M.Sc. (Physics)

DEGREE

SYLLABUS

FOR

CREDIT BASED CURRICULUM

(2010 - 2011 Admission onwards)

DEPARTMENT OF PHYSICS

National Institute of Technology

Tiruchirappalli – 620015

National Institute of Technology, Tiruchirappalli – 620015

DEPARTMENT OF PHYSICS

M.Sc. (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	Quantum Mechanics	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	Thermodynamics and Statistical Physics	3	-	-	3
PH 656	Solid State Physics	3	-	-	3
PH 658	Physics Laboratory - II	-	-	6	2
	Elective - II	3	-	-	3
	Elective - III	3	-	-	3
					17

III SEMESTER		L	T	P	C
PH 661	Atomic and Molecular Physics	3	-	-	3
PH 663	Physics Laboratory - III	-	-	6	2
	Elective – IV	3	-	-	3
	Elective – V	3	-	-	3
	Elective – VI	3	-	-	3
	Elective – VII	3	-	-	3
					17
IV SEMESTER					
PH 660	Nuclear and Particle Physics	3	-	-	3
PH 662	Project Work and Viva-Voce	-	-	-	8
	Elective – VIII	3	-	-	3
					14
	Total Credits				**65**

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

ELECTIVES

I Semester

PH 671 Digital Signal and Image processing

PH 673 Programming in C and Numerical Methods

II Semester

PH 672 Microprocessors

PH 674 Computer Applications in Physics

PH 676 Non-Destructive Testing

III Semester

PH 675 Advanced Electromagnetic Theory

PH 677 Instrumentation

PH 679 Sensors and Transducers

PH 681 Physics and Technology of Thin Films

PH 683 Magnetism and Superconducting Levitation

PH 685 Micro-Electro-Mechanical Systems

PH 687 Fiber Optic Sensors

IV Semester

PH 678 Lasers and Applications

PH 680 Nano Science and Technology & Applications

PH 682 Advanced Statistical Methods and Phase Transition

Any other electives from other departments in consultation with faculty advisor

I SEMESTER

PH 651 – MATHEMATICAL PHYSICS

Unit – I: Matrices
Definitions and types of matrices – rank of matrices – solution of linear algebraic equations (Cramer's rule) – test of consistency – eigenvalue equation and diagonalization – Cayley-Hamilton theorem – functions of matrices – definition of groups – SU(2)-SO(3) homomorphism – applications.

Unit – II: Vector Calculus
Scalar and vector products – gradient – divergence and surface integral – Gauss's theorem – curl and line integral – Stokes's theorem – orthogonal curvilinear co-ordinates – spherical polar and cylindrical co-ordinates – elementary ideas on tensors.

Unit – III: Complex Analysis
Complex numbers – functions of complex variable – derivative and Cauchy-Riemann equation – line integral – Cauchy's integral theorem – Cauchy's integral formula –Laurent series – Cauchy's residue theorem – singular points – evaluation of residues – evaluation of definite integrals.

Unit – IV: Linear Differential Equations
First order equation – homogeneous equation – linear dependence and Wronskian – second order equation – second solution – power series method – Legendre equation – Hermite equation – inhomogeneous equation – undetermined coeffecients – variation of parameters.

Unit – V: Integral Transforms
Fourier series – Fourier integral theorem – Fourier transform – 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 (1970).
2. G. B. Arfken and H.J. Weber, Mathematical Methods for Physicists, 5th edition, Academic Press (2001).
3. E. Kreyszig, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons Inc. (1999).

PH 653 – CLASSICAL MECHANICS

Unit – I: Lagrangian and Hamiltonian Formulation of Mechanics
Calculus of variations – Hamilton's principle of least action – Lagrange's equations of motion – conservation laws – systems with a single degree of freedom – rigid body dynamics – symmetrical top – Hamilton's equations of motion – phase plots – fixed points and their stabilities.

Unit – II: Tow-body Central Force Problem
Equation of motion and first integrals – classification of orbits – Kepler problem – scattering in central force field – transformation to laboratory frames.

Unit – III: Small Oscillations
Linearization of equations of motion – free vibrations and normal coordinates – free vibration of a linear tri-atomic molecule – forced oscillations and the effect of dissipative forces – beyond small oscillations.

Unit – IV: Special Theory of Relativity
Principles and postulates of relativity – Lorentz transformation – relativistic kinematics and dynamics – $E = mc^2$ – momentum four-vector for a particle – relativistic invariance of physical laws.

