M.Sc. DEGREE

(APPLIED PHYSICS)

SYLLABUS

FOR

CREDIT BASED CURRICULUM

(2007-2008 Admission onwards)

DEPARTMENT OF PHYSICS
National Institute of Technology
Tiruchirappalli – 620015

National Institute of Technology, Tiruchirappalli – 620015.
DEPARTMENT OF PHYSICS

M.Sc. (Applied Physics)

Four Semester (Credit System)

I SEMESTER		L	T	P	C
PH 651	Mathematical Physics	3	-	-	3
PH 653	Classical Mechanics	3	-	-	3
PH 655	Thermodynamics and Statistical Physics	3	-	-	3
PH 657	Electronics	3	-	-	3
PH 659	Physics Laboratory - I	-	-	6	2
	Elective - I	3	-	-	3
					17
II SEMESTER					
PH 652	Electromagnetic Theory	3	-	-	3
PH 654	Quantum Mechanics	3	-	-	3
PH 656	Physics Laboratory - II	-	-	6	2
	Elective - II	3	-	-	3
	Elective - III	3	-	-	3
	Elective – IV	3	-	-	3
					17

III SEMESTER		L	T	P	C
PH 661	Solid State Physics	3	-	-	3

		L	T	P	C
PH 663	Atomic and Molecular Physics	3	-	-	3
PH 665	Physics Laboratory - III	-	-	6	2
	Elective - V	3	-	-	3
	Elective - VI	3	-	-	3
	Elective – VII	3	-	-	3
					17

IV SEMESTER

		L	T	P	C
PH 662	Project Work and Viva Voce	-	-	-	8
	Elective – VIII	3	-	-	3
	Elective – IX	3	-	-	3
					14
	Total Credits				**65**

L – Lecture, **T** – Tutorial, **P** – Practical and **C** – Credit

Electives (Odd Semester)

PH 671 Digital Signal and Image Processing

PH 673 Programming in C and Numerical Methods

PH 675 Non-Destructive Testing

PH 677 Instrumentation

PH 679 Sensors and Transducers

Electives (Even Semester)

PH 672 Microprocessors

PH 674 Lasers and Applications

PH 676 Fiber Optic Sensors

PH 678 Nano-Science and Technology & Applications

PH 680 Physics and Technology of Thin Films

PH 682 Nuclear and Particle Physics

Any other Electives from other Departments in consultation with Faculty Advisor.

Semester – I

PH 651 – MATHEMATICAL PHYSICS

Unit - I: Matrices
Definitions and types of matrices – solution of linear algebraic equations – characteristic equation and diagonal form – Cayley-Hamilton theorem – functions of matrices – application in solving linear differential equation.

Unit - II: Vector Calculus
Scalar and vector product of two vectors – gradient – divergence and surface integral – Gauss's theorem – curl of a vector field and Stokes's theorem – orthogonal curvilinear co-ordinates – cylindrical and spherical polar co-ordinates – applications to hydrodynamics, heat flow in solids and electromagnetic theory.

Unit - III: Complex Analysis
Functions of complex variable – derivative and Cauchy-Riemann differential equations - Cauchy's integral theorem and integral formula - Taylor's and Laurent's series - Cauchy's residue theorem – singular points of an analytic function – evaluation of residues – evaluation of definite integrals.

Unit - IV: Linear Differential Equations
Introduction – reduced equation – method of partial fraction – linear dependence and Wronskian – second order equation – Frobenius method – applications (Legendre, Hermite and Laguerre functions).

Unit – V: Integral Transforms
Fourier series – Fourier integral theorem – Fourier transform – Parseval's identity – related problems – Laplace transform – convolution theorem – transform of derivates – application to ordinary differential equation.

References

1. L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw-Hill, New Delhi (1970).
2. G. B. Arfken and H.J. Weber, Mathematical Methods for Physicists, 5^{th} edition, Academic Press, London (2001).
3. E. Kreyszig, Advanced Engineering Mathematics, 5^{th} edition, Wiley Eastern (1991).

PH 653 – CLASSICAL MECHANICS

Unit – I: Lagrangian Formulation
Mechanics of a system of particles – constraints – d'Alembert's principle and Lagrangian equations – conservation theorems and symmetry properties – applications of Lagrangian formulation.

Unit – II: Central Force Problem
Reduction to one body problem – equation of motion and first integral – one dimensional problem and classification of orbits – Kepler problem and planetary motion – scattering in central force field – transformation to laboratory frames.

Unit – III: Rigid Body and Vibrating System
Euler angles – tensor of inertia – kinetic energy of a rotating body – symmetric top and applications. Vibrating string – solution wave equation – normal vibrations – dispersion – coupled vibrating system.

Unit – IV: Hamiltonian Formulation
Legendre transformation – Hamiltonian equation of motion – cyclic coordinates – phase space and Liouville's theorem – Poisson bracket.

Unit – V: Special Relativity
Principles and postulates of relativity – Lorentz transformations - length contraction, time dilation and Doppler effect – velocity addition formula – four vector notation – energy – momentum four-vector for a particle – relativistic invariance of physical laws.

