PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

M.E. APPLIED ELECTRONICS

REGULATION 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER III

Course Code	Course Title	L	T	P	C
PAE16301	Electromagnetic Interference and Compatibility	3	2	0	4
PAE1655*	Elective V	3	0	0	3
PAE1665*	Elective VI	3	0	0	3
PAE16304	Project Work (Phase I)	0	0	12	6

SEMESTER IV

Course Code	Course Title	L	T	P	C
PAE16401	Project Work (Phase II)	0	0	24	12

ELECTIVE V

Course Code	Course Title	L	T	P	C
PAE16551	Testing of VLSI Circuits	3	0	0	3
PAE16552	VLSI for Wireless Communication	3	0	0	3
PAE16553	Photonics	3	0	0	3
PAE16554	Nanoelectronics	3	0	0	3

ELECTIVE VI

Course Code	Course Title	L	T	P	C
PAE16651	Robotics	3	0	0	3
PAE16652	Optical Imaging Techniques	3	0	0	3
PAE16653	MEMS and NEMS	3	0	0	3
PAE16654	Wireless Adhoc Networks	3	0	0	3

PAE16301 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY 3 2 0 4

COURSE OBJECTIVES

- To know about the basics of EMI and EMC Environment
- To know about EMI and EMC Coupling Principles
- To study the control techniques involved in Electromagnetic Interference
- To learn about EMI Specification Standards and Limit
- To know about EMI used in instrumentation system

UNIT I EMI/EMC CONCEPTS 15

EMI-EMC definitions and Units of parameters- Sources and victim of EMI- Conducted and Radiated EMI Emission and Susceptibility-Transient EMI, ESD-Radiation Hazards.

UNIT II EMI COUPLING PRINCIPLES 15

Conducted, radiated and transient coupling- Common ground impedance coupling - Common mode and ground loop coupling- Differential mode coupling - Near field cable to cable coupling, cross talk -Field to cable coupling - Power mains and Power supply coupling.

UNIT III EMI CONTROL TECHNIQUES 15

Shielding- Shielding Material-Shielding integrity at discontinuities, Filtering- Characteristics of Filters- Impedance and Lumped element filters-Telephone line filter, Power line filter design, Filter installation and Evaluation, Grounding- Measurement of Ground resistance-system grounding for EMI/EMC Cable shielded grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control. EMI gaskets.

UNIT IV EMC DESIGN OF PCBS 15

EMI Suppression Cables-Absorptive, ribbon cables-Devices-Transient protection hybrid circuits, Component selection and mounting; PCB trace impedance; Routing; Cross talk control-Electromagnetic Pulse-Noise from relays and switches, Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations.

UNIT V EMI MEASUREMENTS AND STANDARDS 15

Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx/Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Rx and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standards-MIL461E/462- Frequency assignment - spectrum conversation - British VDE standards - Euro norms standards in Japan –comparisons - EN Emission and Susceptibility standards - Specifications.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- examine the concepts of EMI and EMC
- evaluate solution to EMI Sources
- examine solution to EMI problems in PCB level
- measure emission immunity level from different systems to couple with different standards
- analyse and implement EMI system

REFERENCES

1. V.P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, Newyork,2001
2. Henry W.Ott., “Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 2008.
3. Clayton R.Paul, “Introduction to Electromagnetic Compatibility”, John Wiley Publications, 2008.
4. Don R.J.White Consultant Incorporate, “Handbook of EMI/EMC”, Vol I-V.
5. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Ed, Artech house, Norwood, 1987.

