

UNIVERSITY OF KERALA



**Revised Syllabus for
M.Sc Degree Program in Physics**

(With effect from 2020 admissions)

SEM I

11 T, TSM, JC

PH 211: CLASSICAL MECHANICS (6L, 1T)

Objectives: This course is aimed to provide basic and advanced concepts in classical mechanics. The course discusses Lagrangian and Hamiltonian formalisms, central force problems, theory of small oscillations, Hamilton-Jacobi equations, Kepler's problem, Rigid body dynamics and Euler's equations, Concepts of special and general theory of relativity, Non linear dynamical systems and chaos.

Unit I

Lagrangian Mechanics (12 hours) TJM

Mechanics of a particle and system of particles- constraints- D'Alemberts principle and Lagrange's equations-simple applications of Lagrangian formulation-Hamilton's principle- techniques of calculus of variations-derivation of Lagrange's equations from Hamilton's principle-conservation theorems and symmetry properties

Two body central force problem (14 hours) JC

Reduction to one body problem-equations of motion-equivalent one dimensional problem-differential equation for the orbit in the case of integrable power law potentials- Virial theorem- Kepler's problem-inverse square law of force-scattering in central force field-transformation of the scattering problem to laboratory coordinates

Theory of small oscillations (10 hours) JC

✓ Equilibrium and potential energy-theory of small oscillations-normal modes- two coupled pendula- longitudinal vibrations of carbon dioxide molecule

Unit II

Hamiltonian Mechanics (12 hours) JE

Generalised momentum and cyclic coordinates-conservation theorems-Hamilton's equations-examples in Hamiltonian dynamics (harmonic oscillator, motion of a particle in a central force field, charged particle in an electromagnetic field, compound pendulum)- canonical transformations-generating functions- poisson brackets- Liouville's theorem

Hamilton-Jacobi equations (10 hours) JC

Hamilton-Jacobi equation-harmonic oscillator as an example-separation of variables in Hamilton-Jacobi equation-action angle variables-Kepler's problem

Rigid body dynamics (14 hours)

Generalised coordinates of rigid body-Euler's angles- infinitesimal rotations as vectors- angular momentum and inertia tensor- Euler's equations of motion of a rigid body-force free motion of symmetrical top-motion of heavy symmetrical top.

Unit III HT

Special and General Theory of Relativity (16 hours)

Postulates of special theory- four-vectors and tensors- relativistic particle dynamics-/Lorentz transformations -relativistic Lagrangian-/mass-energy equivalence- covariant Lagrangian, Relativistic Lagrangian, Mass energy equivalence.

General theory of relativity principle of equivalence applications - ideas of Riemannian geometry-space time curvature geodesics/-Einstein's equations of General theory of relativity, Observational evidence to general theory of relativity.

Introduction to non-linear dynamics (12 hours)

Linear and nonlinear systems-integration of second order non-linear differential equations-/pendulum equation-phase plane analysis of dynamical systems-linear stability analysis-limit cycles

Elements of classical chaos (10 hours)

Bifurcation- logistic map-strange attractors- Lyapunov exponent and Chaos-ideas of fractals- solitary waves- Kdv equations and solutions

Course Outcome

- (i) Students are able to learn the concepts of Lagrangian and Hamiltonian mechanics and use them to solve problems in mechanics. Able to learn concepts of generating functions, Poisson brackets Hamilton Jacobi equations and action angle variables.
- (ii) To equip the students to deal with central force problem and analyzing Kepler's laws.
- (iii) To inculcate the students the concepts of special and general theory of relativity and related problems.
- (iv) To acquaint the students about the theory of small oscillations and Euler's equations of motions of rigid bodies.
- (v) To analyze nonlinear dynamical systems and to explain the concepts of classical chaos.