References

1. H. Goldstein, Classical Mechanics, 2nd edition, Narosa Publishing House (1994).
2. W. Greiner, Classical Mechanics, Springer-Verlag (2003).

PH 655 – THERMODYNAMICS AND STATISTICAL PHYSICS

Unit – I: Thermodynamics
Basic ideas about heat, temperature, work done – Laws of thermodynamics and their significance – specific heats – thermodynamic potentials – Maxwell relations significance of entropy.

Unit – II: Ensembles
Concepts of phase space, microstates, macro states – equal priori probability – ensemble of particles – micro canonical ensemble – macro canonical ensemble – grand canonical ensemble – derivation of partition function - derivation of thermodynamic quantities from each ensembles.

Unit – III: Classical Statistical Mechanics

Link between entropy and probability – Boltzmann's equation - elementary ideas about three different statistics - classical statistics – Maxwell & Boltzmann statistics – classical Ideal gas equation – equipartition theorem.

Unit – IV: Fermi-Dirac Statistics

Basics for quantum statistics – system of identical indistinguishable particles – symmetry of save functions – bosons, fermions - Fermi & Dirac statistics – Fermi free electron theory – Pauli paramagetism.

Unit – V: Bose-Einstein Statistics

Bose & Einstein statistics – black body radiation – Rayleigh Jeans' formula - Wien's law – Planck radiation law – Bose Einstein condensation – Einstein model of lattice vibrations – Phonons - Debye's theory of specific heats of solids.

References

1. F. Reif, Fundamentals of Statistical and Thermal Physics, International Students Edition, Tata McGraw-Hill (1988).
2. K. Haung, Statistical Mechanics, Wiley Eastern (1991).

PH 657 – ELECTRONICS

Unit – I: Network Analysis

Kirchoff's laws – Thevinin, Norton theorems - superposition, reciprocity, compensation theorems – Source transformation – Delta and Star transformations – Laplace Transformation – convolution integral.

Unit – II: Semiconductor Devices

Basic principles of transistor operation – Biasing – Characteristics of BJT and JFET. MOSFET: Enhancement and depletion modes of operation.

Unit – III: Amplifiers and Oscillators

Low frequency and high frequency and Power amplifiers using transistors – Sine wave generators – Wien bridge and phase shift oscillators – Multivibrator circuits – Triangle and square wave generation – Crystal oscillators - NE 555, 556 timers and their applications.

Unit – IV: Operational Amplifiers

Ideal operational amplifier: characteristics. Feedback types, Applications: Basic scaling circuits – current to voltage and voltage to current conversion – Sum and difference amplifiers – Integrating and differentiating circuits – A.C.amplifiers – Instrumentation amplifiers. Filters, PLL.

Unit – V: Digital Circuits
Logic gates, Half adder, Full adder – Comparators, Decoders, Multiplexers, Demultiplexers – Design of combinational circuits, Sequential circuits, flip flops, counters, Registers, A/D and D/A conversion characteristics.

References

1. J. Milman and C.C. Halkias, Electronic Devices and Circuits, McGraw-Hill (1981).
2. R.J. Higgins, Electronics with Digital and Analogue Integrated Circuits, Prentice Hall (1983).
3. A.P. Malvino, Electronics: Principles and Applications, Tata McGraw-Hill (1991).
4. G.B. Calyton, Operation Amplifiers, ELBS (1980).

PH 659 – PHYSICS LABORATORY - I

1. Hall Effect in Semiconductor
2. Non-Destructive Testing – Ultrasonics
3. Two Probe Method for Resistivity Measurement.
4. Wavelength Measurement of Laser using Diffraction Grating.
5. Op-Amp Arithmetic Operations
6. Op-Amp Square, Ramp Generator and Wien Bridge Oscillator
7. Op-Amp Precision Full Wave Rectifier
8. Numerical Aperture of an Optical Fiber
9. Astable Multivibrator using IC555.
10. Combinational Logic Circuit Design
11. UJT Characteristics
12. MATLAB – Matrix operations.

References

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi (1989).

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Semester – II

PH 652 – ELECTROMAGNETIC THEORY

Unit – I: Electrostatics
Electrostatic field and potential – field lines and Gauss's law – Laplace's and Poisson's equation – electric dipole – work and energy – conductors – polarization – Gauss's law in dielectrics – electric displacement – linear dielectrics.

Unit – II: Magnetostatics
Magnetic induction – electric current and Ohm's law – steady current and Biot-Savart law – Ampere's law and applications – magnetic flux – magnetization – magnetic intensity – energy density – linear and nonlinear media.

Unit – III: Maxwell's Equations
Faraday's law – generalization of Ampere's law – Maxwell's equations – boundary conditions – scalar and vector potentials – Coulomb and Lorentz gauge – Poynting's theorem.

Unit – IV: Electromagnetic Waves
Electromagnetic wave equation – solution and propagation of monochromatic waves in non-conducting media – polarization and energy density – reflection and transmission at oblique incidence – waves in conducting media – wave guides – TE, TM and TEM waves in rectangular wave guide.