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1. https://www.nasa.gov/.../639521main_EMI-EMC_User_Test_Planning_.
2. www.irpel.org/pdf.../electromagnetic-interference-and-compatibility.pdf
3. www.rfwireless-world.com/Terminology/EMI-vs-EMC.html
4. www.leonardo-energy.org/.../Cu0128_Introduction%20to%20EMC_v1.
5. https://www.pericom.com/assets/App-Note-Files/AN011.pdf

PAE16551 **TESTING OF VLSI CIRCUITS** **3 0 0 3**

COURSE OBJECTIVES

- To gain knowledge on digital testing as applied to VLSI design.
- To acquire knowledge on testing of algorithms for digital circuits
- To learn various testing methods for digital circuits.
- To learn memory testing.
- To gain knowledge on different level of diagnosis.

UNIT I BASICS OF TESTING AND FAULT MODELING **9**

Introduction to Testing - Faults in digital circuits - Modeling of faults - Logical Fault Models - Fault detection - Fault location - Fault dominance - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation.

UNIT II TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS **9**

Test generation for combinational logic circuits - Testable combinational logic circuit design - Test generation for sequential circuits - design of testable sequential circuits.

UNIT III DESIGN FOR TESTABILITY **9**

Design for Testability - Ad-hoc design - Generic scan based design - Classical scan based design - System level DFT approaches.

UNIT IV BIST MEMORY TESTING **9**

Built-In Self Test - Test pattern generation for BIST - Circular BIST - BIST Architectures - Testable Memory Design - Test algorithms.

UNIT V LOGIC LEVEL AND SYSTEM LEVEL DIAGNOSIS **9**

Logic Level Diagnosis - Diagnosis by UUT reduction - Fault Diagnosis for Combinational Circuits - Self-checking design - System Level Diagnosis.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- examine the basics of testing and fault modeling
- analyze different testing algorithms
- synthesis for testability
- examine the concepts of BIST and memory testing
- evaluate knowledge about different level of fault diagnosis

REFERENCES

1. M. Abramovici, M.A. Breuer and A.D. Friedman, “Digital Systems a Testable Design” Jaico Publishing House, 2002.
2. P.K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002.
3. M.L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits”, Kluwar Academic Publishers, 2002.

4. A.L. Crouch, “Design for Test for Digital IC's and Embedded Core Systems”, Prentice Hall International, 2002.

WEB LINKS

1. www.ee.ncu.edu.tw/~jfli/vlsi21/lecture/ch06.pdf
2. https://www.ece.cmu.edu/~ece322/LECTURES/Lecture25/Lecture25.pdf
3. nptel.ac.in/courses/106103116/
4. https://www.youtube.com/watch?v=Abld-fSxjNM
5. https://www.ee.iitb.ac.in/~viren/Courses/2014/EE709.htm

PAE16552 **VLSI FOR WIRELESS COMMUNICATION** **3 0 0 3**

COURSE OBJECTIVES

- To gain Knowledge about the basics of wireless communication.
- To acquire the concepts of transceiver architectures.
- To understand the concept of low power design techniques
- To know about wireless circuits
- To learn the design and implementation of various VLSI circuits for wireless communication systems.

UNIT I WIRELESS COMMUNICATION **9**

Digital communication systems- minimum bandwidth requirement, the Shannon limit- overview of modulation schemes- classical channel- Characteristics of wireless channel – path loss- multipath fading- basics of spread spectrum and spread spectrum techniques.

UNIT II TRANSCEIVER ARCHITECTURE **9**

Transceiver design constraints- baseband subsystem design- RF subsystem design- Super heterodyne receiver and direct conversion receiver- Receiver front-end- filter design- non-idealities and design Parameters.

UNIT III LOW POWER DESIGN TECHNIQUES **9**

Source of power dissipation- estimation of power dissipation- reducing power dissipation at device and circuit levels- low voltage and low power operation- reducing power dissipation at architecture and algorithm levels.

UNIT IV WIRELESS CIRCUITS **9**

VLSI Design of LNA-wideband and narrow band-impedance matching - Automatic Gain Control (AGC) amplifier - Active mixer- analysis, conversion gain, distortion analysis- low frequency and high frequency case, noise - Passive mixer- sampling mixer and switching mixer- analysis of distortion, conversion gain and noise in these mixers.