Unit – V: Hamiltonian Mechanics and Chaos
Canonical transformations – Poisson brackets – Hamilton-Jacobi theory – action-angle variables – perturbation theory – integrable systems – introduction to chaotic dynamics.

References

1. H. Goldstein, C. poole and J. Safko, Classical Mechanics, 3rd edition, Addison & Wesley(2000).
2. L.D. Landau and E.M. Lifshitz, Mechanics, Buttorworth-Heinemann (1976).
3. I.C. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press (1983).
4. J.V. Jose and E.J. Saletan, Classical Dynamics: A Contemporary Approach, Cambridge University Press (1998).
5. E.T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, 4th edition, Cambridge University Press (1989).
6. W. Greiner, Classical Mechanics, Springer-Verlag (2003).
7. W. Greiner, Classical Mechanics – Point particles and Relativity, Springer-Verlag (1989).

PH 655 – QUANTUM MECHANICS

Unit – I: Schrödinger Equation
Inadequacy of classical theory – de-Broglie hypothesis of matter waves – Heisenberg's uncertainty relation – Schrödinger'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 of commutation rule – commutations and uncertainty principle – state with minimum uncertainty.

Unit – III: Solvable Problems
Harmonic oscillator – operator method - Schrödinger 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 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
p-n junction diodes: tunnel diode, Schottky barrier diode – *Microwave diodes:* varactor diode, p-i-n diode – *Optoelectronic devices:* solar cell, photodetector, LED, semiconductor laser – basic principles, biasing and characteristics of BJT and JFET – *MOSFET:* enhancement and depletion modes of operation – basic idea of charge coupled devices.

Unit – III: Amplifiers and Oscillators
Low frequency and high frequency amplifiers – power amplifiers – oscillator principle – oscillator types – frequency stability, response – phase shift oscillator – Wein bridge oscillator – LC tunable oscillators – multivibrators – monostable and astable – sine wave and triangle wave generation – clamping and clipping – crystal oscillators 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, comparators, filters, PLL.

Unit – V: Digital Circuits

Logic gates – half adder, full adder – comparators, decoders, multiplexers, demultiplexers – design of combinational circuits – sequential circuits – *Flip-flops:* RS flip-flop, JK flip-flop, JK master-slave flip-flops, T flip-flop, D flip-flop – synchronous and asynchronous counters, registers – A/D and D/A conversion – characteristics.

References

1. C.L Wadhwa, Network Analysis and Synthesis, New Age International Publishers, (2007).
2. J. Milman and C.C. Halkias, Electronic Devices and Circuits, McGraw-Hill (1981).
3. R. L. Boylsted and L. Nashelsky, Electronic Device and Circuits, Pearson Education (2003).
4. R.J. Higgins, Electronics with Digital and Analogue Integrated Circuits, Prentice Hall (1983).
5. A.P. Malvino, Electronics: Principles and Applications, Tata McGraw-Hill (1991).
6. 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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II SEMESTER

PH 652 – ELECTROMAGNETIC THEORY

Unit – I: Electrostatics
Coulomb's law – electric field – divergence and curl – applications Gauss's law – electric potential – work and energy – conductor – Laplace equation (1D, 2D and 3D) – uniqueness theorem – separation of variables: Cartesian and spherical coordinates – multipole expansion.

Unit – II: Electric Field in Matter
Field of an electric dipole – polarization – field of a polarized object – Gauss's law in dielectrics – electric displacement – linear dielectrics – boundary value problems – energy in dielectrics.

Unit – III: Magnetostatics
Lorentz force – electric current – equation of continuity – Biot-Savart law and applications – divergence – Ampere's law and applications – magnetic potential – magnetization – field of a magnetized object – Ampere's law in magnetized material – linear and nonlinear media.

Unit – IV: Maxwell's Equations
Faraday's law of induction – inductance – energy in magnetic field – generalization of Ampere's law – Maxwell's equations – boundary conditions – scalar and vector potentials – Coulomb and Lorentz gauge – Poynting's theorem.

Unit – V: Electromagnetic Waves
Electromagnetic wave equation – solution and propagation of waves in non-conducting media – polarization – electromagnetic energy – reflection and transmission at oblique incidence – waves in conducting media – absorption and dispersion.

References

1. J.D. Jackson, Classical Electrodynamics, John Wiley & Sons, 2nd edition (1990).
2. D. J. Griffiths, Introduction to Electrodynamics, Pearson Prentice Hall, 3nd edition (1999).
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).

