels.
2. Design and optimize low-voltage, low-power adders and logic, comparing architectures and technology scaling trends.
3. Implement and assess multiply architectures for low voltage and power, including Braun, Baugh-Wooley, and Booth designs.
4. Analyze, compare, and design low-power ROM, SRAM, and DRAM memory technologies and predict future development trends.

Course Content

UNIT-I

Fundamentals: Need for Low Power Circuit Design, Sources of Power Dissipation,

Low-Power Design Approaches: Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, Mask level Measures.

Unit- II

Low-Voltage Low-Power Adders: Introduction, Standard Adder Cells, CMOS Adder's Architectures, Low Voltage Low-Power Design Techniques –Trends of Technology and Power Supply Voltage, Low Voltage Low-Power Logic Styles.

Unit- III

Low-Voltage Low-Power Multipliers: Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Booth Multiplier.

Unit- IV

Low-Voltage Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Low Power SRAM, DRAM Technologies.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	3	3	-	-	-	-	-	-	2	3	-
CO-2	3	3	3	3	-	-	-	-	-	-	1	3	-
CO-3	3	3	3	3	-	-	-	-	-	-	2	3	-
CO-4	3	3	3	3	-	-	-	-	-	-	1	3	-
Average	3	3	3	3							1.5	3	

Course Materials

Required Text: Text books

1.Low-Voltage, Low-Power VLSI Subsystems, Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.

Optional Materials: Reference Books

1. CMOS Digital Integrated Circuits – Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.
2. Introduction to VLSI Systems: A Logic, Circuit and System Perspective, Ming-BO Lin, CRC Press.
3. Low Power CMOS Design, Anantha Chandrakasan, IEEE Press, /Wiley International, 1998.
4. Low Power CMOS VLSI Circuit Design, Kaushik Roy, Sharat C. Prasad, John Wiley, & Sons, 2000

Wireless Sensor Networks

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	ELECTIVE	EC107205EC

[Pre-requisites: EC106203EC- Computer Communication and Networks,EC106101EC- Wireless Communication]

Course Outcome

At the end of this course students will be able to

1. Analyze wireless sensor network deployment and architecture.
2. Analyze multiple access Protocol for wireless sensor network
3. Evaluate various routing algorithm for wireless sensor network.
4. Analyze QoS and energy management issues in wireless sensor.

Course Content

UNIT-I

Introduction to Adhoc/sensor networks: Key definitions of Adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering. Issues and Challenges in WSN.

Unit- II

MAC Protocols : Issues in designing MAC protocols for Adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4. Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols

Unit- III

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

Unit- IV

QoS and Energy Management : Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes. Case study of any deployed WSN.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	3	2	3	-	-	-	-	-	3	3	3
CO-2	3	3	3	2	3	-	-	-	-	-	3	3	3
CO-3	3	3	3	2	3	-	-	-	-	-	3	3	3
CO-4	3	3	3	2	3	-	-	-	-	-	3	3	3
Average	3	3	3	2	3						3	3	3

Course Materials

Required Text: Text books

1. Protocols and Architectures for Wireless Sensor Networks, Holger Karl and Andreas Willig, John Wiley & Sons, 2005.
2. Wireless Sensor Networks,Zhao and L. Guibas, Morgan Kaufmann, San Francisco, 2004
3. Wireless Sensor Networks, C. S. Raghavendra, K. M. Shivalingam and T. Znati, Springer, New York,2004.

Optional Materials: Reference Books

1. Wireless Sensor Networks Architecture and Protocols, E. H. Callaway, Jr. E. H. Callaway, CRC Press, 2009.
2.Wireless Sensor Network Designs, Anna Hac, John Wiley & Sons, 2004.
3.Wireless Sensor Networks: Technology, Protocols, and Applications, Kazem Sohraby, Daniel Minoli and Taieb Znati, Wiley Inter Science, 2007.