UNIT V FREQUENCY SYNTHESIZERS **9**

VLSI design of Frequency Synthesizers (FS) – Parameters of FS - PLL based frequency synthesizer, VCO-Phase Detector – Analog Phase Detectors – Digital Phase Detectors, LC oscillators- ring oscillator-phase noise, design approaches(DECT application)

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyze the application of VLSI circuits in wireless communication.
- examine the various architectures used in implementing wireless systems.
- analyze about design and simulation of low power techniques using software
- evaluate the VLSI design of wireless circuits.

REFERENCES

1. Bosco Leung, “VLSI for Wireless Communication”, Springer, 2011.
2. Elmad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI Wireless Design-Circuits and Systems”, Kluwer Academic Publishers, 2002.
3. David Tsee, Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge Univ Press.

WEB LINKS

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4. https://www.youtube.com/watch?v=CRgrQAgLVKc
5. nptel.ac.in/courses/106105034/

PAE16553 **PHOTONICS** **3 0 0 3**

COURSE OBJECTIVES

- To understand the basics of photonics
- To learn the concepts of wave optics
- To know about working condition of lasers
- To learn about holography
- To acquire the concepts of non-linear optics

UNIT I **INTRODUCTION TO PHOTONICS** **9**

Nature of Light – Wave and light terminology, Maxwell equation, light spectra and sources, absorption and emission, black body radiation-Geometric Optics – Light as a ray, law of reflection including plane mirrors, law of refraction including optical fiber applications, prisms and thin lenses including Lensmaker's equation, Lens problems and optical instruments using the thin lens equation.

UNIT II **WAVE OPTICS** **9**

Wave descriptive terminology, wave superposition (interference) including double – slit interference, diffraction and diffraction gratings, interference applications, eg. Michelson, Mach Zender and Fabry Perot interferometers, Thin film interference and Fiber Bragg Gratings. Diffraction Effects including: airy disk, near far field effects - Polarization principles including scattering, reflection and birefringence.

UNIT III **LASERS** **9**

Introduction to Lasers – Basic terminology and theory of operation including specific requirements, principal types of lasers - Laser radiation hazards including effects on the eye and skin -Laser safety standards and hazard classifications - Laser safety precautions and protective measures.

UNIT IV **HOLOGRAPHY** **9**

Holography – Theory and basic principles, Requirement to record and reconstruct holograms – Experimental techniques- Recording Materials-Reflection holography and applications-Holographic Interferometry - Nondestructive testing, optical memory.

UNIT V **NON - LINEAR OPTICS** **9**

Non-linear optics – Harmonic Generation, sum and difference frequency generation, wave mixing - Optical Parametric Oscillator - Non-linear optic materials – inorganic and organic. Phase matching, efficiency efficiency of harmonic generation- powder and single crystal methods - Methods of determination of harmonic coefficients – Z-scan and Electrical Field Induced Second Harmonic. Phase conjugation- Silicon Photonics-Silicon on Insulator Photonics-Fabrication of Silicon Waveguide.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyze the Basic Concepts of photonics
- examine the working and applications of wave optics
- evaluate the concepts of lasers
- synthesis about working of holography

- analyze about application of Non-linear optics

REFERENCES

1. Bahaa E. A. Saleh, Malvin Carl Teich, “Fundamentals of Photonics”, John Wiley & Sons 2011
2. T.P. Pearsall, “Photonics Essentials: An introduction with experiments”, McGraw Hill 2003
3. F.G. Smit and T.A. King, “Optics and Photonics: An introduction”, Wiley & Sons, Ltd 2003
4. B. Balkrishna Laud, “Lasers and Non-Linear Optics”, New Age International 2011
5. R.S. Quimby, “Photonics and Lasers-An Introduction”, Wiley 2006
6. R. Menzel, “Photonics”, Springer-Verlag 2007
7. F.A. Jenkins and H.E. White, “Fundamentals of Optics”, McGraw Hill 1976
8. YarivYeh and PochiYeh, “Photonics – Optical Electronics in Modern Communications”, sixth edition, Oxford University Press 2012