PH 654 – 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
Connection 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).
3. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition, Narosa Publishing House (1998).
4. S.J. Blundell and K.M. Blundell, Concepts in Thermal Physics, Oxford University Press (2006).

PH 656 – SOLID STATE PHYSICS

Unit – I: Crystal Structure and Diffraction
Crystalline and amorphous materials – crystal systems – Bravais lattices – Miller Indices – symmetric elements – symmetric groups – reciprocal lattice – Brillouin zone – point, line,

surface and volume defects – colour centers – crystal bindings – ionic bond, covalent bond, molecular bond, hydrogen bond, metallic bond & Van der waals bond.
Diffraction of X-rays: Bragg's Law – experimental methods in X-ray diffraction – Laue method – rotating crystal method – powder photograph method.

Unit – II: Lattice Vibrations and Thermal Properties
Lattice dynamics: Concept of phonons – momentum of phonons – normal and Umklapp processes – vibrations of one dimentional monoatomic and diatomic linear lattices.
Thermal properties: Theories of specific heat – Dulong and Petit's law – Einstein's theory & Debye's theory – Weidemann-Franz law.

Unit – III: Conductors and Semiconductors
Conductors: Free electron theory – Classical and quantum theory – band theory of solids – density of states – K-space – Bloch functions – Kronig Penny Model.
Semiconductors: Types – carrier statistics in intrinsic and extrinsic semiconductors – electrical conductivity – Hall effect – electronic specific heat.

Unit – IV: Super conductors and Dielectrics
Superconductors: Properties – BCS theory – flux quantization – Josephson effects (AC & DC) - high Tc superconductors – applications.
Dielectrics: Macroscopic electric field – local electric field – eielectric constant and polarizability – Clausius-Mossotti equation – measurement of dielectric constant.

Unit – V: Magnetic Materials
Types: dia, para, ferro, ferri and antiferrimagnetic materials – hysteresis curve – usceptibility measurement: Guoy balance, Quincke's method – quantum theories of para and ferro magnetism – Curie point and exchange intergral – Curie temperature & Neel temperature (definitions) – magnons – domain theory.

References

1. Charles Kittel, Introduction to Solid State Physics, Wiley Eastern, 5th edition, (1983).
2. B.S. Saxena, R.C. Gupta, P.N.Saxena, Fundamentals of solid state physics, Pragati prakashan, 7th edition (1999).
3. A.J. Dekker, Solid State Physics, Prentice Hall of India (1971).
4. N.W. Ashcroftand and N.D. Mermin, Solid State Physics, Saunders College Publishing (1976).
5. Ali Omar, Elementary Solid State Physics, NarosaPublishing House.
6. J.S. Blakemore, Solid State Physics, 2nd edition, Cambridge University Press (1974).

PH 658 – 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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III SEMESTER

PH 661 – 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 group frequencies.

Unit – IV: Raman Spectroscopy
Raman effect – quantum theory of Raman effect – rotational Raman spectra – vibrational Raman apectra – 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 663 – 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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IV SEMESTER

PH 660 – 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

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 – iso-spins.

Unit – III: Radioactivity

Measurements of lifetimes – multipolemoments – theoretical prediction of decay constants – selection rules – angular correlations – internal conversion – Geiger-Nuttel law – barrier penetrations applied to alpha, decay and beta decay – simple theory – Kurie 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 – optical model theory of stripping reactions – 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. Kenneth S. Krane, Introductory Nuclear Physics, John Wiley & Sons, New York (1988).

PH 662 – PROJECT WORK AND VIVA-VOCE

In this course, students are required to do a project work on a research problem and submit their findings as a report followed by a presentation in front of viva-voce committee.

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ELECTIVES

I 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 coefficient 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
Keywords – constants, variables and data types – data input and output – control structures – *if* and *switch* statements – *while*, *do-while* and *for* statements – *goto* statement – functions – arrays – pointer – structures – array of structures – unions - file operations.

Unit – II: Roots of Equations
Roots of quadratic equation - Limits for real roots of a polynomial equation – Bisection method, False position method and Newton Raphson method for finding roots of the equations.

Unit – III: Linear Algebra
Eigen values and eigen vector of matrix – inverse of a matrix – determinant – solution of linear systems of equations – Gauss elimination and pivotal condensation methods.

