FACULTY OF SCIENCES

SYLLABUS

FOR

M. Sc. Applied Physics (Electronics)

(Under Credit Based Continuous Evaluation Grading System)

(Semester: III & IV)

Examintions: 2014- 15

GURU NANAK DEV UNIVERSITY
AMRITSAR

(ii) Subject to change in the syllabi at any time.
Please visit the University website time to time.

M.Sc. Applied Physics (Electronics) (Semester System)
(Under Credit Based Continuous Evaluation Grading System)

Course Code: PHB 3

Semester III

Course No.	**C/E/I**	**Course Title**	**Hrs/Week**	**LTP**
APL-501	C	Computer Programming and Computational Methods	4	4-0-0
APL-502	C	Semiconductor Devices	4	4-0-0
APL-503	C	Microprocessors	4	4-0-0
APL-504	C	Fabrication of Electronic Devices	4	4-0-0
E-1	E		3	3-0-0
APP-521	C	Computer Lab	6	0-0-3
APP-522	C	Advanced Electronics Lab	6	0-0-3
			Total Credit	**25**

Elective Courses

NSL-501 Carbon Nanotubes and its Functionalization
NSL-502 Nano Sensors and Nanodevices
NSL-503 Nano Semiconductors, Plasmonics Spintronics

Semester IV

Course No.	**C/E/I**	**Course Title**	**Hrs/Week**	**LTP**
E-2	E		3	3-0-0
E-3	E		3	3-0-0
E-4	E		3	3-0-0
I-1	I		3	3-0-0
I-2	I		3	3-0-0
APD-571	Project		12	0-0-6
			Total Credit	**21**

Elective Courses

PHL-581 Experimental Methods
PHL-582 Reactor Physics
PHL-583 Material Science
PHL-584 Nanotechnology
PHL-585 Communication Electronics
PHL-586 Radiation Physics
PHL-587 Plasma Physics
APL-581 Physics of Low Dimensional Semiconductors
APL-582 Digital Signal Processing
APL-583 Digital Communications
APL-584 Optical Communications

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

COMPUTER PROGRAMMING & COMPUTATIONAL METHODS

Course No.	**L**	**T**	**P**
APL-501	**4**	**0**	**0**

Unit – I

Numerical Methods – I

Finite Differences and Interpolation: Difference Operators, Finite differences and differentiation, Interpolation using forward differences, Lagrange's Polynomial Interpolation. Differential Equations: Solving Differential equations by Taylor series method, Euler's method, Runge-Kutta second order and fourth order methods. Differentiation based on equal – interval interpolation, Newton's Backward difference formula, Differentiation based on Lagrange's interpolation formula. Numerical Integration: General Quadrature formula, Trapezoidal, Simpson's one third and three eighth rules, Gauss quadrature formula.

Unit – II

Numerical Methods – II

Solutions of non-linear equations: Bisection method, Newton-Raphson method, System of Linear Equations: Gauss elimination methods, Triangularization method, Inverse of a matrix by compact schemes, Jacobi's iterative method . Eigen values and Eigen vectors : Introduction, properties of eigen values and eigenvectors, Determination of Eigen values and Eigenvectors by Iterative (Power method) and Jacobi methods. Curve Fitting: Fitting Linear equations, Fitting Transcendental equations, Fitting a Polynomial equations.

Unit – III

Matlab – I

Introduction: Basics of MATLAB, working with arrays, creating and printing plots, Interacting Computations: Matrices and Vectors, Matrices and Array Operations, built in functions, saving and loading data, plotting simple graphs Programming in MATLAB: Script files, function files, Compiled files, p-code, variables, loops, branches, and control flow, Input/Output, Advanced data objects, structures, cells.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Unit IV

Matlab – II

Linear Algebra; solving a linear system, Gaussian elimination, finding eigen values and eigen vectors, matrix factorization, Curve fitting and Interpolation; polynomial curve fitting, least square curve fitting, interpolation, Data analysis and statistics, Numerical integration; double integration, Ordinary differential equation; first order linear ODE, second order nonlinear ODE, tolerance, ODE suite, event location, Non linear algebraic equations

Recommended Books:

1. Numerical Methods, S. Balachandra Rao and C.K.Shantha, Stosius Inc/Advent Books Division, 2000.
2. Numerical Methods, E Balagurusamy, Tata McGraw Hill Publishing Co Ltd., 1999.
3. Getting Started with MATLAB - Rudra Pratap-Oxford University Press-2005.
4. A Concise Introduction to MATLAB, William J Palm III, McGraw Hill, 2008.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

SEMICONDUCTOR DEVICES

Course No.	L	T	P
APL-502	**4**	**0**	**0**

Unit-I

Semiconductor Materials: Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors; Determination of bandgap by optical method. Degenerate and compensated semiconductors, Carrier Transport in Semiconductors: Carrier Drift under low and high fields in (Si and GaAs), saturation of drift velocity, High field effects in two valley semiconductors, Carrier Diffusion, Carrier Injection, Generation Recombination Processes - Direct, Indirect bandgap semiconductors, Minority Carrier Life Time, Drift and Diffusion of Minority Carriers (Haynes-Shockley Experiment), Determination of Conductivity by (a) four probe and (b) Van der Paw techniques, Hall Coefficient, Minority Carrier Life Time.