Unit – V: Radiating System
Radiation from an oscillating electric dipole – radiation from a half-wave dipole – application to antenna – types of antennas.

References

1. J.D. Jackson, Classical Electrodynamics, John Wiley & Sons, 2nd Edition (1990).
2. D. J. Griffiths, Introduction to Electrodynamics, Prentice Hall of India, 2nd edition, (1989).
3. J.R. Reitz., F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House (1979).
4. E.C. Jordon and K.G. Balmain, Electromagnetic Waves and Radiating Systems, 2nd edition, Prentice-Hall of India (1998).
5. P. Lorrain and D. Corson, Electromagnetic Fields and Waves, CBS Publishers and Distributors (1986).

PH 654 – QUANTUM MECHANICS

Unit – I: Schroedinger Equation
Inadequacy of classical theory – de-Broglie hypothesis of matter waves – Heisenberg's uncertainty relation – Schroedinger's wave equation – physical interpretation and conditions on wave function – eigenvalues and eigenfunctions – particle in a square-well potential – potential barrier.

Unit – II: Operators and Eigenfunctions
Linear operator – orthogonal systems and Hilbert space - expansion in eigenfunctions – hermitian operators – fundamental commutation rule – commutations and uncertainty principle – state with minimum uncertainty.

Unit – III: Solvable Problems
Harmonic oscillator – operator method - Schroedinger equation for spherically symmetric potentials – angular momentum operator – condition on solutions and eigenvalues – spherical harmonics – rigid rotor – radial equation of central potential – hydrogen atom – degenerate states.

Unit – IV: Angular Momentum and Spin
Eigenvalues of angular momentum **J** – matrix representation of **J** – electron spin – Zeeman effect – addition of angular momentum – Clebsh-Gordan coeffecients – identical particles with spin.

Unit - V: Scattering Theory and Approximation Methods
Scattering cross section – Born Approximation – partial wave analysis – differential and total cross sections – phase shifts – exactly soluble problems – mutual scattering of two particles – perturbation theory and variation method.

References

1. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill (1977).
2. J.L. Powell and B. Crasemann, Quantum Mechanics, Narosa Publishing House (1993).
3. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1999).

PH 656 – PHYSISICS LABORATORY - II

1. Michelson Interferometer
2. Forbe's Method
3. Fourier Filtering
4. Photo-diode Characteristics
5. Elastics Constants – Elliptical and Hyperbolic Fringes
6. Hysteresis (B – H Curve)
7. Helmholtz Galvanometer
8. ESR Spectroscopy
9. MATLAB: Digital Signal Processing
10. MATLAB: Solving Ordinary Differential Equations
11. Conductivity of Thin Film – Four Probe Method
12. Solar-Cell Characteristics
13. Quincke's Method
14. Curie Temperature of Magnetic Materials
15. Dielectric Constant and Curie Temperature of Ferroelectric Ceramics

References

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi (1989).

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Semester - III

PH 661 – SOLID STATE PHYSICS

Unit – I: Crystal Structure
Bravais lattices, crystal systems – point groups, space groups and typical structures, Reciprocal Lattice, Planes and directions – Point, line, surface and volume defects - Ionic crystals: Born Mayer potential. Thermochemical Born-Haber cycle – Van der Waals binding: rare gas crystals and binding energies – Covalent and metallic binding: characteristic features and examples.

Unit – II: Crystal Diffraction and Lattice Vibrations
X-rays, neutrons, electrons – Bragg's law in direct and reciprocal lattice – Structure factor – diffraction techniques – Lattice dynamics: monoatomic and diatomic lattices. Born-von Karman method. Phonon frequencies and density of states. Dispersion curves, inelastic neutron scattering – Thermal and elastic properties: Reststrahlen Specific heat. Thermal expansion. Thermal conductivity. Normal and Umklapp processes, Propagation of elastic waves and measurement of elastic constants.

Unit – III: Conductors and Semiconductors
Free electron theory of metals – Thermal and transport properties – Bloch functions – Nearly free electron approximation – Formation of energy bands. Kronig Penny Model, Brillouin zone, Effective mass, concept of holes, Fermi surface – *Semiconductors:* carrier statistics in intrinsic and extrinsic crystals, electrical conductivity, Hall effect Electronic specific heat.

Unit – IV : Super conducting Optical and Dielectric materials
Superconductors: Properties, BCS theory, Flux quantization, Josephson effects, High T_c superconductors, Applications – *Optical Materials:* Optical absorption, colour centres, Trap, recombination, excitons, Photoconductivity, luminescence – *Dielectrics:* Macroscopic electric field, Local electric field in an atom, dielectric constant and polarizability, Clausius-Mossotti equation, measurement of dielectric constant, Ferroelectrics.

Unit – V: Magnetic Materials
Magnetic materials: Types, Quantum theories of dia and para magnetism – *Susceptibility measurement:* Guoy Balance, Quincke’s method – Ferromagnetic order, Hysterisis, Curie point and exchange intergral, Magnons, domain theory – Ferri and antiferrimagnetic order , Curie temperature, susceptibility and Neel Temperature.