Unit – IV: Integration and Differentiation
Trapezoidal rule – Simpson's rule (one-third) – solution of ordinary differential equation by Euler method and Runge-Kutta methods – physics examples – ideal harmonic oscillations.

Unit – V: Interpolation and Statistical Parameters
Linear least square fitting – Lagrange’s interpolation – cubic spline fitting – arithmetic mean-median-mode-standard deviation-correlation.

References

1. Byron S. Gottfried, Schaum's outline of Theory and Problems of Programming with C, Tata McGraw-Hill (1991).
2. Suresh Chandra, Application of Numerical Techniques with C, Narosa Publishing House (2006).
3. Brain W. Kernighan and Dennis. M. Ritchie, The C Programming Language, 2nd edition, Printice-Hall of India (1988).
4. E. Balagurusamy, Numerical Methods, TMH edition, New Delhi (1999).
5. A.K. Ghattak, T.C. Goyal and S.J. Chua, Mathematical Physics, Macmillan, New Delhi (1995).

II 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 – COMPUTER APPLICATIONS IN PHYSICS

Unit – I: C programming
C programming basics - arithmetic operators– library functions – data input and output – relational operators – control statements – looping arrays functions – simple programs – user defined functions – passing arguments – pointer declarations – passing pointers to functions – structures – array of structures – unions – file operations.

Unit – II: Introduction to MATLAB
MATLAB environment – working with data sets – data input/output – logical variables and operators – array and X-Y Plotting – simple graphics – data types matrix, string, cell and structure – manipulating of data of different types – file input –output – matlab files – simple programs.

Unit – III: MATLAB Tools
Signal processing – toolbox – digital and analog filter design – spectral analysis – filtering and discrete FFTs – Z-transform – DFT and FFT – MATLAB tools for wavelet transform – instrument control toolbox – partial differential equation toolbox – finite element method.

Unit – IV: Introduction to LABView
Introduction – palette, controls & functions palette – data types, conversion.
Front Panel: Construction, containers, decorations, vi properties, tabs – parallel data flow, create indicators/controls/constants indicators, controls – math operations, booleans, arrays, case structures, sequences – for loops, while loops, shift registers, clusters, clusters.

Unit – V: Interfacing with LABView
Error handling, bundle/unbundle sub VI'S **-** I/O: reading and writing to files, paths, data taking, charting, graphing timing function, timed loops, event structures signal generation/processing, waveform types, dynamic data, Fourier analysis – connecting to hardware – DAQ, Serial, GPIB, TCP/IP and USB interface.

References
1. Suresh Chandra, Applications of Numerical Techniques with C, Narosa (2006).
2. Vinay K. Lngle and John G. Proakis, Digital Signal Processing Using Matlab, PWS Publishing Company (1997).
3. Ross L. Spencer and Michael Ware, Introduction to Matlab, Brigham Young University (2010).

4. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, Digital Image Processing Using MATLAB, Prentice-Hall (2003).
5. Learning MATLAB – The MathWorks, Inc (1999).
6. LabVIEW Basics I Course Manual, National Instruments Corporation.
7. Kenneth L. Ashley, Analog Electronics with LabVIEW, Pearson Education (2003).

PH 676 – 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).
4. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, 3rd edition, Narosa Publishing House (2007).

III Semester

PH 675 – ADVANCED ELECTROMAGNETIC THEORY

Unit – I: Potentials and Fields
Scalar and vector potentials – gauge transformation – Coulomb gauge and Lorentz gauge – retarded potentials – Lienard-Wiechert potentials – field of a moving point charge.

Unit – II: Radiating System
Radiation – radiation of an oscillating electric diploe – Hertzian dipole – half wave antenna – magnetic dipole radiation – radiation from an arbitrary source – power radiated by a moving point charge – radiation reaction.

Unit – III: Guided Waves
Waves between parallel planes – TE, TM, TEM waves – wave impedence – transmission lines – rectangular wave guides – circular wave guides – Q factor.

Unit – IV: Special Theory of Relativity
Einstein's postulates – geometry of space-time – Lorentz transformation – covariance of electromagnetic equations – transformation of electromagnetic fields – field of a moving point charge.

Unit – V: Plasma Physics
Definition – particle motion in plasma – hydromagnetic equation – pinch effect – controlled thermo-nuclear fusion – plasma oscillations.

References

1. J.D. Jackson, Classical Electrodynamics, John Wiley & Sons, 2nd edition (1990).
2. D. J. Griffiths, Introduction to Electrodynamics, Pearson Prentice Hall, 3rd edition, (1999).
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).