Unit-II

Junction Devices: (I) p-n junction - Energy Band diagrams for homo and hetero junctions. Current flow mechanism in p-n junction, effect of indirect and surface recombination currents on the forward biased diffusion current, p-n junction diodes rectifiers (high frequency limit), (ii) Metal-semiconductor (Schottky Junction): Energy band diagram, current flow mechanisms in forward and reverse bias, effect of interface states. Applications of Schottky diodes, (iii) Metal-Oxide-Semiconductor (MOS) diodes). Energy band diagram, depletion and inversion layer. High and low frequency Capacitance Voltage (C-V) characteristics. Smearing of C-V curve, flat band shift, Applications of MOS diode.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Unit-III

Transistors: JFET, BJT, MOSFET and MESFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions. High frequency limits, Memory Devices: Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, non-volatile-NMOS, magnetic, optical and ferroelectric memories, charge coupled devices (CCD).

Unit-IV

Switching Devices: p-n-p-n Shockley diode; UJT; SCR; DIAC and TRIAC, Microwave Devices: Gunn Diodes, IMPATT diodes, BARRITT diodes, Klystron and Magnetron.

Recommended Books:

1. The Physics of Semiconductor Devices, D.A. Eraser, Oxford Physics Series, 1986.
2. Semiconductor Devices (Physics and Technology), S.M. Sze, Wiley, 1985.
3. Semiconductor Material and Device Characterization, Dieter K Schroder, John Wiley & Sons, 2006.
4. Introduction to Semiconductor Devices and Materials, M.S. Tyagi, John Wiley & Sons, 1991.
5. Solid State Electronics Devices, B.G. Streetman and S. Banerjee, Prentice Hall, 1999.
6. Microwaves, K. C. Gupta, Wiley Eastern Ltd., New Delhi, 1983.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

MICROPROCESSORS

Course No.	**L T P**
APL-503	**4 0 0**

Unit-I

Introduction to Microprocessors: Microprocessors, binary digits, Microprocessor as a programmable device, Input/Output, Microprocessor as a CPU, Organization of a Microprocessor based system, Arithmetic/Logic unit register array, control unit, Machine Language, 8085 Machine language, 8085 Assembly language, ASCII codes.

Unit – II

Microprocessor Architecture: Microprocessor Architecture and its operations, Microprocessor initiated operations and 8085 BUS organization, Internal data operations at the 8085 operations, peripheral or externally initiated operations, memory, memory map and memory addresses, memory classifications, Input/Output devices, tristate devices, buffer, decoder, encoder, de flip-flop,

Unit- III

Memory Interface Devices: 8085 MPU, Microprocessor communications and BUS timing, De-multiplexing the Bus AD_7-AD_0, ALU, Memory structures and its requirement, basic concepts in memory interfacing, address coding, interfacing circuits, address coding and memory addresses.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Unit- IV

Interfacing I/O devices: Peripheral I/O instruction, I/O execution, Device selection and data transfer, Input interfacing, Interfacing I/Os using decoder, Interfacing Output displays, Interfacing Input devices.

Recommended Books:

1. Microprocessors Architecture, Programming and Application with 8085, Third edition, Ramesh S. Gaonkar, Penram International Publishing India, 1997.

2. The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, and Pentium Pro Processor Architecture, Programming, and Inter-facing, 5th Edition, Barry B. Brey, Prentice Hall, 2000.

3. Microprocessors and Interfacing: Programming and Hardware 2nd edition, Douglas V. Hall, Glencoe McGraw-Hill, 1991.

4. 80X86 IBM PC and Compatible Computers: Assembly Language, Design, and Interfacing (Vol. 1 & 2), 4th Edition, Muhammad Ali Mazidi and Janice Gillispie, Mazidi, Pearson Education, 2002.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

FABRICATION OF ELECTRONIC DEVICES

Course No.	**L**	**T**	**P**
APL-504	**4**	**0**	**0**

Unit-I

Crystal growth: Czochralski and Bridgman techniques, Float Zone growth, Distribution coefficients, Zone refining, Wafer preparation and specifications. Epitaxy: importance of lattice matching in epitaxy, CVD of Si, Thermodynamics of vapour phase growth, defects in epitaxial growth, MBE technology.

Unit – II

Diffusion: Fick's diffusion equation in one dimension, Atomistic models of diffusion, analytic solution of Fick' s law for different cases. Diffusivities of common dopants in Si and SiO_2. Diffusion enhancements and retardation, Thermal Oxidation: Deal-Grove model of oxidation, Linear and Parabolic oxidation rate coefficients. Effects of dopants during oxidation, oxidation induced defects, Ion Implantation: channeling and projected range of ions, implantation damage, Rapid Thermal Annealing (RTA).

Unit - III

Metallization applications: Gates and interconnections, Metallization choices, metals, alloys and silicides, deposition techniques, metallization problems, step coverage, electromigration, Etching: Dry and wet chemical etching, Reactive Plasma Etching, Ion enhanced etching and ion induced etching, Plasma etchers and Barrel reactors.