References

1. Charles Kittel, Introduction to Solid State Physics, Wiley Eastern, 5th edition, (1983).
2. A.J. Dekker, Solid State Physics, Prentice Hall of India (1971).

3. N.W. Ashcroft and N.D. Mermin, Solid State Physics, Saunders College Publishing (1976).
4. Ali Omar, Elementary Solid State Physics, Narosa Publishing House.
5. J.S. Blakemore, Solid State Physics, 2nd edition, Cambridge University Press (1974).

PH 663 – ATOMIC AND MOLECULAR PHYSICS

Unit – I: Atomic Spectra

Quantum states of Electron in atoms - Hydrogen atom spectrum - Electron spin- Stern Gerlach Experiment- Spin Orbit interaction- Lande interval rule - Two electron systems- LS – JJ coupling Schemes – Fine structure – Spectroscopic terms and selection rules – Hyperfine structure – Exchange symmetry of wave function – Pauli's exclusion principle – periodic table – Alkali type spectra Equivalent electrons.

Unit – II: Atoms in External Fields and Resonance Spectroscopy

Zeeman and Paschen Back Effect of one and two electron systems - Selection Rules – Stark effect – Inner Shell vacancy – X-ray – Auger transitions – Compton Effect – NMR – Basic principles – Classical and Quantum mechanical description – Spin-spin and Spin-lattice relaxation times – Magnetic dipole coupling – Chemical shift – Knight shift. ESR – Basic principles – Nuclear interaction and Hyperfine Structure – g-factor – Zero field splitting.

Unit – III: Microwave Spectroscopy and IR Spectroscopy

Rotational spectra of diatomic molecules – Rigid rotator – Effect of isotropic substitution – Non rigid rotator – Rotation spectra of polyatomic molecules – Linear, symmetric top and asymmetric top molecules – Experimental Techniques. Diatomic vibrating rotator – Linear, Symmetric top molecule – Analysis by infrared techniques – Characteristic and grroup frequencies.

Unit – IV: Raman Spectroscopy

Raman effect – Quantum theory of Raman effect – Rotational Raman spectra Vibrational Raman Spectra – Raman spectra of polyatomic molecules – Raman Spectrometer – Hyper raman effect – experimental techniques.

Unit – V: Electronic Spectroscopy

Electronic spectra of diatomic molecules – Frank-Condon principle – Dissociation energy and dissociation products – Rotational fine structure of electronic vibration transitions - Fortrat Diagram – Predissociation

References

1. C.N. Banwell, Fundamentals of Molecular Spectroscopy, 4th edition, McGraw-Hill, New York (2004).
2. Manas chanda, Atomic Structure and Chemical Bond, Tata McGraw-Hill, New Delhi (2003).
3. Arthur Beiser, Concepts of Modern Physics, 6th edition, Tata McGraw-Hill, New Delhi (2003).
4. G. Aruldhas, Molecular Structure and Spectroscopy, Prientice Hall of India, NewDelhi (2002).
5. B.P. Straughan & S. Walker, Spectroscopy: Vol. I, Chapmen and Hall (1976).
6. G.M Barrow, Introduction to Molecular Spectroscopy, McGraw Hill Ltd., Singapore (1986).

PH 665 – PHYSICS LABORATORY – III
(Microprocessors)

1. Simple Programs
2. Programs using Subroutine
3. D/A Converter – Interfacing
4. A/D Converter – Interfacing
5. Waveform Generator
6. Stepper Motor Interface
7. Traffic Control
8. Interfacing Display
9. Interfacing with Voltmeter
10. Generation of Square , Triangular, Saw-Tooth and Sin wave – DAC 0800
11. Interface with Thermometer
12. Block Data Transfer Operations

References

1. L.A. Leventhal, Micro Computer Experimentation with the Intel SDK-85 (1980).

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Electives (Odd Semester)

PH 671 - DIGITAL SIGNAL AND IMAGE PROCESSING

Unit - I: Discrete Time Signal and Systems
Discrete-time signals – Sequences – Linear shift-invariant systems-Stability and Causality- Linear constant Co-efficient difference equations – Frequency-domain-Representation of Discrete-time systems and signals – Representation of discrete-time signals by Fourier transform.

Unit - II: Transform analysis of linear time invariant systems
Z-transform – Region of convergence – Relation between Z-transform and Fourier Transform – Frequency response – Phase distortion and delay – system functions – Frequency response of rational system functions- first-order systems – Basic Digital filter structures - FIR and IIR filters.

Unit - III: Filter Design Techniques and Fast Fourier Transform
Design of FIR filters by window method – Rectangle – Hanning, Hamming – Kaiser – IIR Filters design – Bilinear Transformation – Discrete Fourier Transform – Computation of DFT- Decimation in time FFT and Frequency. Introduction to optimal filters.