PH 677 – INSTRUMENTATION

Unit – I: Errors in Measurement Systems
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: Vacuum Systems
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: Temperature Measurement
Production and measurement of low temperatures – design of cryostats – high temperature furnaces: resistance, induction and arc furnaces – measurement of high temperatures.

Unit – IV: Radiation Detectors
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 Resonances
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.

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 – mechanical and electromechanical sensors: resistive potentiometer – strain gauge-inductive sensors – capacitative sensors.

Unit – II: Thermal Sensors
Gas thermometric sensors – thermal expansion type – Acoustic – dielectric constant and refractive index thermosensors – helium low temperature 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 and Applications
Introduction – 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. Jacob Fraden, Hand book of modern sensors: physics, design, and application, 3rd edition, Springer (2004).
3. M. J. Usher, Sensors and Transducers, Macmillan, London (1985).

PH 681 – PHYSICS AND TECHNOLOGY OF THIN FILMS

Unit – I: Preparation of Thin-films
Kinetic aspects of gases in a vacuum chamber – classifications of vacuum ranges – production of vacuum - pressure measurement in vacuum systems – thin film (epitaxy) – definition – types of epitaxy.
Different Growth Techniques: Liquid phase epitaxy – vapour phase epitaxy – molecular beam epitaxy – metal organic vapour phase epitaxy – sputtering (RF & DC) – pulsed laser deposition.
Thickness Measurement: Microbalance technique – photometry-ellipsometry – interferometry.

Unit – II: Kinetics of Thin films

Nucleation Kinetics: types of nucleation – kinetic theory of nucleation – energy formation of a nucleus – critical nucleation parameters; spherical and non spherical (cap, disc and cubic shaped)

Growth Kinetics: Kinetics of binary (GaAs, InP, etc.), ternary ($Al_{1-x}Ga_xAs$, $Ga_{1-x}In_xP$, $InAs_{1-x}P_x$, etc.) and quaternary ($Ga_{1-x}In_xAs_{1-y}P_y$, etc.) semiconductors – derivation of growth rate and composition expressions.

Unit – III: Characterization

X-ray diffraction – photoluminescence – UV-Vis-IR spectrophotometer – Atomic Force Microscope – Scanning Electron Microscope – Hall effect – Vibrational Sample Magnetometer – Secondary Ion Mass Spectrometry – X-ray Photoemission Spectroscopy.

Unit – IV: Properties of Thin films

Dielectric properties – experimental technique for the determination of dielectric properties – optical properties – experimental technique for the determination of optical constants – mechanical properties – experimental technique for the determination of mechanical properties of thin films – magnetic and superconducting properties.

Unit – V: Applications

Optoelectronic devices: LED, LASER and Solar cell – Micro Electromechanical Systems (MEMS) – Fabrication of thin film capacitor – application of ferromagnetic thin films; data storage, Giant Magnetoresistance (GMR) – sensors – fabrication and characterization of thin film transistor and FET – quantum dot.

References

1. K.L. Chopra, Thin Film Phenomena, McGraw- Hill book company New York, (1969).
2. Ludminla Eckertova, Physics of Thin Films, Plenum press, New York (1977).
3. A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi (1996).

PH 683 – MAGNETISM AND SUPERCONDUCTING LEVITATION

Unit – I: Fundamentals of Magnetism

Magnetic moment – magnetic field – field produced by solenoids – Lorentz force laws – Biot-Savart law – field and moment measurement – demagnetizing field – Zeeman effect – origin of magnetism – g factor – quantized angular momentum – theory of diamagnetism.

Unit – II: Types of Magnetism

Langevin's theory of paramagnetism – quantum theory of paramagnetism – Brillouin function – molecular field theory of ferromagnetism – exchange interaction – band theory – antiferromagnetism – sublattice magnetization – internal fields – crystal field effects.

Unit – III: Magnetic Phenomena
Magnetic anisotropy – magnetocrystalline and shape anisotropy – random anisotropy model – magnetostriction – domain theory – coercivity mechanism – fine particle magnetism – magnetocaloric effect.

Unit – IV: Superconducting Materials
Superconductivity basics – physical properties below Tc – duration of persistent currents – Magnetic field effects on superconductors –high Tc Superconductors – cuprate superconductors – wires and tapes – MgB_2 – iron and carbon based superconductors – superconducting magnets.