Unit – IV

Optical lithography: photoresists, Contact and proximity printers, projection printers, Mask alignment, X-ray and electron beam lithography, Fundamental considerations for IC processing: Building individual layers, Junction and Trench isolation of devices, NMOS IC technology, CMOS IC technology, Bipolar IC technology.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Recommended Books:

1. The Science and Engineering of Microelectronics Fabrication, SA Campbell, Oxford University Press, 1996.

2. VLSI Technology, SM Sze, McGraw Hill International Editions, 1988.

3. Fundamentals of Microelectronics Processing, HH Lee, McGraw Hill, 1990.

4. The Theory and Practice of Microelectronics, SK Gandhi, John Wiley & Sons, 1968.

5. Silicon VLSI Technology: Fundamentals, Practice and Modeling, James D. Plummer, Michael D. Deal, Peter B. Griffin, Prentice Hall, 2000.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

COMPUTER LAB

Course No.	**L T P**
APP-521	**0 0 3**

ADVANCED ELECTRONICS LAB

Course No.	**L T P**
APP-522	**0 0 3**

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
CARBON NANOTUBES AND ITS FUNCTIONALIZATION

Course No.	L T P
NSL-501	3 0 0

Unit I

Preparation of Carbon Nano-Tubes; CVD and other methods of preparation of CNT, Structure and properties of single walled and multi walled carbon nanotubes; Electrical, Optical, Mechanical, Vibrational properties and ballistic conductance of carbon nanotubes.

Unit II

Applications of Carbon Nanotubes; Field emission, Fuel Cells, Display devices, Energy Storage, nanotube sensors, composites for military and space applications, applications in NanoFET

Unit III

Functionalization of Carbon Nanotubes; Reactivity of Carbon Nanotubes, Covalent Functionalization -Oxidative Purification Defect Functionalization –Transformation and Modification of Carboxylic Functionalization like Amidation, Thiolation, Halogenations, Hydrogenation, Addition of Radicals, Addition of Nucleophilic Carbenes, Sidewall Functionlization through Electrophilic Addition, Cycloadditions, Carbenes Addition, Addition of Nitrenes, Noncovalent Exohedral Functionalization, Endohedral Functionalization

Unit IV

Other Important Carbon based materials; Preparation, properties and Characterization of Fullerene and other associated carbon clusters/molecules, Graphene-preparation, characterization and properties, DLC and nanodiamonds.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Recommended Books:

1. Nanoscale Materials- Liz Marzan and Kamat, Springer, 2003.
2. Physical Properties of Carbon Nanotube, R. Saito, G. Dresselhaus, and M. S. Dresselhaus, Imperial College Press, 1998.
3. Applied Physics of Carbon Nanotubes: Fundamentals Of Theory, Optics And Transport Devices, S. Subramoney & S.V. Rotkins, Springer, 2005.
4. Carbon Nanotubes: Properties and Applications, Michael J. O'Connell, CRC Press, 2006.
5. Carbon Nanotubes, Liming Dai, Elsevier, 2006.
6. Nanotubes and Nanowires, CNR Rao and A Govindaraj, Royal Society of Chemistry, 2005.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
NANO SENSORS AND NANODEVICES

Course No.	L	T	P
NSL-502	**3**	**0**	**0**

Unit I

Micro and Nano-Sensors: Fundamentals and characterization of sensors, micro fluids, MEMS and NEMS, packaging of sensors, methods of packaging at zero level and first level.

Unit II

Sensors: Sensors for aerospace and defense, accelerometer, pressure sensor, chemical sensors, strain gauges, night vision system, optical sensors, nano tweezers, nano-cutting tools, integration of sensor with actuators and electronic circuitry, metal insulator semiconductor devices, Schottky devices, other civil applications: metrology, bridges etc.

Unit III

Biosensors: Sensor for bio-medical applications: cardiology, neurology, clinical diagnostics and tools, generation of biosensors, immobilization, characteristics, applications, conducting Polymer based sensor, DNA biosensors, biochips, molecular electronics, information storage, molecular switching.

Unit IV

Quantum Structures and Devices: Quantum layers, wells, dots and wires, optical properties of quantum dots, quantum wires and quantum wells, quantum well lasers. mesoscopic devices, ballistic transport, nanoscale transistors, single electron transistors, MOSFET and NanoFET, resonant tunneling devices, carbon nanotube based logic gates.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Recommended Books:

1. Sensors. Vol. 8. Micro-and Nanosensor Technology/Trends in Sensor Markets-H. Meixner and R. Jones (Editors)–John Wiley & Sons – 2000.

2. Between Technology & Science: Exploring an Emerging Field Knowledge Flows & Networking on the Nanoscale - Martin S. Meyer - D-Phil Thesis - Publisher : Disseration.com – 2003.

3. Nanoscience & Technology: Novel Structure and Phenomena - Ping Sheng (Editor) - Taylor & Francis - 2003.

4. Nano Engineering in Science & Technology: An Introduction to the World of Nano-Design: Series on the Foundations of Natural Science & Technology-Vol. 6 - Micheal Reith - World Scientific – 2003.