Unit - IV: Continuous and Digital Image Characterization
Image representation – 2D-systems – 2D-Fourier Transform – Light perception – Eye Physiology – Visual phenomena – Monochrome vision model – 2D Image sampling & reconstruction – Image sampling systems – Aliasing effects – Image reconstruction systems – Vector-space Image representation – Image Quantisation – Monochrome.

Unit - V: Linear Image Processing and Image Enhancement
Generalized 2D Linear operator – Superposition – Convolution – Unitary transformations – Fourier Transform – Cosine Transformation – Image Enhancement – Contrast manipulation – Histogram modification – Noise cleaning – Edge crispening.

References

1. William K. Pratt, Digital Image Processing, 3rd edition, John Wiley & Sons, Inc., USA (2001).
2. Alan V. Oppenheim and Ronald W. Schafer, Digital Signal Processing, New Delhi (2000).
3. L.R. Rabiner and B. Gold, Theory and Applications of Digital Signal Processing, Prentice Hall of India.

PH 673 – PROGRAMMING IN C AND NUMERICAL METHODS

Unit – I: Programming in C

Control system Data structure – Identifiers and Keywords – Constants, Variables and Data types – Operators and expressions – Data Input and Output – Control Structures – *if* and *switch* statements – *while*, *do-while* and *for* statements – *goto* statement – Arrays – Character strings – Simple programs

Unit – II: Functions and Pointers

User defined Functions – Defining and accessing functions – Passing arguments – Function prototypes – Recursion – Storage classes – Pointer Declarations – Passing pointers to functions – Pointers and arrays – Operations on pointers – Arrays of pointers

Unit – III: Structures, Unions and Data Files

User defined data types – Structures – Declaring structures and Accessing members – Array of structures – Structure within structure – Unions – File operations – open, close, reading and writing – Random access files – Linked list – Preprocessor directives – Macros – Command line arguments

Unit IV: Solution of Equations and Interpolation

Bisection, iterative and Newton Raphson method for finding roots of the equations – solution of simultaneous linear equation by Gauss elimination and Gauss Seidal method – finite differences – Newton's forward difference interpolation formula.

Unit V: Integration and Ordinary Differential Equations

Trapezoidal rule – Simpson's 1/3 rule – Solution of ordinary differential equation by Euler method – Runge-Kutta second order and fourth order method.

References

1. Byron S. Gottfried, Schaum's outline of Theory and Problems of Programming with C, Tata McGraw-Hill (1991).
2. B. W. Kernighan and D. M. Ritchie, The C Programming Language, 2nd edition, Prentic-Hall of India (1988).
3. Bjarne Stroustroup, The C++ Programming Language, 2nd edition, Addison-Wesley (1991).
4. E. Balagurusamy, Numerical Methods, Tata McGraw-Hill, New Delhi (1999).
5. S.S. Sastry, Introductory Methods of Numerical Analysis, 4th edition, Prentice Hall of India (2005).

PH 675 – NON-DESTRUCTIVE TESTING

Unit – I: Liquid Penetrant Testing

Principles – types and properties of liquid penetrants - developers – advantages and limitations of various methods - Preparation of test materials - Application of penetrants to parts, removal of surface penetrants, post cleaning - selection of penetrant method - solvent removal, water washable, Post emulsifiable – Units and lighting for penetrant testing - dye penetrant process.

Unit –II: Ultrasonic Testing

Nature of sound waves, wave propagation - modes of sound wave generation - Various methods of ultrasonic wave generation - Piezo electric effect, Piezo electric materials and their properties- Principle of pulse echo method, through transmission method, resonance method - Advantages, limitations - contact testing, immersion testing, couplants - Data presentation A, B and C scan displays - Time of Flight Diffraction (TOFD)

Unit-III: Radiography

Geometric exposure principles, shadow formation, shadow sharpness, etc – Radioisotopic sources – types and characteristics- Production and processing of radioisotopes - radiographic cameras - X-ray sources generation and properties - industrial X-ray tubes - target materials and characteristics. High energy X-ray sources - linear accelerators. Principles and applications of Fluoroscopy/Real-time radioscopy - advantages and limitations - recent advances, intensifier tubes, vidicon tubes etc.

Unit-IV: Eddy Current

Generation of eddy currents - effect of created fields - effect of change of impedance on instrumentation - properties of eddy currents - eddy current sensing elements, probes, type of arrangement - a) absolute b) differential lift off, operation, applications, advantages, limitations - Through encircling or around coils, type of arrangements a)absolute b) differential fill factor, operation, application, advantages, limitations.

Unit-V: Advanced NDT

Thermography: Contact and non contact inspection methods – Heat sensitive paints and other coatings – Heat sensitive papers – Advantages and limitation, Instrumentations and methods, applications. *Optical holography:* recording and reconstruction – holographic interferometry – real-time, double-exposure & time-averaged techniques – holographic NDT – methods of stressing and fringe analysis. *Acoustical Holography:* Liquid Surface Acoustical Holography – Optical System – Reconstruction

References

1. American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th edition, Metals Park, OH (1989).
2. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, 3rd edition, New York, Springer-Verlag (1983).