Books for study

- a. H. Goldstein, C. Poole and S. Safko, *Classical Mechanics*, 3rd Edn, Pearson Education Inc (2008 Print)
- b. V.B. Bhatia, *Classical Mechanics with introduction to nonlinear oscillations and chaos*, Narosa Publishing House (1997)
- c. J.C. Upadhyaya, *Classical Mechanics*, Revised Edition, Himalaya Publishing Company (2005)
- d. G. Aruldas, *Classical Mechanics*, Prentice Hall of India Pvt Ltd (2008 Print)
- e. K.D. Krori, *Fundamentals of Special and General Relativity*, PHI Learning Pvt Ltd (2010)
- f. S.K. Srivastava, *General Relativity and Cosmology*, PHI learning Pvt Ltd (2008)
- g. P.G. Drazin and R.S. Johnson, *Solitons – an Introduction*, Cambridge University Press (1989)

References

1. N.C. Rana and B.S. Joag, *Classical Mechanics*, Tata McGraw Hill (1991)
2. M. Tabor *Chaos and integrability in nonlinear dynamics*, John Wiley & Sons (1989)
3. R.K. Pathria, *The Theory of Relativity*, Second Edition, Over Publications (2003)

PH 212: Mathematical Physics (6L, 1T)

Objectives: This course is aimed to equip the students with the mathematical techniques used for developing strong back ground in the basic and advanced level problems. The course describes about curvilinear coordinates, Fourier series and transforms, probability distributions, partial differential equations and different integral transforms, special functions, tensors and group theory.

Unit I

Vector analysis and matrices (8 hours)

Review of vector analysis-vector calculus operators-orthogonal curvilinear coordinates-gradient, divergence, curl, Laplacian in cylindrical and spherical polar coordinates-orthogonal and unitary matrices- Hermitian matrices- diagonalization of matrices- normal matrices- Cayley-Hamilton theorem

Complex analysis (8 hours)

Cauchy-Riemann conditions-Cauchy's integral theorem and formula-singularities and mapping-calculus of residues-dispersion relations

Fourier series and applications (8 hours)

General principles of Fourier series, Complex representation, Parseval's identity, Fourier's Integrals, Fourier transforms and its properties.

Probability (12 hours)

Definitions and simple properties of probability-random variables- Chebychev inequality and moment generating function-discrete and continuous probability distributions-binomial distributions- poisson distributions- Gauss Normal distribution-error analysis and least square fitting-chi-square and student 't' distributions

Unit II

Differential equations (16 hours)

Partial differential equations-first order equations-separation of variables-singular points-series solutions and Frobenius method- non-homogeneous partial differential equations-Green's functions-Laplace transforms and inverse Laplace transforms-applications to solution of simple differential equations

Special functions (20 hours)

Bessel functions of the first kind-orthogonality-Neumann functions-Hankel functions-modified Bessel functions-spherical Bessel functions-Legendre functions-generating

function-recurrence relations and orthogonality-associated Legendre functions-
 spherical harmonics-Hermite functions-Laguerre functions-Chebyshev polynomials-
 hypergeometric functions

Unit III

Tensor analysis (18 hours)

Notations and conventions in tensor analysis-Einstein's summation convention-covariant and contravariant and mixed tensors-algebraic operations in tensors-symmetric and skew symmetric tensors-tensor calculus- Christoffel symbols-kinematics in Riemann space-Riemann- Christoffel tensor.

Group theory (18 hours) H7

Definitions of a group-elementary properties-sub groups-homomorphism and isomorphism of groups-representation of groups/reducible and irreducible representations/simple applications in crystallography and molecular symmetry- Lie groups- $SU(2)$ groups and their representations

Course Outcome

- (i) To apply and analyze the various vector and matrix operations and to perform complex analysis for solving physical problems.
- (ii) To demonstrate and utilize the concepts of Fourier series and its transforms.
- (iii) To explain and differentiate different probabilistic distributions.
- (iv) To apply partial differential equations and special functions for solving mathematical problems.
- (v) To illustrate and apply concepts of group theoretical operations and tensors.