WEB LINKS

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3. nptel.ac.in/courses/117101054/
4. www.nptelvideos.in/2012/12/advanced-optical-communication.html
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6. www.nptel.ac.in/courses/115101008/

PAE16554 **NANO ELECTRONICS** **3 0 0 3**

COURSE OBJECTIVES

- To understand the nano electronics concepts
- To learn the concept of fabrication and measurement Techniques
- To know about properties of nano electronic materials
- To learn about nano structure devices
- To study the logic devices and applications

UNIT I INTRODUCTION TO NANO ELECTRONICS **9**

Microelectronics towards biomolecule electronics-Particles and waves- Wave-particle duality- Wave mechanics- Schrodinger wave equation- Wave mechanics of particles: - Atoms and atomic orbitals- Materials for nano electronics- Semiconductors- Crystal lattices: Bonding in crystals- Electron energy bands- Semiconductor hetero structures- Lattice-matched and pseudo morphic hetero structures- Inorganic-organic hetero structures- Carbon nano materials: nano tubes and fullerenes.

UNIT II FABRICATION AND MEASUREMENT TECHNIQUES **9**

Growth, fabrication, and measurement techniques for nanostructures- Bulk crystal and hetero structure growth- Nanolithography, etching, and other means for fabrication of nanostructures and nano devices- Techniques for characterization of nanostructures- Spontaneous formation and ordering of nanostructures- Clusters and nano crystals- Methods of nano tube growth- Chemical and biological methods for nano scale fabrication- Fabrication of nano-electromechanical systems.

UNIT III PROPERTIES **9**

Dielectrics-Ferroelectrics-Electronic Properties and Quantum Effects-Magneto electronics – Magnetism and Magneto transport in Layered Structures-Organic Molecules – Electronic Structures, Properties, and Reactions-Neurons – The Molecular Basis of their Electrical Excitability-Circuit and System Design- Analysis by Diffraction and Fluorescence Methods-Scanning Probe Techniques

UNIT IV NANO STRUCTURE DEVICES **9**

Electron transport in semiconductors and nanostructures- Time and length scales of the electrons in solids- Statistics of the electrons in solids and nanostructures- Density of states of electrons in nanostructures- Electron transport in nanostructures-Electrons in traditional low-dimensional structures- Electrons in quantum wells- Electrons in quantum wires- Electrons in quantum dots- Nanostructure devices- Resonant-tunneling diodes- Field-effect transistors- Single-electron-transfer devices- Potential-effect transistors- Light-emitting diodes and lasers- Nano-electromechanical system devices- Quantum-dot cellular automata

UNIT V LOGIC DEVICES AND APPLICATIONS **9**

Logic Devices-Silicon MOSFETs-Ferroelectric Field Effect Transistors-Quantum Transport Devices Based on Resonant Tunneling-Single-Electron Devices for Logic Applications-Superconductor Digital Electronics-Quantum Computing Using Superconductors-Carbon Nanotubes for Data Processing- Molecular Electronics. **TOTAL PERIODS 45**

COURSE OUTCOMES

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

- examine the basic concepts of nano electronics and hetero structures.
- evaluate the techniques for characterization of nanostructures
- synthesis the knowledge about electronic properties and reactions
- analyze in-depth knowledge about the components and structure of nano devices
- analyze the concepts of logic devices and its applications.