Unit – V: Superconducting Levitation
Magnetic levitation systems – stability and levitation – superconducting bearings – levitation forces – static and dynamic – superconducting Maglev vehicles – equation of motion – aerodynamic effects – guideway.

References

1. B. D. Cullity and C.D. Graham, Introduction to Magnetic Materials, Wiley, NJ, (2009).
2. S. Chikazumi, Physics of Ferromagnetism, Oxford University Press (1997).
3. C. Kittel, Introduction to Solid State Physics, 7^{th} edition, Wiley (2006).
4. F. C. Moon, Superconducting Levitation, Wiley (2004).

PH 685 – MICRO-ELECTRO-MECHANICAL SYSTEMS

Unit – I: Introduction
Emergence – devices and application – scaling issues – materials for MEMS – thin film deposition – lithography and etching.

Unit – II: Bulk micro machining
Introduction – etch-stop techniques – dry etching – buried oxide process – silicon fusion bonding and anodic bonding.

Unit – III: Surface micro machining
Introduction – sacrificial layer technology – material systems in sacrificial layer technology – plasma etching – combined IC technology and anisotropic wet etching.

Unit – IV: Microstereolithography
Introduction – scanning method – projection method – applications – LIGA process: introduction, basic process and application.

Unit – V: MEMS Devices
Electronic interfaces – design, simulation and layout of MEMS devices using CAD tools.

References
1. S.M. Sze, Semiconductor Sensors, John Wiley & Sons (1994).
2. M. Elwenspoek and R.Wiegerink, Mechanical Microsensors, Springer-Verlag (2001).
3. Massood Tabib-Azar, Microactuators - Electrical, Magnetic, Thermal, Optical, Mechanical, Chemical and Smart structures, Kluwer Academic Publishers (1997).
4. Eric Udd, Fiber Optic Smart Structures, John Wiley & Sons (1995).

PH 687 – 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 step index and graded index optical fibers.

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.

References
1. D.A. Krohn, Fiber Optic Sensors: Fundamentals and Applications, 2nd 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).

IV Semester

PH 678 – 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 680 – 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 and Andreas Greiner, Semiconductors for Micro and Nanotechnology – an Introduction for Engineers, Weinheim Cambridge: Wiley-VCH (2001).
2. N John Dinardo and Weinheim Cambridge, Nanoscale Characterisation of Surfaces & Interfaces, 2^{nd} 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 682 – ADVANCED STATISTICAL METHODS AND PHASE TRANSITION

Unit – I: Probability and Random Process

Fluctuations and random processes – Brownian motion – diffusion – random walks – Langevin equation – fluctuation-dissipation theorem – irreversibility – Markov processes – master equation – Fokker -Planck equation.

Unit – II: Phase Transition Theories

Examples of first order and continuous phase transitions – mean field (van der Waals and Weiss molecular field) theories – fluid-magnet analogy – correlations – classical (Ornstein -Zernicke) theory.

Unit – III: Statistical Mechanical Models

Ising, lattice gas, Heisenberg, XV and Potts models – transfer matrix method –illustration using one-dimensionallising model – duality in the two-dimensionallsing model – high and low temperature series expansions.

Unit – IV: Critical Phenomena

Long-range order, order parameter, scaling, universality, critical exponents – Peierls argument for phase transitions – spontaneous breakdown of symmetry – Landau theory of phase transitions – role of fluctuations, lower and upper critical dimensions – Ginzburg-Landau model – Higgs mechanism – examples – Mermin-wagner theorem – topological (Berezinski-Kosterlitz-Thouless) phase transition.

Unit –V: Renormalization Group Theory

Elements of re-normalization group approach to continuous phase transitions –flows in parameter space, fixed points, epsilon expansion, real-space re-normalization – connection with Euclidean field theories – elementary ideas on percolation.

References

1. N.G. Van Kampen, Stochastic Processes in Physics and Chemistry, North-Holland (1985).
2. C.W. Gardiner, Handbook of Stochastic Methods, Springer-Verlag (1983).
3. C.J. Thompson, Classical Equilibrium Statistical Methods Springer-Verlag (1988).
4. H.E. Stanley, Introduction to Phase Transitions and Critical Phenomena, Clarendon Press, Oxford (1971).
5. J.M. Yeoman, Statistical Mechanics of Phase Transitions, Clarendon Press, Oxford (1992).
6. D. Stauffer, Introduction to Percolation Theory, Taylor and Francis (1985).

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