Books for study

1. G.B. Arfken and H.J. Weber, *Mathematical methods for Physicists*, 6th Edition, Elsevier (2005).
2. H.K. Dass and R. Verma, *Mathematical Physics*, S.Chand & Co Pvt Ltd (1997)
3. A.W. Joshi, *Matrices and Tensors in Physics*, 3rd Edition, New Age International Pub (1995)
4. B.D. Gupta, *Mathematical Physics*, 4th Edition, Vikas Publishing House (2004)
5. A.W. Joshi, *Elements of Group Theory for Physicists*, Fourth Edition, New Age International Pub (1997).
6. S.C. Bagchi, S.Madan, A. Sitaram, V.B Tewari, *A first course in representation theory and linear Lie groups*, Universities Press (India) Pvt Ltd (2000).
7. C. Harper, *Introduction to Mathematical Physics*, Prentice Hall (1986)

References

1. Harry Lass, Vector and Tensor Analysis, McGraw Hill Pub (1950)
2. M.L.Jain, Vector Spaces and Matrices in Physics, Alpha Science International (2001)
3. W.W.Bell, Special Functions for Scientists and Engineers, Dover Publications (2004)
4. W.K.Tung, Group theory in Physics, World Scientific Pub Co (1999)
5. A.K. Ghatak, I.C. Goyal and S.T. Chua, Mathematical Physics, Macmillan India (1985)

PH 213: BASIC ELECTRONICS (6L,1T)

Objectives: This course is aimed to introduce the students with the basic knowledge of analog and digital circuits. The course illustrates the concepts of various amplifier circuits, solid state electronic devices, sequential digital circuits, optoelectronics devices and measurements using electronic instruments.

Unit I ~~A~~ L C

Selections from electronic circuits (10 hours)

Frequency response of an amplifier circuits-power and voltage gain- impedance matching- Bode plots- Miller effects- rise time bandwidth relations- frequency analysis of BJT and FET amplifier stages

Operational amplifier and its applications (18 hours)

Opamp - frequency response, poles and zeroes, transfer functions (derivation not required), expression for phase angle- Active filters-first order and second order Butterworth transfer function-first order and second order active filters- low pass, high pass and band pass filters- comparators-OP Amp as a voltage comparator-zero crossing detectors-Schmitt trigger-voltage regulators- square, triangular and saw tooth wave form generators-Weinberg oscillator- monostable and astable multivibrator circuits using IC 555 timer- Phase Locked Loop circuits (PLL)

Microwave solid state electronic devices (8 hours)

Tunnel diode-varacter diode-IMPATT diode- QWITT diode- TRAPATT diode- Gunn diode

Unit II

Digital electronics

Arithmetic and data processing digital circuits (16 hours)

Binary adder and subtractor- arithmetic logic unit- binary multiplication and division- arithmetic circuits using HDL- multiplexers- demultiplexers- BCD to decimal decoder- seven segment decoder- parity generators and checkers- magnitude comparator- programmable logic arrays

Sequential digital circuits (20 hours)

Flip flops- edge triggered- SR flip flops- JK flip flop- D- flip flop- JK master-slave flip flop- different types of registers (SISO, SIPO, PISO, PIPO)- universal shift registers- applications- counter asynchronous and synchronous electronic counters- decade counters-

Optical fibre as a wave guide-mode theory of circular wave guide- modes in step index fibres- signal distortion in optical fibres- group delay, material dispersion, wave guide dispersion- sources of attenuation- absorption, scattering, bending loss, core and cladding loss- optical sources- LED's- structure, quantum efficiency and power- laser diodes- modes and threshold conditions, rate equations, efficiency and resonant frequency- photo detector- pin and avalanche photodiodes- principles- optical amplifier- basic applications and types, semiconductor optical amplifiers, erbium doped fibre amplifiers.

Electronic Instrumentation (14 hours)

LC 4

Electronic measurements and instruments-comparison between analog and digital instruments- performance and dynamic characteristics-ideas of errors and measurement standards- voltmeters-ammeters- CRO- Block diagram, CRT, CRT circuits, vertical deflection system- delay line, multiple trace, horizontal deflection system, oscilloscope probes and transducers, oscilloscope techniques, storage oscilloscope, digital storage oscilloscope- classification of transducers-active and passive transducers-force and displacement transducers-strain gauges- temperature measurements-thermistors- thermocouples-flow measurements.