REFERENCES

1. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press 2011
2. Supriyo Datta,"Lessons from Nanoelectronics: A New Perspective on Transport", World Scientific 2012

WEB LINKS

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2. https://www.youtube.com/watch?v=tW1-fSRiAdc
3. www.nptel.ac.in/syllabus/117108047/
4. ocw.mit.edu › Courses › Electrical Engineering and Computer Science
5. https://ece.uwaterloo.ca/~ece493t1/t1/documents.html

ELECTIVE VI

PAE16651 **ROBOTICS** **3 0 0 3**

COURSE OBJECTIVES

- To study the fundamental concepts of kinematics.
- To gain the knowledge about various sensors used in robotics.
- To understand the concepts of computer vision and AI techniques to design a robot
- To acquire knowledge about Robot mapping
- To learn the various types algorithms for mapping and navigation

UNIT I LOCOMOTION AND KINEMATICS **9**

Introduction to Robotics – key issues in robot locomotion – legged robots – wheeled mobile robots – aerial mobile robots – introduction to kinematics – kinematics models and constraints – robot Maneuverability

UNIT II ROBOT PERCEPTION **9**

Sensors for mobile robots – vision for robotics – cameras – image formation – structure from stereo – structure from motion – optical flow – color tracking – place recognition – range data

UNIT III MOBILE ROBOT LOCALIZATION **9**

Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization – EKF localization – UKF localization – Grid localization – Monte Carlo localization – localization in dynamic environments

UNIT IV MOBILE ROBOT MAPPING **9**

Autonomous map building – occupancy grip mapping – MAP occupancy mapping – SLAM – extended Kalman Filter SLAM – graph-based SLAM – particle filter SLAM – sparse extended information filter – Fast SLAM algorithm

UNIT V PLANNING AND NAVIGATION **9**

Introduction to planning and navigation – planning and reacting – path planning – obstacle avoidance techniques – navigation architectures – basic exploration algorithm

TOTAL PERIODS 45

COURSE OUTCOMES

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

- examine the basic principles of robotics
- evaluate the knowledge about navigation and movement of the robots and robotic arm.
- synthesis the function of various sensors used in robotics.
- analyze and implementation of robotics in specific applications.
- compare the planning and navigation using different algorithms.

REFERENCES

1. Howie Choset et al., “Principles of Robot Motion: Theory, Algorithms, and Implementations”, A Bradford Book, 2005.
2. Gregory Dudek and Michael Jenkin, “Computational Principles of Mobile Robotics”, Second Edition, Cambridge University Press, 2010.
3. Maja J. Mataric, “The Robotics Primer”, MIT Press, 2007.
4. Roland Seigwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Second Edition, MIT Press, 2011.
5. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.

WEB LINKS

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4. https://see.stanford.edu/materials/aiircs223a/handout5_robots_and_vision.pdf
5. https://www.youtube.com/watch?v=68uD1asyJzE
6. http://www.iai.uni-bonn.de/~rhino/research/papers/haehnel-populated.pdf
7. https://people.kth.se/~hu/papers/iros36.pdf

PAE16652 **OPTICAL IMAGING TECHNIQUES** **3 0 0 3**

COURSE OBJECTIVES

- To gain the basic fundamentals of light sources
- To acquire the basic knowledge of mathematical analysis for grating patterns
- To know about the transforms used for Optical Imaging techniques.
- To understand the key concepts of various imaging techniques
- To know the different imaging instruments and applications of Optical imaging networks.

UNIT I FUNDAMENTALS OF OPTICAL LIGHT SOURCES **9**

Coherence and light sources – properties -numerical aperture- optical image formation – Fresnel diffraction-Franhoufer diffraction – Single slit – double slit circular aperture – double aperture gratings – 1D and 2D lens aperture – Interference.

UNIT II FOURIER SERIES AND TRANSFORM **9**

Fourier series – Fourier coefficients – optical and crystal diffraction gratings – Fourier series formulation – Fourier transform and single slit diffraction – grating pattern – Fourier transform of light waves – correlation.

UNIT III OPTICAL IMAGING AND PROCESSING **9**

Incoherent optical imaging – transfer function – coherent optical imaging – periodic and non periodic objects – optical transform – Holography – coherent and incoherent optical processing.