RADAR Engineering

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	ELECTIVE	EC107206EC

[Pre-requisites: EC106102EC-Microwave Engineering, EC104105EC-Analog Communication, EC105101EC- Digital Communication]

Course Outcome

At the end of this course students will be able to

1. Explain radar fundamentals, construct block diagrams, apply the radar range equation, and identify real-world radar applications.
2. Analyze radar equation terms, assess signal detection in noise, calculate detection probabilities, and evaluate effects of system parameters.
3. Distinguish MTI and Pulse Doppler radar principles, implement delay-line cancelers, and evaluate moving target detection methods and limitations.
4. Explain and compare tracking radar techniques, analyze tracking accuracy factors, and design automatic tracking systems and basic radar measurements.

Course Content

UNIT-I

Introduction to Radar: Basic radar, the simple form of radar equation, Radar block diagram, Radar frequencies, Applications to radar.

Unit- II

Radar Equation: Introduction, Detection of signal in noise, Receiver noise and the signal to noise ratio, Probability density functions, Probabilities of detection and false alarm, Integration of Radar pluses, Radar cross section of targets, Radar cross section fluctuations, Transmitter power, Pulse repetition frequency, antenna parameters, system losses, Other Radar equation considerations.

Unit- III

MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar, Delay-Line cancelers, Staggered pulse repetition frequencies, Doppler filter banks, Digital MTI processing, Moving target detector, Limitation of MTI performance, MTI from a moving platform, Pulse Doppler Radar, CW Radar.

Unit- IV

Tracking Radar: Tracking with Radar, Mono-pulse tracking, Conical scan and sequential lobbing, Limitation to tracking accuracy, Low-angle tracking, Tracking in range, Comparison of trackers, Automatic tracking with Surveillance Radar (ADT), Basic Radar Measurements.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	2	2	2	-	-	-	-	-	-	2	-	3
CO-2	3	3	2	1	-	-	-	-	-	-	2	-	3
CO-3	2	3	3	2	-	-	-	-	-	-	2	-	3
CO-4	2	3	3	1	-	-	-	-	-	-	3	-	3
Average	2.5	2.75	2.5	1.5							2.25		3

Course Materials

Required Text: Text books

1. Introduction to RADAR systems, M. I. Skolnik, 3rd Ed., McGraw Hill, 2017.
2. Principles of modern RADAR systems, M. H. Carpentier, Artech house publishers, 1988.

Optional Materials: Reference Books

1. Fundamentals of RADAR signal processing, Richards M.A.,Indian Ed., McGraw Hill, 2005.
2. Principles of Radar, J.C. Toomay, Paul J. Hannen, Third Edition.

Design, verification, and testing of VLSI circuits

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering [Pre-requisites: EC106103EC – VLSI Design]	3-0-0, (3)	Elective	EC107207EC

Course Outcome
At the end of this course students will be able to

1. Analyze the scope and challenges of testing and verification in complex VLSI designs and SoCs.
2. Apply fault models, automatic test pattern generation, and design for testability techniques in VLSI circuits.
3. Execute system-level testing methods including IDDQ, delay fault testing, and built-in self-test (BIST) for logic and memories.
4. Perform test automation and apply simulation-based, analytical, and formal verification techniques for functional and timing correctness.
5. Conduct equivalence checking, model checking, hardware emulation, and reliability modeling to ensure robust VLSI design verification.

Course Content

UNIT-I

Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs.

Unit- II

Fundamentals of VLSJ testing. Fault models. Automatic test pattern/generation. Design for testability. Scan design. Test interface and boundary scan.

Unit- III

System testing and test for SOCs. Iddq testing. Delay fault testing. BIST for testing of logic and memories.

Unit- IV

Test automation. Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification, Formal verification.