Course Outcome

- (i) To equip the students design and analyze different analogue and digital circuits.
- (ii) To summarize the knowledge of basic arithmetic and data processing circuits and memory devices.
- (iii) To equip the students to explain various components in optical communications systems and microwave devices.
- (iv) To measure and analyze the different electronic signals.

Books for study

1. A. Malvino and D.J.Bates, *Electronics Principles*, 7th Edition, Tata McGraw Hill (2007)
2. R.A. Gayakwad, *Operational Amplifiers and Linear integrated Circuits*, Prentice Hall of India (2000)
3. M.S. Tyagi, *Introduction to semiconductor materials and devices*, Wiley India (2005)
4. B.G. Streetman, S.K. Banerjee, *Solid state electronic devices*. Pearsoninc (2010)
5. J. Millman, C. Halkias and C.D. Parikh, *Integrated Electronics*, Tata McGraw Hill (2010)
6. D.P. Leach, A.P. Malvino, and G. Saha, *Digital principles and applications*, Tata McGraw Hill (2011)

7. G. Keiser, *Optical Fibre Communication*, 3rd edition, McGraw Pub (2000)
8. Lal Kishore, *Electronic measurements and Instrumentation*, Dorling Kindersley (India) Pvt Ltd (2010)
9. W.D. Cooper, A.O. Helfrik and H. Albert, *Electronic Instrumentation and measurement Techniques*, PHI (1997)
10. *Electronic Devices and Circuits Theory*, Robert L. Boylestad, Louis Nashelsky, Pearson 10th edition (2009).

References

1. T.F. Bogart Jr, J.S. Beasley and G. Reid, *Electronic devices and circuits*, Sixth Edition, Pearson Inc (2004)
2. Thomas. L. Floyd, *Digital Fundamentals*, 10th edition, Dorling Kindersley (India) Pvt Ltd (2011)
3. Joachion Piprek, *Semiconductor Optoelectronic Devices*, Academic Press (2003)

PH 221: MODERN OPTICS AND ELECTROMAGNETIC THEORY (6L, 1T) 17.10

Objectives: This course covers linear and non-linear optical phenomenon, propagation of electromagnetic waves, relativistic electrodynamics, radiation and antenna theory.

Unit I

Modern optics (24 hours) JJ

Multiple beam interference-Fabry-Perot interferometer- theory of multilayer films- antireflection films and high reflectance films -Fresnel- Kirchhoff integral theorem and formula- Fraunhofer and Fresnel diffraction patterns and theory-applications of Fourier transforms to diffraction- acoustic- optic modulation- basic ideas of Raman-Nath diffraction and Bragg diffraction- holography as wavefront reconstruction-propagation of light in crystals-optical activity and Faraday rotation

Non-linear optics (12 hours) JJ

Harmonic generation- second harmonic generation- phase matching- third harmonic generation- optical mixing- paramagnetization of light- self focusing- multiquantum photoelectric effect- two photon process and theory- multiphoton processes- three photon processes- second harmonic generation- parametric generation of light.

Unit II

Electromagnetic waves (12 hours)

Electromagnetic wave equations-electromagnetic waves in non-conducting media-plane waves in vacuum-energy and momentum of electromagnetic waves-propagation through linear media- reflection and transmission at normal and oblique incidence-electromagnetic waves in conductors-modified wave equations and plane waves in conducting media-reflection and transmission at a conducting interface

Relativistic electrodynamics (14 hours)

Vector and scalar potential- gauge transformations- Coulomb gauge and Lorentz gauge- Magnetism as a relativistic phenomena- transformation of the field-electric field of a uniformly moving point charge-electrodynamics in tensor notation-electromagnetic field tensor-potential formulation of relativistic electrodynamics

Radiation (10 hours)

Dipole radiation- electric dipole radiation- magnetic dipole radiation- radiation from an arbitrary source- point charges- power radiated by a point charge- radiation reaction