3. R. Halmshaw, Industrial Radiography, Applied Science Publishers Inc., Englewood, NJ (1982).

PH 677 – INSTRUMENTATION

Unit – I
Errors in observations and treatment of experimental data – estimation of errors – theory of errors and distribution laws – least squares method: curve fitting, statistical assessment of goodness of fit.

Unit – II
Production and measurement of high vacuum – principles and operation of various pumps and gauges – design of high vacuum systems - high pressure cells and measurements at high pressures.

Unit - III
Production and measurement of low temperatures – Design of cryostats – High temperature furnaces: resistance, induction and arc furnaces – measurement of high temperatures.

Unit-IV
Optical monochromators, filters and spectrophotometers for UV, visible and infrared. Measurement of reflectivity, absorption and fluorescence. Radiation detectors: pyroelectric, ferroelectric, thermoelectric, photoconducting, photoelectric and photomultiplier, scintillation types of detectors, circuits, sensitivity and spectral response, photon counters.

Unit – V
Magnetic resonance techniques: NOR, ESR, NMR, ENDOR – principles and schematic working systems – measurement of high and low electrical resistivity – d.c. and a.c. four probe technique – Impedance considerations and accuracy – Signal processing and signal averaging – Time domain measurements Box car integrator – Computer data processing, programming languages.

References

1. C.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw-Hill (1983).
2. H.H. Willard, L.L. Merrit and John A. Dean, Instrumental Methods of Analysis, 6th edition, CBS Publishers & Distributors (1986).
3. Barry E. Jones, Instrumentation Measurement and Feedback, Tata McGraw-Hill (1978).
4. J.F. Rabek, Experimental Methods in Photochemistry and Photophysics, Parts 1 and 2, John Wiley (1982).

5. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press (1988).
6. N.C. Barford, Experimental Results: Precision, Error and Truth, John Wiley, 2nd edition (1985).
7. D. Malacara (ed), Methods of Experimental Physics, Series of Volumes, Academic Press Inc. (1988).

PH 679 - SENSORS AND TRANSDUCERS

Unit – I: Mechanical and Electromechanical Sensors
Introduction to sensors – classification – static and dynamic characteristics – characterization – Mechanical and electromechanical sensors: Resistive potentiometer – strain gauge-inductive sensors – capacitative sensors – ultrasonic sensors.

Unit –II: Thermal Sensors
Gas thermometric sensors – thermal expansion type – Acoustic – dielectric constant and refractive index thermosensors – Helium low temperature thermometer-Nuclear thermometer – magnetic thermometer – resistance change type – thermo emf-junction semiconductor type-thermal radiation sensors-quartz crystal thermoelectric sensors.

Unit –III: Magnetic Sensors
Principles behind Yoke coil, coaxial type and force and displacement sensors – magnetoresistive sensors-Hall effect sensors – Inductance and Eddy current sensors – Angular/rotary movement transducers – Electromagnetic flowmeter-switching magnetic sensors-SQUID sensors.

Unit –IV: Radiation Sensors
Basic characteristics – Types of photosensistors/photodetectors – X-ray and Nuclear radiation sensors – Fibre optic sensors.

Unit - V: Smart sensors, Applications of sensors
Introduction-primary sensors – Excitation-amplification – Filters – converters-data communication – standards for smart sensor interface – Film sensors – MEMS sensors-Nano sensors – Applications of sensors

References

1. D. Patranabis, Sensors and Transducers, 2nd edition, Prentice-Hall of India (2005).
2. M.J. Usher, Sensors and Transducers, Macmillan, London (1985).

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Electives (Even Semester)

PH 672 – MICROPROCESSORS

UNIT – I

Basic components of a digital computer – CPU-ALU – Timing and control unit Memory – Bus architecture – I/O devices – 8085 Microprocessor architecture, Various registers, stacks.

UNIT – II

8085 addressing modes – instruction set – Instruction cycle – Timing diagram – subroutines, programming examples Memory and I/O interfacing, memory mapped I/O, I/O mapped I/O schemes, Data Transfer schemes

UNIT – III

Interrupt structure in 8085 – Hardware and software interrupt, I/O Ports – DMA principles. Serial I/O: Basic concepts, Asynchronous and synchronous communication

UNIT – IV

Programmable Peripheral interfacing(PPI) – 8255, pins and signals, operation, interfacing – Programmable 8253 Timer/Counter, Programmable Interrupt controller (PIC), 8259A – Programmable 8237 DMA controller – Special purpose Interfacing devices.

UNIT – V

8086 Internal Architecture – Addressing modes, bus cycles – bus controller, 8086 Instruction set, programming examples – 8086 interrupts – Protected mode operation, Virtual memory, Mulitasking – Special features and overviews of 80286, 80386, 80486, Pentium, and Pentium-IV processors.