Unit- V

Basics of equivalence checking arid model checking. Hardware emulation. Parametric testing, Reliability modeling, Yield models.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	2	3	2	-	-	-	-	-	2	3	1
CO-2	3	3	3	2	3	-	-	-	-	-	2	3	1
CO-3	3	2	3	3	3	-	-	-	-	-	2	3	1
CO-4	3	3	3	3	3	-	-	-	-	-	3	3	1
CO-5	3	3	3	3	3	-	-	-	-	-	3	3	1
Average	3	2.8	2.8	2.8	2.8						2.4	3	1

Course Materials

Required Text: Text books

1. Jan M. Rabaey, “Digital Integrated Circuits”, Prentice Hall, 2003.
2. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson Education India, 1997
3. Viswani D. Agraval Michael L. Bushnell, “Essentials of Electronic Testing for digital memory and mixed signal VLSI circuit”, Kluwer Academic Publications, 1999.
4. Alfred L. Crouch “Design for test for digital ICs and embedded core systems”, PHI, 1999.

Analog IC Design

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	ELECTIVE	EC107208EC

[Pre-requisites: EC103102EC-Microelectronic Devices and Circuits, EC104104EC-Linear Integrated Circuits and Applications]

Course Outcome

At the end of this course students will be able to

1. Apply SPICE simulation techniques to analyze electronic circuits in time and frequency domains.
2. Design and simulate basics of analog IC. To explore operational amplifier characteristics and frequency response.
3. Explain frequency response, stability in amplifiers.
4. Evaluate the performance of Operational Amplifier.

Course Content

UNIT I:

Introduction to SPICE Simulation, Analysis of complex electronic circuits, simulation and analysis using SPICE, AC/DC operation, DC sweep transfer function, frequency response, feedback control analysis, transient response, device models, simulation and analysis of electronic circuits and systems.

UNIT II

Basic Analog Building Blocks, Switches, Active Resistors, Current and Voltage sources, Current and voltage references, Voltage regulators.

UNIT III

Amplifiers: Basic Amplifiers: CS, CG and source follower, Cascode Amplifiers, High Gain Amplifier Structure.

UNIT IV

Differential Amplifier, Current Mirrors, Operational Amplifiers: Operational Amplifier characteristics, Frequency response, stability and noise issues in amplifiers.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	3	2	-	-	-	-	-	-	2	3	-
CO-2	3	3	3	2	-	-	-	-	-	-	1	3	-
CO-3	3	3	3	2	-	-	-	-	-	-	2	3	-
CO-4	3	3	3	2	-	-	-	-	-	-	2	3	-
Average	3	3	3	2							1.75	3	

Required Text: Text books

1. CMOS: circuit design, layout, and simulation, R. J. Baker, Wiley, 2008
2. Design of Analog CMOS Integrated Circuits, B Razavi, Tata McGraw-Hill.

Optional Materials: Reference Books

1. Analysis and design of analog integrated circuits, Meyer, Paul R Gray, Hurst, Lewis, Wiley, 2009.
2. CMOS Analog Circuit Design, P. E Allen., D. R Holberg, Oxford University Press, 2012.
3. Introduction to Device Modeling and Circuit Simulation, T. A Fjeldly, T Ytterdal., M. S. Shur, Wiley, 1998.

Real Time Embedded Systems

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	OPEN ELECTIVE	EC107301EC

[Pre-requisites: EC105102EC-Microprocessors & Microcontrollers]

Course Outcome

At the end of this course students will be able to

1. Analyze the concepts of embedded system design
2. Analyze RTOS principles like scheduling, synchronization, and process management.
3. Apply and design real-time applications using RTOS-based programming techniques.
4. Design and case studies of program modelling.

Course Content

UNIT I

Hardware Software Co-design and program Modelling: Characteristics of an Embedded System, Quality Attributes of Embedded Systems, Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modelling Language (UML), Hardware Software Tradeoffs.

UNIT II

REAL-TIME OPERATING SYSTEMS (RTOS) BASED EMBEDDED SYSTEM DESIGN Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling :Putting them Altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS.

UNIT III

PROGRAM MODELING CONCEPTS: Program Models, DFG Models, state Machine Programming Models for Event controlled Program Flow, Modeling of Multiprocessor Systems, UML Modeling.