Unit III

Transmission lines (12 hours)

Transmission line parameters and equations-input impedance-standing wave ratio and power- The Smith Chart-applications of transmission lines

Waveguides (12 hours)

Rectangular wave guides-transverse magnetic (TM) modes-Transverse electric (TE) modes- wave propagation in the wave guide-power transmission and attenuation

Antennas (12 hours) JJ

Radiation from Hertzian dipole-half wave dipole antenna-quarter wave monopole antenna- antenna characteristics -antenna arrays-effective area and Friji's equations

Course Outcome

- (i) To demonstrate the linear and nonlinear optical phenomena.
- (ii) To explain and discuss propagation of electromagnetic waves through different media.
- (iii) To restate formulations and relativistic effects in electrodynamics.
- (iv) To analyse the propagation of electromagnetic waves through waveguides.
- (v) To use radiation theory in developing different antennas.

Books for study

1. G.R. Fowles,, *Introduction to Modern Optics*, Second Edition, Dover Publications (1989).
2. A. Yariv, *Introduction to Optical electronics*, Holt, Reinhart and Winston (1976).
3. A. Ghatak and K. Thyagarajan, *Optical Electronics*, Cambridge University Press (1998)
4. D. Roody and J. Coolen, *Electronic Communications*, Fourth Edition, Dorling Kindersley (India) Pvt Ltd (2008)
5. D.J. Griffiths *Introduction to Electrodynamics*, PHI Learning India Pvt Ltd (2007).
6. M.N.O. Sadiku, *Elements of electromagnetics*, Oxford University Press (2007).
7. B.B. Laud, *Lasers and Non-linear Optics*, Second Edition, Wiley-Eastern Limited (1991)

References

1. J.R. Meyer-Arendt, Introduction to Classical and Modern Optics, Prentice Hall Intl (1995)
2. J.C. Palais, Fibre optic communications, Fifth Edition, Pearson Education Inc (2005)
3. E.C. Jordan and K.G. Balmain, Electromagnetic waves and radiating systems, Second Edition, Pearson Education (2002)
4. D.K.Cheng, Field and Wave electromagnetics , Second Edition ,Addison Wesley (1999).
5. L.Ganesan and S.S.Sreejamole, Transmission lines and wave guides, Second Edition, Tata McGraw Hill (2010)

PH 222: THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS (6L, 1T)

Objectives: This course is aimed to introduce the concepts of thermodynamic equations, foundations of classical and quantum statistics, theory of phase transitions and foundations quantum mechanics together with problems.

Unit I

Thermodynamic relations and consequences (20 hours)

Thermodynamic functions and Maxwells's equations-Clausius -Clapeyron equations- Properties of thermodynamic potentials-Gibbs-Helmoltz relation-thermodynamic equilibrium-Nernst -heat theorem and its consequences-Gibb's phase rule-chemical potential-vapour pressure relation and chemical constants

Foundations of classical statistical physics (16 hours)

Phase space-ensembles-Liouville's theorem-statistical equilibrium-microcanonical ensemble-partition functions and thermodynamic quantities-Gibb's paradox-Maxwell-Boltzmann distribution laws-grand canonical ensemble

Unit II

Quantum statistics (26 hours)

Quantum statistics of classical particles-density matrix in microcanonical, canonical and grand canonical ensembles-Bose Einstein statistics and Bose Einstein distribution law-Maxwell Boltzmann statistics and Maxwell Boltzmann distribution law—Fermi Dirac statistics and Fermi Dirac distribution law-comparison of three types of statistics-applications of quantum statistics-Planck radiation laws-Bose Einstein gas and Bose Einstein condensation—Fermi Dirac gas-electron gas in metals-thermionic emission-statistical theory of white dwarfs

Phase transitions (10 hours)

Triple point-Vanderwal's equation and phase transitions-first and second order phase transitions- Ehrenfest's equations- Ising model

Foundations of quantum mechanics (14 hours)

Basic postulates of quantum mechanics- Hilbert space- observables- Hermitian operators- general statistical interpretation- Uncertainty principle- minimum uncertainty wave packet- energy time uncertainty principle- Dirac notation- Matrix representation of state vectors and operators- change of representations- eigenvalue problem in matrix mechanics- energy and momentum representations- unitary transformations involving time- Schrodinger, Heisenberg and interaction pictures.