5. 5. Enabling Technology for MEMS and Nano Devices - H. Baltes, O. Brand, G. K. Fedder, C. Hierold, J. G. Korvink, Dr. O. Tabata (Editors) - WILEY-VCH Verlag GmbH & Co. – 2004.

6. Optimal Synthesis Methods for MEMS - G. K. Ananthasuresh (Editor) - Kluwer Academic Publishers – 2003.

7. Quantum Transport: Atom to Transistor - Supriyo Datta- Cambridge University Press - 2005

8. Fundamentals of Nanoelectronics, George W. Hanson, Pearson Education Inc., Prentice Hall -2008.

9. Sensor Technology Handbook; MEMS Applications, Edited by Mohamed –El-Hak, Taylor & Francis -2006.

10. Sensor Technology Handbook, Edited by Jon Wilson, Elsevier Inc. -2005.

11. MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering, Tai-Ran Hsu, John Wiley & Sons, Inc.-2008.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
NANO SEMICONDUCTORS, PLASMONICS SPINTRONICS

Course No.	L	T	P
NSL-503	3	0	0

Unit I

Confinement and transport in nanostructure- size–dependant physical properties; current, reservoirs, and electron channels, conductance formula for nanostructures, quantized conductance, Landauer formula, Ballistic transport, Diffusive transport, Single particle conductance, Coulomb Blockade, Single electron transistors, Resonant Tunneling devices.

Unit -II

Semiconductor nanoparticles – applications; optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles, carrier injection, polymer-nanoparticle, LED and solar cells, electroluminescence, doping nanoparticles, light emission from indirect semiconductors, light emission form Si nanodots, semiconductor heterostructures .

Unit III

Optical properties of noble metals, Plasmons, Drude-Sommerfeld theory, Surface plasmon polaritons at plane interfaces, excitation of surface plasmon polaritons: Otto and Kretschmann configurations, Surface plasmon sensors, Surface plasmons in nano-optics, plasmons supported by nanowires and particles.Photonic crystals, theory of photonic bandgap, optical microcavities, merging photonics and electronics at nanoscale dimensions, single photon transistor using surface plasmons, optical modulation by plasmonic excitation of quantum dots, near field photonics, localized surface plasmons, slow guided surface plasmons at telecom frequencies.

M.Sc. Applied Physics (Electronics) (Semester – III)
(Under Credit Based Continuous Evaluation Grading System)

Unit IV

Spintronics Introduction, Overview, History & Background, Generation of Spin Polarization; theories of spin injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.

Recommended Books:

1. Fundamentals of Nanoelectronics, George W. Hanson, Pearson Education Inc. Prentice Hall –2008.
2. Principles of Nano-optics, Lukas Novotony and Bert Hecht, Cambridge University Press 2006
3. Nanoplasmonics, From Fundamentals to Applications Vol. 1 & 2 - S. Kawata & H. Masuhara - Elsevier - 2004.
4. Springer Handbook of Nanotechnology - Bharat Bhushan – Springer - 2004.
5. Handbook of Semiconductor Nanostructures and Nanodevices Vol. 1-5- A. A. Balandin - K. L. Wang - American Scientific Publishers – 2006.
6. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong - Imperial College Press - 2004.
7. Concepts in Spintronics – Sadamichi Maekawa - Oxford University Press – 2006.
8. Spin Electronics – David Awschalom – Springer – 2004.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

PROJECT

Course No.	L	T	P
APD-571	**0**	**0**	**6**

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
EXPERIMENTAL METHODS

Course No.	**L T P**
PHL-581	**4 0 0**

Interaction & Detectors: Interaction of heavy charged particles, Interaction of fast electrons interaction of gamma rays, Interaction of Neutrons, Radiation exposure & Dose, Angular distribution, Gamma-Gamma angular distribution, Theory of internal Conversion, charged particles, neutrons etc, GM counter, Scintillation detectors, Solid State detectors.

Counting Statistics & Error Prediction: *Error analysis, least square fitting, Chi square test, Normal and Poisson distribution, Statistical errors in nuclear particle counting, propagation of errors, Plotting of graphs.*

Vacuum & Low Temperature Techniques: Vacuum techniques, Basic idea of conductance, pumping speed, Pumps: Mechanical pumps, Diffusion pumps, Ionization pumps, turbo molecular pumps, gauges; Penning, Pirani, Hot cathode, Low temperature: Cooling a sample over a range upto 4 K and measurement of temperature.

Transducers and Temperature Measurements: Classification of transducers, Selecting a transducers, qualitative treatment of strain gauge, capacitive transducers, inductive transducers, linear variable differential transformer (LVDT), photoelectric transducers, piezoelectric transducers, temperature measurements (Resistance thermometer, thermocouples, Themisters).