References

1. R.S. Gaonkar, Microprocessor Architecture: Programming and Applications, 3rd edition, Penram International Publishing India (1997).
2. B. Ram, Fundamentals of Microprocessors and Microcomputers, 5th edition, Dhanpat Rai publication, India (2001).
3. Yu Cheng Liu and G.A. Gibson, Microprocessor Systems: The 8086 /8088 Family: Architecture, Programming and Design, Prentice Hall of India (1994).
4. B.B. Brey, The Intel Microprocessors: 8086/8088, 80186/80188,80286,80486 Pentium and Pentium Pro Processor – Architecture, Programming and Interfacing, 4th edition, Prentice Hall of India.
5. N. Mathivanan, Microprocessors: PC Hardware and Interfacing, Prentice Hall of India (2005).

PH 674 – LASERS AND APPLICATIONS

Unit-I: Properties and Types of Lasers
Laser Fundamentals: spontaneous and stimulated emission, Einstein coeffecients, population inversion – *Properties:* temporal and spatial coherence, directionality – *Types:* Ruby laser, Helium Neon laser, CO_2 Laser, Dye Lasers, Semiconductor lasers.

Unit-II: Holography
Spatial Frequency Filtering – Holography – Applications of holography – HNDT (Holographic Non-Destructive Testing) holographic storage – optical disk storage – Laser speckle and speckle meteorology – SNDT (Speckle Non-Destructive Testing).

Unit –III: Fibre Optics
Optical fibre principle – types of fibres –properties- fiber optical communication-fibre amplifiers, Fiber-optic sensors: intensity-phase- polarization and frequency dependent techniques

Unit-IV: Lasers in Science
Saturation spectroscopy – excited state spectroscopy – nonlinear spectroscopy – time domain and its applications – stimulated Raman Emission – Laser fusion – Isotope separation – Medical applications, photo-chemical applications

Unit-V: Lasers in industry
Materials processing – drilling, cutting, welding – alloying – glazing – oblation – laser chemical vapour deposition (LCVD) – laser thermal deposition – hardening, annealing – Laser Tracking – Lidar.

References

1. K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, Mcmillan (1981).
2. K. Koebner (ed.), Industrial Applications of Lasers, Wiley (1984).
3. J.T. Cuxon and D.E. Parker, Industrial Lasers and their Applications, Prentice Hall (1985).
4. B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
5. F.C. Appard, Fiber Optics Handbook, McGraw-Hill (1989).

PH 676 – FIBER OPTIC SENSORS

Unit – I
Introduction – plane polarized wave – propagation of a light through a quarter wave plate – reflections at a plane interface – Brewster angle – Total internal reflection-interference-refraction – concept of coherence – Diffraction of Gaussian beam.

Unit – II
Fiber optic fundamentals – Numerical aperture – attenuation in optical fibers – pulsed dispersion in step index optical fiber – Loss mechanisms – absorptive loss – radiative loss- Principle of optical waveguides – Characteristics of fibers – pulsed dispersion in planar optical waveguide – Modes in planar waveguides – TE,TM modes – propagation characteristics of a Step index fiber and Graded index optical fiber.

Unit – III
Intensity-Modulated Sensors – Transmission concept – reflective concept – microbending concept-intrinsic concepts – transmission and reflection with other optical effects – source of error and compensation schemes. Phase modulation mechanisms in optical fibers- optical fiber interferometers – optical fiber phase sensors for mechanical variables – the optical fiber sagnac interferometer – optical fiber interferometric sensors.

Unit – IV
Frequency modulation in optical fiber sensors – introduction – optical fiber Doppler system – development of the basic concepts. Polarization modulation in fiber sensors-introduction – optical activity – faraday rotation – electro-gyration – electro-optic effect-kerr effect – photoelastic effect – polarization modulation sensors.

Unit – IV
Wavelength distribution sensor – introduction – techniques for colour modulation – colour probes. Bragg grating concept – introduction – fabrication – application.

Reference

1. D.A.Krohn, Fiber Optic Sensors: Fundamentals and Applications, Second Edition, Instrument Society of America (1992).
2. B.Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
3. Djafar K.Mynbaev and Lowell L.Scheiner, Fiber-Optic Communications Technology, Peason Education Asia (2001).

PH 678 – NANOSCIENCE AND TECHNOLOGY & APPLICATIONS

Unit – I: Nanomaterials and Structures
Nanomaterials and types: Nanowires, Nanotubes, Fullerenes, Quantum Dots, Nanocomposites – Properties – *Methods of preparation:* Top Down , Bottom Up.

Unit – II: Characterization Tools
Electron Microscopy Techniques – SEM, TEM, X ray methods – Optical Methods Fluorescence Microscopy – Atomic Force Microscopy, STM and SPM.

Unit – III: Nanomagnetism
Mesoscopic magnetism – Magnetic measurements: Miniature Hall Detectors, Integrated DC SQUID Microsusceptometry – Magnetic recording technology, Biological Magnets.

Unit – IV: Nanoelectronics and Integrated Systems
Basics of nanoelectronics – Single Electron Transistor – Quantum Computation – tools of micro-nanofabrication – nanolithography – quantum electronic devices – MEMS and NEMS – Dynamics of NEMS – limits of integrated electronics.