UNIT IV

DESIGN EXAMPLES AND CASE STUDIES OF PROGRAM MODELING AND PROGRAMMING WITH RTOS: Case study of Communication between Orchestra Robots, Embedded Systems in Automobile, Case study of an Embedded System for an Adaptive Cruise Control(ACC) System in a Car, Case study of an Embedded System for a Smart Card, Case study of a Mobile Phone Software for Key Inputs.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	2	2	1	2	1	-	-		1	-	1	1	-
CO-2	2	2	2	1	2	-	-		1	-	2	2	-
CO-3	2	2	2	1	2	-	-		1	-	2	2	-
CO-4	3	2	2	1	2	-	-		1	-	2	2	-
Average	2.25	2	1.75	1.25	1.75				1		1.75	1.75	

Course Materials

Required Text: Text books

1. Introduction to Embedded System, Shibu K V, McGraw Hill Higher Edition.
2. Embedded Systems Architecture, Programming and Design, Raj Kamal, Second Edition, McGraw Hill.
3. Embedded System Design, Peter Marwedel, Springer.

Optional Materials: Reference Books

1. Embedded System Design – A Unified Hardware/Software Introduction, Frank Vahid, Tony D. Givargis, John Wiley, 2002.
2. Embedded/ Real Time Systems, KVKK Prasad, Dream tech Press, 2005.
3. An Embedded Software Primer, David E. Simon, Pearson Ed. 2005.

Industrial Internet of Things

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	OPEN ELECTIVE	EC107302EC

[Pre-requisites: EC105102EC - Microprocessor and Microcontrollers]

Course Outcome

At the end of this course students will be able to

1. Explain the evolution of industrial revolutions and analyze the role of IoT and IIoT technologies in enabling Industry 4.0 and smart factories.
2. Demonstrate the use of sensors, actuators, microcontrollers, and wireless communication protocols to implement IIoT-based data acquisition, monitoring, and control systems.
3. Illustrate the concept of Cyber-Physical Systems and evaluate the role of next-generation sensors, AR/VR, and security frameworks in IIoT environments.
4. Develop and apply IIoT solutions for industrial domains such as healthcare, power, and manufacturing, and analyze case studies to address current societal and industrial needs.

Course Content

UNIT-I

Introduction to Industrial IoT (IIoT) Systems:
The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories.

Implementation systems for IIoT:
Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems.

UNIT-II

IIoT Data Monitoring & Control:
IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring.

UNIT-III

Cyber Physical Systems:
Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Security in IIoT.

UNIT-IV

Industrial IoT- Applications:
Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Case Studies of IIoT Systems:
IIoT application development with Embedded PC based development boards, Development of mini Project on new version of Operating systems and Edge development board. That project should also address to the current societal needs

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	2	3	-	-	-	-	-	2	3	3	2
CO-2	3	3	3	3	-	-	-	-	-	3	3	3	3
CO-3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO-4	3	3	3	3	-	-	-	-	-	3	3	3	3
Average	3	3	2.75	3						2.75	3	3	2.75

Course Materials
Required Text: Text books

1. Industry 4.0: The Industrial Internet of Things Alasdair GilchristPublications: Apress
2. The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics Authors: Bartodziej, Christoph Jan Springer: Publication in the field of economic science.

Optional Materials: Reference Books
1. Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystem by Dr. OvidiuVermesan, Dr. Peter Friess,River Publishers.
3. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication).
4. Industrial Internet of Things: Cybermanufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
5. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)

Nanoelectronics

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	Open Elective	EC107303EC

Course Outcome
At the end of this course students will be able to

1. Analyze the fundamentals of CMOS scaling and analyze the challenges involved in nanoscale device miniaturization.
2. Evaluate nanoscale MOSFET architectures such as FinFETs, Vertical MOSFETs, and spintronic devices considering scaling and system integration limits.
3. Analyze the operation principles of quantum devices including quantum dots, wells, wires, resonant tunneling diodes, and single-electron transistors.
4. Illustrate the design and apply the working principles of nanoelectronic-based sensors such as biosensors, gas sensors, temperature sensors, and pH sensors.
5. Analyze the properties of carbon nanotubes and graphene, and evaluate their band structure, transport mechanisms, and applications in nanoelectronic devices.