Text and Reference Books:

1. Electronic Devices and Circuits: Jacob Milliman, C. Halkias
2. Vacuum Technology: A. Roth.
3. Techniques for Nuclear and Particle Physics Experiments: W.R. Leo.
4. Radiation Detection and Measurements: Glenn F. Knell.
5. Electronic Instrumentation and Measurements Techniques: William David Cooper.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
REACTOR PHYSICS

Course No.	**L T P**
PHL-582	**4 0 0**

Interaction of Neutrons with Matter in Bulk
Thermal neutron diffusion, Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium, extrapolation length and diffusion length-the albedo concept.

Moderation of Neutron
Mechanics of elastic scattering, energy distribution of thermal neutrons, average logarithmic energy decrement, slowing down power and moderating ratio of a medium, Slowing down density, slowing down time, Fast neutron diffusion and Fermi age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length and Fermi age.

Theory of Homogeneous Bare Thermal and Heterogeneous Natural Uranium Reactors
Neutron cycle and mulplication factor, four factor formula, neutron leakage, typical calculations of critical size and composition in simple cases, the critical equation, material and geometrical bucklings, effect of reflector.
Advantages and disadvantages of heterogeneous assemblies, various types of reactors with special reference to Indian reactors and a brief discussion of their design feature.

Power Reactors Problem of Reactor Control
Breeding ratio, breeding gain, doubling time, Fast breeder reactors, dual purpose reactors, concept of fusion reactors, Role of delayed neutrons and reactor period, Inhour formula, excess reactivity, temperature effects, fission product poisoning, use of coolants and control rods.

Reference Books:

1. Glasstone & Edlund: The Elements of Nuclear Reactor Theory-Van Nostrand, 1952.
2. Murray: Introductions of Nuclear Engineering, Prentice Hall, 1961.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
MATERIAL SCIENCE

Course No.	**L T P**
PHL-583	**4 0 0**

Thin Film Technology: Classification of Thin films configurations; Film deposition method: Physical vapor deposition, Chemical vapor deposition, Spray pyrolysis, Sputtering (RF, DC); Modes of film growth by vapor deposition: from vapor to adatoms, from adatoms to film growth, growth modes based on surface energies; film microstructure: Epitaxial films, polycrystalline films, Origin of films stress: classification, stress in epitaxial films, stress in polycrystalline films, consequence of stress in film; effect of substrate temperature, deposition angle and thickness on thin film formation.

Polymers & Ceramics: Characteristics, Application and Processing of polymers; Polymerization, Polymer types: Stress- Strain behaviour, melting and glass transition, thermosets and thermoplasts; Characteristics, Application and Processing of Ceramics, glasses and refrectories.

Characterization Techniques-I: Electrical, Optical and Mechanical method for determination of thickness of films, Transmission electron microscopy (TEM), Scanning electron microscopy (SEM); Scanning tunneling microscopy (STM); Atomic force microscopy (AFM).

Characterization Techniques-II: X-ray diffraction, data manipulation of diffracted X-rays for structure determination; X-ray fluorescence spectrometry for element detection with concentration; Auger electron spectroscopy (AES), X-ray photoelectron spectroscopy (XPS), Secondary ion mass spectroscopy (SIMS)

Text and Reference Books:

1. Thin Film Materials-Stress, Defect, Formation and Surface Evolution: L.B. Freund and S. Suresh- Cambridge,
2. Thin Film Phenomena: K.L. Chopra-McGraw Hill Book, Comp., 1979.
3. Thin Film Fundamentals: A. Goswami, New Age International, 2007.
4. Material Science and Engg: W.D. Callister, John Wiley, 2001.
5. Elements of X-ray Diffraction (3rd edition): B.D. Cullity, S.R. Stock-Prentice Hall, 2001.
6. X-ray Fluorescence Spectroscopy: R. Jenkins-Wiley Interscience, New York, 1999.
7. Methods of Surface Analysis: J.M. Walls- Cambridge University Press, 1989.
8. The principles and Practice of Electron Microscopy: Ian M. Watt-Cambridge University Press, 1997
9. Modern Techniques for Surface Science: D.P. Woodruff and T.A. Delchar- Cambridge University Press, 1994.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
NANOTECHNOLOGY

Course No.	**L T P**
PHL-584	**4 0 0**

Introduction and Synthesis of Nanomaterials: Basic idea of Nanomaterials and Nanotechnology, Physical Methods: inert gas condensation, arc discharge, Laser ablation, molecular beam epitaxy, electron deposition, ball milling; electron beam lithography; Chemical Methods: sol-gel, micelles and micro emulsions.

Nanoparticles: Introduction to Nanoparticles; Metal Nanoclusters: magic numbers, theoretical modeling of nanoparticles, geometric structure, electronic structure, reactivity, magnetic clusters, bulk to nanotransition; Semiconducting nanoparticles: optical properties, photofragmentation, columbic explosion; Rare gas and molecular clusters.

Quantum Nanostructures: Introduction to quantum wells wires and dots**;** preparation using lithography; Size and dimensionality effects: size effects, conduction electrons and dimensionality, potential wells, partial confinement, properties dependent on density of states, single electron tunneling; Application: Infrared detectors, Quantum dot Lasers.

Carbon Nanostructure: Carbon molecules: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C_{60}, alkali doped C_{60}; Carbon nanotubes: fabrication, structure, electrical properties, vibrational properties, mechanical properties, Application of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis.