Unit – V: Biomedical Applications of Nanotechnology
Biological structures and functions – Drug delivery systems – organic-inorganic nanohybrids – Inorganic carriers – Nanofluidics.

References

1. Jan Korvink & Andreas Greiner, Semiconductors for Micro and Nanotechnology – an Introduction for Engineers, Weinheim Cambridge: Wiley-VCH (2001).
2. N John Dinardo, Weinheim Cambridge, Nanoscale Characterisation of Surfaces & Interfaces, 2nd edition, Wiley-VCH (2000).
3. G Timp (ed), Nanotechnology, AIP press, Springer (1999).
4. M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic Sciences and Energy Technologies, Overseas Press (2005).

PH 680 – PHYSICS AND TECHNOLOGY OF THIN FILMS

Unit – I
Preparation methods: electrolytic deposition, cathodic and anodic films, thermal evaporation, cathodic sputtering, chemical vapour deposition. Molecular beam epitaxy and laser ablution methods.

Unit – II
Thickness measurement and monitoring: electrical, mechanical, optical interference, microbalance, quartz crystal methods. *Analytical techniques of characterization:* X-ray diffraction, electron microscopy, high and low energy electron diffraction, Auger emission spectroscopy. Photoluminescence(PL) – Raman Spectroscopy, UV-Vis-IR Spectrophotometer – AFM – Hall effect – SIMS – X-ray Photoemission Spectroscopy (XPS) – Vibrational Sample Magnetometers, Rutherford Back Scattering (RBS).

Unit – III
Thermodynamics and Kinetics of thin film formation – Film growth – five stages – Nucleation theories – Incorporation of defects and impurities in films – Deposition parameters and grain size – structure of thin films.

Unit – IV

Mechanical properties of films: elastic and plastic behavior. Optical properties. Reflectance and transmittance spectra. Absorbing films. Optical constants of film material. Multilayer films. Anisotropic and gyrotropic films. *Electric properties to films:* Conductivity in metal, semiconductor and insulating films. Discontinuous films. Superconducting films. Dielectric properties.

Unit – V: Applications

Micro and optoelectronic devices, quantum dots, Data storage, corrosion and wear coatings – Polymer films, MEMS, optical applications – Applications in electronics – electric contacts, connections and resistors, capacitors and inductances – Applications of ferromagnetic and super conducting films – active electronic elements, micro acoustic elements using surface waves – integrated circuits – thin films in optoelectronics and integrated optics.

References

1. K.L. Chopra, Thin Film Phenomena, McGraw-Hill (1983).
2. K.L. Chopra and I.J. Kaur, Thin Film Solar Cells, Plenum Press (1983).
3. L.I. Maissel and Glang (Eds.), Handbook of Thin film Technology, McGraw-Hill (1970).
4. J.C. Anderson, The Use of Thin Films in Physical Investigation, Academic Press (1966).
5. J.J. Coutts, Active and Passive Thin Film Devices, Academic Press (1978).
6. R.W. Berry, P.M. Hall and M.T. Harris, Thin Film Technology, Vn Nostrand (1968).
7. George Hass, Physics of Thin Films: Volumes 1:12, Academic Press (1963).

PH 682 – NUCLEAR AND PARTICLE PHYSICS

Unit – I: Nuclear Properties and Forces

Angular Momentum – Parity – magnetic dipole moment – electric quadrupolemoment – Simple theory of Deuteron – Properties of Nuclear forces –Spin dependence of nuclear force.

Unit – II: Nuclear Models

The Semi empirical mass formula – Single particle model of the nucleus – magic numbers – spin – Orbit coupling – angular Momentum of the energy states, excited states and the Shell Model – Magnetic moments and Schmidt lines – Isospins.

Unit – III: Radioactivity

Measurements of lifetimes – Multipolemoments – Theoretical prediction of decay constants – Selection Rules – Angular correlation's – Internal conversion – Geiger – Nuttel law – barrier penetrations applied to alpha decay and beta decay – simple theory – Curie plots – Comparative half life – selection rules – electron Capture – Parity violation.

Unit – IV: Nuclear Reactions

Reaction dynamics The Q equation - theory of Nuclear reaction - paritial wave analysis – Compound nucleus formations and break up – Resonance scattering and reactions – The Optical model Theory of stripping reactions – The Fission process – Neutron released in the fission process.

Unit – V: Elementary Particles

Classification – Types of Interactions – Conservation laws- CPT theorms – strangeness – hyper charge – Detection of Neutrino – Concept of Antiparticles – Tau – theta puzzle – neutral kaon – strange hyperons – Elementary idea of quark model Su(2), Su(3) group and their applications to multiplet measured baryon state.

References

1. Heral Enge, Introduction to Nuclear Physics, Addison Wesley (1981).
2. D.C. Tayal, Nuclear Physics, 4th edition, Himalaya House, Bombay (1980).
3. W.C. Burcham, Elements of Nuclear Physics, ELBS (1979).
4. Kenntah S. Krane, Introductory Nuclear Physics, John Wiley & Sons, New York (1988).

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