

## EC 401 ANTENNA AND WAVE PROPAGATION

L T P C  
3-0-1-4

**Objective:** This course helps students understand how electromagnetic waves travel from the transmitter to the receiver and how the antenna converts electrical energy into electromagnetic waves. The various types of transmitting and receiving antennas are also discussed.

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**Antenna Principles:** Potential Functions & Electromagnetic Field, Current Elements, Radiation from Monopole & Half Wave Dipole, power radiated by current element, radiation resistance, Antenna Gain, Effective Area, Antenna Terminal Impedance, Practical Antennas and Methods of Excitation, Antenna Temperature and Signal to Noise Ratio.

**Antennas Arrays:** Two Element Array, Horizontal Patterns in Broadcast Arrays, Linear Arrays, Multiplication of patterns, effect of the earth on vertical patterns, Binomial array

**Practical Antennas:** VLF and LF transmitting antennas, effect of antenna height, Field of short dipole, electric field of small loop antenna, Directivity of circular loop antenna with uniform current, Yagi-Uda Rhombic Antenna: Weight and Leg length, Slot Antenna Parabolic Reflectors: Properties, Comparison with corner reflectors Horn Antenna: Length and Aperture, Introduction to Turstile Antenna, Effect of ground on antenna performance.

**Broadband Antenna:** Frequency independent concept, RUMSEY's Principle, Frequency independent planar log spiral antenna, Frequency independent conical spiral Antenna.

**Wave Propagation:** Modes of Propagation, Plane Earth Reflection, Space wave and Surface Wave, Reflection and refraction waves by the Ionosphere Tropospheric Wave. Ionosphere Wave Propagation in the Ionosphere, Virtual Height, MUF Critical frequency, Skip Distance, Duct Propagation, Space wave

**Antenna Measurement:** Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement.

### Text Books:

1. Jordan Edwards C. and Balmain Keith G. "Electromagnetic Waves and Radiating Systems"/ Prentice Hall (India)
2. Prasad, K.D. "Antennas and Wave Propagation" Khanna Publications

### Reference Books:

1. Kraus, John D. & Mashefka, Ronald J. "Antennas: For All Applications" Tata McGraw Hill, 3rd Ed.
2. Collin, R. "Antennas and Radiowave Propagation" Tata McGraw-Hill
3. Hayt Jr. William H. "Engineering Electromagnetics " Tata McGraw- Hill
4. Das, Annaparna & Das, Sisir K. "Microwave Engineering" Tata McGraw Hill.
5. Roy, Sitiesh Kumar & Mitra, Monojit "Microwave Semiconductor Devices" Prentice Hall (India).

## EC 402 MICROELECTRONICS TECHNOLOGY

L-T-P-C  
3-0-0-3

**Objective:** This course helps develop awareness about the challenges in designing and fabricating VLSI chips.

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**Miniaturization & its impact on characterization of Electronic Systems:** Introduction, Trends & Projections in IC Design & Technology, Comparison between semiconductor materials, Basics of Thick and thin Film Hybrid Technology and monolithic chips, Advantages, limitations & Classification of ICs.

**Bipolar & MOS Techniques:** Flow chart of Bipolar, NMOS and CMOS technologies, Basics of VLSI Design & Process Simulation.

**Crystal Growth and Epitaxy:** Starting material for formation of crystal, Horizontal Bridgeman Method, Czochralski growth, Distribution of dopants, Zone refining, Silicon Float Zone process, Si-Wafer preparation, Epitaxial growth, Techniques used for epitaxial growth(LPE,VPE,MBE)

**Silicon oxidation:** Thermal oxidation process (Kinetics of growth , Thin oxide growth), Effect of impurities on the oxidation rate, Preoxidation Cleaning, Various oxidation techniques, Masking properties of SiO<sub>2</sub> , Photolithography and Etching, Pattern generation/Mask making, Contact and Proximity printing, Photoresistant, Photolithography Process(Lift off technology , Fine line photolithography), Wet/Dry etching, Reactive Plasma etching techniques and applications

**Diffusion and Ion implantation:** Basic diffusion process(Diffusion equation, Diffusion profiles), Extrinsic diffusion, Lateral Diffusion, Ion Implantation Process (Ion distribution , Ion Stopping), Implant Damage and Annealing process (Furnace and RTA), VI IC PACKAGING, Isolation Techniques, Testing of the Chip, Wire Bonding techniques, Flipchip technique, Various Packaging methods and Materials,

**Fabrication of monolithic components:** Fabrication of Diodes, Resistors, capacitors and inductors, Fabrication of BJT and FET, Fabrication of MOS Devices, CMOS fabrication techniques (n-well and p-well process sequences), Reliability issues in CMOS VLSI, Latching, Electromigration.