Text and Reference Books:

1. Thin Film fundamentals: A. Goswami-New Age International, 2007
2. Introduction to Nanotechnology: Charles P. Poole Jr. and Franks J. Qwens,-John Wiley & Sons, 2003.
3. Solid State Physics: J.P. Srivastva-Prentice Hall, 2007.
4. Nanotubes and Nanowires: CNR Rao and A Govindaraj-Royal Society of Chemistry, 2005.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
COMMUNICATION ELECTRONICS

Course No.	**L T P**
PHL-585	**4 0 0**

Amplitude Modulation: Frequency spectrum of AM wave, representation and power relations in AM wave, evaluation and description of SSB, superstition of unwanted side bands, form of amplitude modulation.
Frequency Modulation: Theory of frequency and phase modulation, mathematical representation, frequency spectrum of FM wave. Generation of frequency modulation.
Pulse Modulation: Information theory, pulse modulation: PWM, PPM and PCM, Multiplexing: frequency-division multiplexing. Time division multiplexing, shot, medium and long-hand system.
Microwave Devices: Klystrons, Magnetrons, Velocity modulation, Basic principles of two cavity Klystrons and Reflex Klystrons, principles of operation of magnetrons., Transferred electron devices, Gunn Effect, Principles of operation. Modes of operation, Read diode, IMPATT diode, TRAPATT diode, Tunnel diode and Stimulated emission and associated devices.
Microwave Communications: Advantages and disadvantages of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, fading sources, detectors, components, antennas used in MW communication systems.
Radar Systems
Radar block diagram an operation, radar frequencies, pulse considerations. Radar range equation, derivation of radar range equation, minimum detectable signal, receiver noise, signal to noise ratio, integration of radar pulses. Radar cross section. Pulse repetition frequency. Antenna parameters, system Losses and propagation losses. Radar transmitters, receivers. Antennas, Displays.

Reference Books:
1. Microelectronics: Jacob Millman, McGraw Hill International Book Co., New Delhi, 1990.
2. Optoelectronics: Theory and Practice, Edited by Alien Chappal. McGraw Hill Book Co., New York.
3. Microwaves :K.L. Gupta-Wiley Eastern Ltd., New Delhi, 1983.
4. Advanced Electronics Communications Systems: Wayne Tomasi., Phi. Edn.
   Electronic Communication Systems: G. Kennedy-Tata McGraw-Hill.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
RADIATION PHYSICS

Course No.	**L**	**T**	**P**
PHL-586	**4**	**0**	**0**

Ionizing Radiations and Radiation Quantities:
Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement – The free air chamber and air wall chamber. Absorbed dose and its measurement; Bragg Gray Principle, Radiation dose units- rem, rad, Gray and Sievert dose commitment, dose equivalent and quality factor.

Dosimeters:
Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors, simple numerical problems on dose estimation.

Radiation Effects and Protection
Biological effects of radiation at molecular level, acute and delayed effects, stochastic and non-stochastic effects, Relative Biological Effectiveness (RBE), Linear energy transformation (LET), Dose response characteristics. Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials. The ALARA, ALI and MIRD concepts, single target, multitarget and multihit theories, Rad waste and its disposal, simple numerical problems.

Radiation Shielding
Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations – The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source. Practical applications and some simple numerical problems.

Reference Books:

1. Nuclear Reactor Engineering, S. Glasstone and A. Seasonke, Van Nostrand Reinhold, 1981.
2. Radiation Theory, Alison. P. Casart.
3. Radiation Biology-A.Edward Profio-Prentice Hall, 1968
4. Introduction to Radiological Physics and Radiation Dosimetry, F.H. Attix-Wiley VCH, 1986.

M.Sc. Applied Physics (Electronics) (Semester – IV) (Elective Courses)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Course)
PLASMA PHYSICS

Course No.	**L T P**
PHL-587	**4 0 0**

Basics of Plasmas: Occurrence of plasma in nature, definition of plasma, concept of temperature, Debye shielding and plasma parameter. Single particle motions in uniform E and B, nonuniform magnetic field, grad B and curvature drifts, invariance of magnetic moment and magnetic mirror. Simple applications of plasmas.

Plasma Waves: Plasma oscillations, electron plasma waves, ion waves, electrostatic electron and ion oscillations perpendicular to magnetic field, upper hybrid waves, lower hybrid waves, ion cyclotron waves. Light waves in plasma.

Boltzmann and Vlasov Equations: The Fokker Planck equation, integral expression for collision term, zeroth and first order moments, the single equation relaxation model for collision term. Applications of kinetic theory to electron plasma waves, the physics of Landau damping, elementary magnetic and inertial fusion concepts.

Non-Linear Plasma Theories: Non-linear Electrostatic Waves, KdV Equations, Non-linear Schrodinger Equation, Solitons, Shocks, Non-linear Landau Damping.

Non-Linear Effects: Introduction, SHEATHS, ion acoustic shock waves, Ponderomotive force, Parametric Instabilities, The Korteweg-de-Vries Equation.