UNIT IV IMAGE COMPRESSION TECHNIQUES **9**

Imaging techniques- X – ray computed tomography – reconstruction by simple back projection – iterative reconstruction –analysis methods – magnetic resonance imaging – Ultrasonic computed tomography.

UNIT V APPLICATIONS **9**

Michelson's stellar interferometry – spectral interferometer – fringe visibility and spectral distribution –partial coherence and correlation – Fourier transform spectroscopy – Synthetic aperture radar – Intensity interferometer – Imaging by holographic techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyze the basic knowledge and competence in the area of optical imaging networks
- apply engineering tools and techniques to conduct engineering design/experiments as well as to analyze and interpret data.
- gain an in-depth knowledge about the various imaging techniques
- learn critical thinking and problem solving capabilities.
- understand the major applications and instruments related to Optical Imaging.

REFERENCES

1. E.G. Stewart, “Fourier Optics an Introduction”, 2nd Edition, Ellis Harwood limited, Chichester, 1987.
2. Dror.G. Feitelson, “Optical Computing”, MIT press, Cambridge, 1988.
3. MilmanSonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis and Machine Vision”, Brooks/Cole, Vikas Publishing House, II ed., 1999.
4. David Salomon, “Data Compression – The Complete Reference”, Springer Verlag New York Inc., 2nd Edition, 2001
5. William K.Pratt, “Digital Image Processing”, John Wiley, NewYork, 2002.
6. Sid Ahmed, M.A., “Optical Image Processing Theory, Algorithms and Architectures”, McGraw-Hill, 1995.

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5. https://www.youtube.com/watch?v=VdNhREmkrmE
6. https://www.youtube.com/watch?v=VWxYsZPtTsI

PAE16653 **MEMS AND NEMS** **3 0 0 3**

COURSE OBJECTIVES

- To understand the basic concepts of MEMS and NEMS
- To acquire the basic knowledge of fabrication techniques of MEMS
- To know about the performance evaluation of MEMS
- To understand the key concepts of various sensors of Nano electronics
- To know the different nanostructures and its dynamics.

UNIT I **OVERVIEW AND INTRODUCTION** **9**

New trends in Engineering and Science: Micro and Nano scale systems Introduction to Design of MEMS and NEMS, MEMS Roadmap, Benefits of Miniaturization, Overview of Nano and Micro electromechanical systems, Applications of Micro and Nano electromechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT II **MEMS MICRO SYSTEM FABRICATION TECHNOLOGIES** **9**

Micro system fabrication processes: Photolithography, Ion Implantation, Diffusion, and Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, Wafer bonding: High Aspect-Ratio (LIGA and LIGA-like) Technology; Smart Material Processing, Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.

UNIT III **NANO SENSORS** **9**

Sensor Characteristics and Physical effects, Nano based Inorganic sensors-optical, mechanical and plasma resonance sensors, applications-Nano tube based sensors, Cantilever array sensors, Detectors-Bio detector, Nano array based detector.

UNIT IV **PACKAGING OF MEMS AND MICRO SENSORS** **9**

Non –Silicon MEMS, Polymers in Microsystems, Packaging of MEMS devices by bonding, Pressure sensors and packaging, MEMS Performance Evaluation, Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor.

UNIT V **NEMS FABRICATION AND QUANTUM MECHANICS** **9**

Nano electrical mechanical systems- Fabrication and process techniques, Integration of Nano systems and devices, NEMS Performance Evaluation, NEMS Applications and Future Challenges, Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Molecular Wires and Molecular Circuits.

TOTAL PERIODS **45**

COURSE OUTCOMES

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

- analyze the basic concepts of MEMS and NEMS
- acquire in-depth knowledge about fabrication process of MEMS
- evaluate the various packaging models of MEMS

- analyze the major applications and sensors of MEMS and NEMS.
- analyze the performance evaluation of micro and Nano electrical materials.