### Text Books:

1. S.M. Sze, "VLSI Technology", TMH
2. S.K. Gandhi, "VLSI Fabrication Principles", John Willey & Sons
3. S.M. Kang & Y. Leblibici, "CMOS Digital Integrated Circuits-Analysis and Design", TMH.
4. D.Nagchoudhuri "Principles of Microelectronics Technology" PHI
5. Microelectronics: Jacob and Millman

### Reference Books

1. Carmen Capillo, "Surface Mount Technology".
2. Eshraghian & Pucknell, "Introduction to VLSI", PHI INC, 2005

# PH 401 Nanotechnology

L – T – P – C  
3 – 0 – 0 – 3

*Aim of this course is to discuss why and how changes occur in the properties of bulk materials when their size approaches a billionth of a meter and the uses of these properties in nanostructures, nanotubes, molecular electronics, scanning probes, nanobiotechnology, quantum dots etc.*

## 1. Introduction

What is nano? Why nano? Nanomaterials and Nanodevices

## 2. Review of Quantum Mechanics and Solid State Physics

Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle, Pauli Exclusion Principle, Schrödinger's equation, Properties of the wave function, Structure and bonding, lattice vibration, energy bands – insulators, semiconductors and conductors, energy gape of semiconductors, Fermi surfaces, localized particles, donors, acceptors, deep traps, mobility and excitons

## 3. Nanoclusters

Magic numbers, Model for nanoclusters, Geometrical and Electronic structure, Semiconducting nanoclusters

## 4. Nanostructures

Carbon molecules and clusters, C<sub>60</sub>, alkali doped C<sub>60</sub>, Carbon nanotubes –Fabrication, structure, electrical properties, vibrational and mechanical properties. Concepts of quantum well, wires and dots, properties of quantum nanoclusters, bottom-up and top-down methods, size effects, conduction electrons and dimensionality, Fermi gas and density of states, potential wells, partial confinement.

## 5. Nanomaterials:

Properties of Nanomaterials: Mechanical properties, Structural properties, Melting of nanoparticles, Electrical conductivity, Optical properties, Magnetic properties, Structural characterization of nanomaterials using XRD, TEM, SEM, STM, AFM

## 6. Nanoelectronics

Molecular electronics, molecular switching, Schottky devices, Quantum structures and devices, Mesoscopic devices, Nanoscale Transistors, Single Electron Transistors, MOSFET and NanoFET, Resonant Tunneling Devices, Carbon Nanotube based logic gates, optical devices, Fuel cells, Sensors, Connection with quantum dots, quantum wires, and quantum wells, quantum dot lasers, Nanolithography – lithography using photons and particle beams, Scanning probe lithography, soft lithography.

## Books:

1. Charles P. Poole Jr. and Frank J. Owens, Introduction to Nanotechnology 2007, Wiley-India Edition
2. Nanotechnology: Principles and Practices  
Sulbha K. Kulkarni, Captial Publishers, ISBN: 978-8185589299

3. Edward L. Wolf, *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*, 2nd ed., WILEY-VCH, 2006, ISBN: 3-527-40651-4
4. John H. Davies, *The Physics of Low Dimensional Semiconductors: An Introduction*, Cambridge University Press, 1998.
5. Quantum transport: Atom to Transistor, Supriyo Datta, Cambridge University Press; 2nd edition (2005), ISBN-13: 978-0521631457

**MB 402 ETHICS AND IPR**

**L T P C**

**3- 0- 0- 3**

**Objective:** The aim of this course is to sensitize students towards professional ethics, values, fairness issues and their critical aspects. The course also throws light on computer crimes which are increasing at fast pace and intellectual property related issues which are need of modern industrial and business enterprises.

**Ethics and Human Values:** Ethics and morals values, Ethical theory, Applied ethics, Professional ethics, Guidance for living ethically, Respect for others, Valuing Time, Cooperation, Commitment, Self Confidence and Character, Work Ethos, Need for values, Indian perspectives, Secular Vs Spiritual values, Science and human values, Settlement of dispute by collective Bargaining , Employee Right and Occupational Crime.

**Critical-Thinking Skills:** Introduction and overview, Errors arising from ambiguity, Circular arguments that beg the question, Use of unwarranted assumptions, Fallacies involving missing evidence, Incorrectly identified causation, Premises irrelevant to the stated conclusion, Irrelevant appeals to emotion/authority/loyalty/, Diversion from the main point, Incorrect deductive inference.

**Professional Codes of Ethics:** Introduction, The IEEE code of ethics, The ACM code of ethics, The NSPE code of ethics, IE(India) and IETE(India) etc., Points of contrast between codes, Problems with codes of ethics.

**Computer Crime:** Separate Category for Computer Crime. Introduction, Hacking, Consequences, Prevention; Amateur and Career Crackers Information and The Law: Information as an object. Legal issue related to information. Protecting program and data, Protection for computer objects, Privacy of Electronic data, Cryptography standards (Private-key encryption, The Data Encryption Standard, Public-key encryption, The RSA algorithm, The Escrowed Encryption Standard), Status and ethical issues.

**Software Piracy:** Software alliance, Anti-piracy organizations, Whistle-blowing incidents, Laws protecting whistle blowers.

**Intellectual Property Issues:** Protecting the intangible, Patents and its eligibility. Employee/employer patent rights, Using a patent, Infringement, Changes to watch for, Patent searches, Copyrights, Requirements for registration of a copyright, Infringement. Fair use of copyrighted material Trade secrets, Reverse engineering, The "look and feel" copyright controversy, Software patents.

**Environmental and Health Concerns:** Introduction, Manufacturing, Day-to-day use, Resource conservation

**Striving For Fairness:** Introduction, A brief historical perspective, under representation, dealing with discrimination, Sexual harassment, racial discrimination, Other Forms of Bias.