Exactly solvable problems in quantum mechanics (22 hours)

One dimensional eigen value problems- square well potential- potential barrier- alpha particle emission- Bloch waves in periodic potential- linear harmonic oscillator problem using wave mechanics and operator methods- free particle wave functions and solutions- three dimensional eigen value problems- particle moving in spherical symmetric potential- rigid rotator- hydrogen atom problem- three dimensional potential well- Deuteron

Course Outcome

- (i) To explain the basic thermodynamic relations, Maxwell's equations and its consequences.
- (ii) To equip the students to demonstrate and apply classical and quantum statistics in different physical phenomena.
- (iii) To distinguish the different phase transitions using Ising model.
- (iv) Outline and apply foundations of quantum mechanics.

Books for study

1. R. K. Pathria, *Statistical Mechanics*, Pergamon Press (1991)
2. Satya Prakash, *Statistical Mechanics*, Kedarnath Ram Nath Publishers, Meerut and Delhi (2009)
3. B.K. Agarwal and Hari Prakash, *Quantum Mechanics*, Prentice Hall of India (2002)
4. S. Devanarayanan, *Quantum Mechanics*, Sci Tech Publications (India) Pvt Ltd (2005)
5. D.J. Griffiths, *Introduction to Quantum Mechanics*, Second Edition, Pearson Education Inc ((2005)
6. G. Aruldas, *Quantum Mechanics*, Second Edition, PHI learning Pvt Ltd (2009).
7. J. J Sakurai, *Modern Quantum Mechanics*, Second edition, Pearson (2010).
8. N. Zettili, *Quantum Mechanics concepts and Applications*, Second edition, Wiley (2009).

References

1. R.K. Srivastava and J. Asok, *Statistical Mechanics*, Wiley Eastern Ltd (2005)

2. S.K. Sinha, Statistical Mechanics-Theory and Applications, Tata Mc Graw Hill
3. P.M. Mathews and K.Venkitesan, A Text Book of Quantum Mechanics, Tata Mc Graw Hill (2010)
4. A. Ghatak and S. Lokanathan ,Quantum Mechanics Theory and Applications, Kluwer Academic Publishers (2004).
5. V.K. Thankappan, Quantum Mechanics, Second Edition, New Age International Pvt Ltd (2003).

PH 223: COMPUTER SCIENCE AND NUMERICAL TECHNIQUES (6L, 1T) AA

Objectives: This course provides introduction to computer architecture, microprocessors, programming in python and C++ and computational numerical methods.

Unit I

Foundations of computer science (12 hours) AA JC

Introduction to computers-computer architecture-memory (RAM and ROM, cache) and storage- I/O devices- operating systems-data communications, computer networks and topology

Introduction to microprocessors (12 hours) JC

Evolution of microprocessors-microcontrollers and digital signal processors- Intel 8085 8 bit microprocessor- pin description-functional description- 8085 instruction format-addressing modes of 8085- interrupts of 8085- memory interfacing- 8085 machine cycles and Bus timings- assembly language programming of 8085

Introduction to Python Programming (12 hours) AA

Python - Python shell, number, variables, comparisons and logic, Python objects - strings, lists, tuples, loops; control flow, file input and output functions

Unit II

Programming with C++ (36 hours) AA

C++- flow control-conditional statements-iterative statements-switch statements-conditional operators as an alternative to IF-nested loops-break statements-ext() functions-structured data types-arrays-storage classes-multidimensional arrays-sorting of strings-functions-built in and user defined- accessing function and passing arguments to functions-calling functions with arrays-scope rule for functions and variables-structures in C++-classes and objects - definition- class declaration-class function definitions-creating objects-use of pointers in the place of arrays-file handling in C++-basic file operations-serial and sequential files-reading and writing on to disks.