REFERENCES

1. W.R.Fahmer,"Nanotechnologyand",Nanoelectronics:Materials,Devices,MeasurementTechniques",Springer 2005
2. Marc Madou, "Fundamentals of Micro fabrication", CRC press 1997.
3. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2001
4. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata McGraw Hill, 2002.
5. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006
6. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002
7. Branda Paz, "A Handbook on Nano electronics"

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3. video.mit.edu/watch/nanosensors-3466/
4. https://www.youtube.com/watch?v=j9y0gfN9WMg
5. nptel.ac.in/courses/112104162/
6. nptel.ac.in/courses/117105082

PAE16654 **WIRELESS ADHOC NETWORKS** **3 0 0 3**

COURSE OBJECTIVES

- To understand the basic Science of ADHOC
- To learn the concepts of routing and security
- To acquire the concepts of QoS
- To learn about energy management

UNIT I **AD HOC NETWORKS** **9**

Ad hoc Wireless Networks – What is an Ad Hoc Network? Heterogeneity in Mobile Devices – Wireless Sensor Networks – Traffic Profiles – Types of Ad hoc Mobile Communications – Types of Mobile Host Movements – Challenges Facing Ad hoc Mobile Networks – Ad hoc wireless Internet. Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks –

UNIT II **ROUTING PROTOCOLS** **9**

Classifications of Routing Protocols – Table–Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV) – Wireless Routing Protocol (WRP) – Cluster Switch Gateway Routing (CSGR) – Source–Initiated On–Demand Approaches – Ad hoc On–Demand Distance Vector Routing (AODV) – Dynamic Source Routing (DSR) – Temporally Ordered Routing Algorithm (TORA) – Signal Stability Routing (SSR) – Location–Aided Routing (LAR) – Power–Aware Routing (PAR) – Zone Routing Protocol (ZRP).

UNIT III **MULTICAST ROUTING** **9**

Issues in Designing a Multicast Routing Protocol – Operation of Multicast Routing Protocols – An Architecture Reference Model for Multicast Routing Protocols –Classifications of Multicast Routing Protocols – Tree–Based Multicast Routing Protocols– Mesh–Based Multicast Routing Protocols – Summary of Tree and Mesh based Protocols – Energy–Efficient Multicasting – Multicasting with Quality of Service Guarantees – Application – Dependent Multicast Routing – Comparisons of Multicast Routing Protocols - Design Goals of a Transport Layer Protocol for Ad hoc Wireless Networks –Classification of Transport Layer Solutions – TCP over Ad hoc Wireless Networks

UNIT IV **SECURITY AND QOS** **9**

Security in Ad Hoc Wireless Networks – Network Security Requirements – Issues and Challenges in Security Provisioning – Network Security Attacks – Key Management – Secure Routing in Ad hoc Wireless Networks - Issues and Challenges in Providing QoS in Ad hoc Wireless Networks – Classifications of QoS Solutions – MAC Layer Solutions – Network Layer Solutions – QoS Frameworks for Ad hoc Wireless Networks

UNIT V **ENERGY MANAGEMENT** **9**

Energy Management in Ad hoc Wireless Networks – Introduction – Need for Energy Management in Ad hoc Wireless Networks – Classification of Energy Management Schemes – Battery Management Schemes – Transmission Power Management Schemes – System Power Management Schemes.

TOTAL PERIODS **45**

COURSE OUTCOMES

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

- analyze the concepts of Ad Hoc Networks

- examine the Basic of routing protocols
- synthesis the multicast routing
- analyze the knowledge about security and its applications
- evaluate the energy management

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1. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004.
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WEB LINKS

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2. www.ece.rochester.edu/courses/ECE586/lectures/MANETS_Routing.pdf
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4. home.iitk.ac.in/~adityaj/Bio.html