Reference Books:

1. Introduction to Plasma Physics and Controlled Fusion: F F Chen-Springer, 1984
2. Plasma Physics: R.O. Dendy-Cambridge University Press, 1995.
3. Ideal Magnetohydrodynamics: J P Friedberg-Springer, Edition, 1987.
4. Fundamental of Plasma Physics: S R Seshadri-American Elsevier Pub. Co. 1973.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
PHYSICS OF LOW DIMENSIONAL SEMICONDUCTORS

Course No.	**L T P**
APL-581	**4 0 0**

Unit 1

General properties of heterostructures, Growth of heterostuctures: MBE & MOCVD, Band Engineering, Band Diagrams of different heterostructures, Superlattice devices, Doped Heterostuctures: Modulation Doping, band diagram of modulation doped layer, MODFET, electrostatic potential, conduction band and gate bias, threshold voltage, gate-channel capacitance, screening by 2D electron gas, layered structures, band structure modifications by strain, Quantum wires and dots.

Unit –II

Solution of Schrodinger wave equation in one dimensional square wells of finite and infinite. depths, parabolic and triangular wells, Low dimensional systems, sub-bands and their occupation, Two and three dimensional quantum wells: cylindrical, two dimensional parabolic and spherical wells, Quantum wells in heterostructures, Tunneling transport in semiconductors, potential step, square barrier, T -matrices, Tunneling current in one, two and three dimensions, Resonant Tunneling through Quantum Wells, Coulomb Blockade and single electron devices, Tunneling in Heterostructures, Intervalley transfer.

Unit-III

Semiclassical dynamics of electrons in a magnetic field, semiclassical approach to magenetotransport, Quantum mechanical approach to electrons in uniform magnetic fields, Landau levels, Aharonov-Bohm effect, De-Haas effect, Shubnikov-de-Haas Effect, Quantum Hall Effect, Fractional Quantum Hall Effect.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

Unit-IV

General Theory of optical properties of Quantum Wells; Kramers-Kronig relations, optical - response functions, sum rules, valence band structure: Kane model, energy bands in a quantum well, interband Transitions in quantum wells, Absorption spectrum, optical gain and lasers, Excitons in two and three dimensions, Excitons in a quantum well.

Reference Books:

1. Physics of Low Dimensional Semiconductors - John H Davies –- Cambridge University Press -1998.
2. Low Dimensional Semiconductor Heterostructures - Keith Barnham & Dimitri Vvedensley – Cambridge University Press – 2001.
3. Physics of Semiconductors and their Heterostructures - Jasprit Singh – McGraw Hill 1994.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
DIGITAL SIGNAL PROCESSING

Course No.	L T P
APL-582	**4 0 0**

Unit-I

Signals and Systems: Introduction, classification of signals, representation of signals, elementary discrete-time signals, manipulation of signals, classification of systems, static and dynamic systems, linear systems, time invariant systems, causal and non-causal system, stable and unstable systems, Fourier analysis; trigonometric, complex and exponent forms of Fourier series, Parseval identity, power spectrum, Fourier transform and its properties, Fourier transform of power and energy signals, Z-Transform: Introduction, definition, properties, evaluation of inverse z-transform.

Unit-II

DFT and FFT: The DFT, Properties of DFT: Linearity, periodicity, circular shift of a sequence, time reversal of a sequence, circular frequency shift, complex conjugate property, circular convolution, Hilbert transform, FFT: radix-2 FFT, decimation in time (DIT) algorithm, decimation in frequency (DIF) algorithm. Fast convolution: Overlap-add method, Overlap-save method, correlation.

Unit-III

Finite Impulse Response (FIR) Filters: Introduction, magnitude and phase response of digital filters, frequency response of linear phase FIR filters, design techniques, design of optimal linear phase transformations.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

Unit-IV

Infinite Impulse Response (IIR) Filters: Introduction, IIR filters design by derivatives, impulse invariant and bilinear transformation method, frequency transformations. Adaptive filters: Theory, structure and applications (speech analysis and mobile communication)

Reference Books:

1. Digital Signal Processing - Alan V. Oppenhein and Ronald W. Schaffer - Prentice Hall Inc. 2002.
2. Digital Signal Processing - S Salivahanan, A. Vallavaraj and C Gnanapriya -Tata McGraw Hill-2000.
3. Digital Signal Processing - S.K. Mitra- Tata McGraw Hill-2005.
4. Digital Filter Designers Handbook - C.B. Rorabaugh- McGraw Hill-1993.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
DIGITAL COMMUNICATIONS

Course No.	L	T	P
APL-583	4	0	0

Unit-I

Digital Modulation -Techniques and System: Introduction, comparison of analog and digital signals, advantages and disadvantages of digital communication, elements of digital communication system, pulse code modulation (PCM), quantization noise, companding, signal representation: sampling theorem, PCM bandwidth, PCM system, advantages of PCM over analog modulation, differential PCM, delta modulation (DM), continuously variable slope delta modulator (CVSDM) or adaptive delta modulation.