Course Content
UNIT-I
Shrink-down approaches: Introduction, CMOS Scaling.
Unit- II
The nanoscale MOSFET, FinFETs, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), and spintronics devices.
Unit- III
Quantum dot, well and wire, Resonant Tunneling Diode & Transistors, Single electron transistors.
Unit- IV
Nanoelectronic based sensors: Bio-sensor, Gas sensor, Temperature sensor, pH Sensor.
Unit- V
Carbon nanotube electronics, band structure & transport, devices, applications, Graphene based Electronics, Band gap Modulation and Graphene devices and its applications.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	2	3	-	-	-	-	-	-	2	-	2
CO-2	3	3	3	3	-	-	-	-	-	-	2	-	3
CO-3	3	3	3	3	-	-	-	-	-	-	1	-	3
CO-4	3	3	3	3	-	-	-	-	-	-	2	-	3
CO-5	3	3	3	3	-	-	-	-	-	-	1	-	3
Average	3	3	2.8	3							1.6		2.8

Course Materials
Required Text: Text books

1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens,Wileyÿ (2003), C.P. Poole Jr.,F.J. Owens,Wiley (2003).
2. Nanoelectronics and Information Technology (Advanced Electronic Materials and Novel Devices), Waser Ranier ,Wiley-VCH,2003.
3. Nanosystems, K.E. Drexler,Wiley (1992),1992.
4. The Physics of Low-Dimensional Semiconductors,John H. Davies,"Cambridge University Press, "1998.

Optical Communication Lab

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	0-0-2, (1)	CORE	EC107401EC

Course Outcome

At the end of this course students will be able to

1. Understand and demonstrate optical fiber types, connectors, power measurement, and link setup.
2. Analyze PAM, PWM, and PPM schemes over analog and digital optical links.
3. Evaluate characteristics of laser diode, photodetector, and avalanche photodiode for optical communication.
4. Measure numerical aperture, attenuation, bending loss, dispersion, and WDM link performance.

List of Experiments

1. Demonstration and study of different types of Optical Fibers, Connectors and Optical Power Meter.
2. Setting up a Fiber Optic Analog and Digital Link.
3. Study of Pulse Amplitude Modulation (PAM) over analog optical fiber link.
4. Study of Pulse Width Modulation (PWM) over digital optical fiber link for different frequencies of carrier pulses.
5. Study of Pulse Position Modulation (PPM) over digital optical fiber link.
6. Characteristics of LASER diode.
7. Characteristics of PHOTO DETECTOR.
8. Characteristics of AVALANCHE PHOTODIODE (APD).
9. Measurement of NUMERICAL APERTURE.
10. Measurement of ATTENUATION AND BENDING LOSS.
11. Fiber Dispersion Measurement.
12. Characteristics of WDM LINK.

(COs)	(POs)											(PSOs)	
	PO-1	PO-2	PO-3	PO-4	PO- 5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO- 1	PSO- 2
CO-1	3	3	2	1	1	-	1	2	2	-	2	-	3
CO-2	3	3	2	1	1	-	1	2	2	-	2	-	3
CO-3	3	3	2	2	1	-	1	2	2	-	2	-	3
CO-4	3	3	2	2	1	-	1	2	2	-	2	-	3
Average	3	3	2	1.5	1		1	2	2		2		3

Course Materials

Required Text: Text books

1. Digital Optical Communications, Le Nguyen Binh, CRC Press, Chennai, 2009.
2. Fiber-Optic Communication Systems, 4ed, G. P. Agrawal, John Wiley & Sons, NY, 2010.