Unit-II

Digital Carrier - Modulation Techniques and System: Introduction, Amplitude Shift Keying (ASK), ASK spectrum, ASK modulator, Coherent ASK detectors, Noncoherent ASK detector, Frequency Shift Keying (FSK), bandwidth and frequency spectrum of FSK, Non-coherent FSK detector, Coherent FSK detector, FSK detection using PLL, Binary Phase Shift Keying, Binary PSK spectrum, Coherent PSK detection, Quadrature Phase Shift Keying (QPSK), QPSK demodulator, Differential PSK.

Unit-III

Spread-Spectrum Techniques and Communication Systems: Introduction, principles of spread spectrum, direct sequence pseudo noise (DSPM) spreading, Frequency Hop Coding, Time Hop Spreading, spread spectrum modulation systems, generation of pseudo random Sequences, Sequence length, independence of Sequences, number of ones and zeros in maximal Sequence, clustering in a PN Sequence, correlation properties, spread spectrum modulation, Continuous-Phase-Shift-Modulation (CPSM),Code Division Multiple Access (CDMA).

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

Unit-IV

Cellular and Mobile Communication Systems: Introduction, main methods of radio transmission, GSM standard for cellular phones, GSM architecture, features of GSM, cellular mobile radio systems, inside the cell phone, other services of GSM, future of telecommunication, operation of cellular systems, concept of frequency, reuse channels, frequency reuse schemes, frequency reuse distance, consideration of components of cellular systems, switching equipment data links, security and identification, supervision, power controls, function of the MTSO, cellular analog switching equipments, description of analog switching equipment, modification of analog switching equipment, cell site controllers and hardware, cellular digital switching equipment, general concept, elements of switching, radio.

Reference Books:

1. Communication Systems - Simon Haykins - 4th edition - John Wiley & Sons - 2001.
2. Digital and Analog Communication System - K Sam Shanmugam - John Wiley & Sons 1979.
3. Elements of Digital Communication - N Sarkar - Khanna Publishers - 2003.
4. Modern Electronic Communication: Principles and Practice - A. K. Sharma and R. K. Sinha -- Dhanpat Rai Publishing Company - 2001.

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

(Elective Courses)
OPTICAL COMMUNICATIONS

Course No.	**L T P**
APL-584	**4 0 0**

Unit -I

Advantages of Optical Fibre Communication, Ray Theory, Modes in planar guide, Cylindrical fibre, Mode Coupling. Step index fibres: Multimode Step index Fibres, Single Mode Step Index Fibres, Graded index Fibres, Attenuation, Material Absorption Losses, Linear Scattering Losses, Non-Linear Scattering Losses, Fibre Bend Loss, Dispersion, Interamodal, Intermodal Dispersion, Overall fibre dispersion, Multimode, Single mode, Modal Noise, Liquid phase Technique, Vapor phase Deposition Technique, Fibre Cables, Fibre Splices, Fibre Connectors, Fibre attenuation measurements, Dispersion measurements, Fibre refractive index profile, Fibre Numerical Aperture, Fibre diameter, Field Measurements (OTDR).

Unit -II

Lasers, Basic concepts, Emission from semiconductors, Injection laser, Multimode injection laser, Single mode injection laser, Single mode structures, Injection laser characteristics, Non semiconductor lasers, LED, Efficiency, Double heterostructure, Planar, Dome, Burrus type, Lens coupling, Edge emitting, LED characteristics, power, spectrum, Modulation bandwidth, Reliability, Modulation.

Unit -III

Detectors, Device type, Absorption, Quantum efficiency, Responsivity, Longwavelength cut-off, p-n, p-i-n, Avalanche, Silicon reachthrough, Germanium avalanche, Drawbacks of avalanche diodes, Receiver Noise, Thermal, Dark Current, Quantum Noise, p-n and pin diode receiver noise, Receiver capacitance, APD Excess Noise, Receiver Structure, Low impedance front end, Transimpedance front end, FET preamplifiers, GaAs MESFETs, PIN-FET hybrid

M.Sc. Applied Physics (Electronics) (Semester – IV)
(Under Credit Based Continuous Evaluation Grading System)

Unit –IV

Optical transmitter circuit, Source limitation, LED drive circuits, Laser drive circuits, Optical receiver circuits, Preamplifier, Automatic gain control, equalizaiton, System Design, Component choice, Multiplexing, Digital system, The regenerative repeater, The Optical transmitter, The Optical Receiver, Channel losses, Temporal response, Optical power budgeting, Line coding, Analog Systems, Direct intensity modulation, System Planning, Subcarrier intensity modulation, Subcarrier double sideband modulation, Subcarrier phase modulation, Pulse analog techniques, Coherent Systems, Public Network Applications, Military Applications, Civil and Consumer Applications, Industrial Applications, Computer Applications, Integrated Optics, Integrated Optical devices.

Reference Books:

1. Optical Fiber Communication - J.M.Senior, Perason Education, 2nd Edition- 1990.
2. Optical Fiber Communication – G.E.Keiser –Tata McGraw Hill , 3rd Edition- 2000
3. Optical Communication Systems – J. Gowar- Prentice Hall- 1993
4. An Introduction to Fiber Optics- A. K. Ghatak and K. Thyagarajan- Cambridge University Press-1998.