Unit III

Numerical Techniques (36 hours)

Solution of simultaneous linear algebraic equations-Gauss elimination method-Gauss

Jordan method-inverse of a matrix using Gauss elimination method-Finite differences-forward and backward differences-central differences-difference of a polynomial-error propagation in difference table-Interpolation with equal intervals-Gregory Newton forward and backward formula- error in polynomial interpolation-central difference interpolation formula-Gauss's forward and backward formula- Strling's formula-Lagrange interpolation formula-numerical differentiation-numerical integration using general quadrature formula-Trapezoidal rule- Simsons 1/3 and 1/8 rules-numerical solutions to ordinary differential equations-Euler and modified Euler methods-Runge Kutta methods-numerical solution to partial differential equations-solutions to Poisson and Laplace equations.

Course Outcome

- (i) To summarize computer hardware and its operating systems
- (ii) Explain internal architecture of microprocessors 8085 and create assembly language programing.
- (iii) To develop and compile programs in python and C++.
- (iv) Apply numerical methods to solve physical problems.

Books for study

1. ITL Education Solutions Ltd, *Introduction to Computer Science*, Second Edition, Dorling Kindersley (India) Pvt Ltd (2011)
2. V.N. Vadamurthy and N. Iyengar, *Numerical Methods*, Vikas Publishing Pvt Ltd (1998)
3. K. Udayakumar, and B.S. Umasankar, *The 8085 microprocessor*, Dorling Kindersley (India) Pvt Ltd (2008)
4. Christian Hill, *Learning Scientific Programming with Python*, Cambridge University Press (2015)
5. V. Carl Hamacher, Z.G.Vranesic and S.G. Zaky, *Computer Organization*, Fourth Edition, McGraw Hill International Edition (1996)
6. Peter Norton et al., *Beginning Python*, Wiley Publishing (2005)
7. Abishek Yadav, *Microprocessor 8085 8086*, University Science Press, New Delhi (2008)
8. D.Ravichandran, *Programming in C++*, Tata McGraw Hill (2011)
9. M.T.Somasekhara, *Programming in C++*, PHI Pvt Publishing (2005).
10. B. Ram, *Fundamentals of Microprocessors and Microcontrollers*, Dhanpat Rai Publications (2008).
11. S. S. Sastry, *Introductory method of Numerical analysis*, Fifth Edition, PHI (2012).

References

1. V. Rajaraman, *Fundamentals of Computers*, Fifth Edition, PHI (2010)
2. R.S.Gaonkar, *Microprocessor-Architecture, Programming and Applications with 8085*
3. S.S. Sastry, *Introductory method of Numerical analysis*, Fifth Edition, PHI
4. P. Ghosh, *Numerical Methods with computer programs in C++*, PHI learning Pvt Ltd
5. Bjorne Stroustrup, *The C++ Programming Language*, Fourth Edition, Addison Wesley

PH231: ADVANCED QUANTUM MECHANICS (6 L, 1 T)

Objectives: This course describes a thorough conceptual understanding of advanced quantum mechanics covering variation method, WKB approximation, perturbation theory, symmetry and conservation laws, theory of scattering, system of identical particles, angular momentum and relativistic quantum mechanics.

Unit I

Variation method (6 hours)

The variational principle-Rayleigh Ritz method-variation method for excited states-ground state of Helium and Deuteron.

WKB approximation (8 hours)

WKB method-connection formulas-barrier potential-penetration-alpha particle emission-bound states in a potential well

Time dependent and time-independent perturbation theory (22 hours)

Time independent perturbation- basic concepts- non-degenerate energy levels- anharmonic oscillator-ground state of helium- effect of electric field on the ground state of hydrogen- degenerate energy levels- effect of electric field on the $n=2$ state of hydrogen- spin-orbit interaction.
Time dependent perturbation- first order, harmonic, transition to continuous states, absorption and emission of radiation- Einstein's coefficients- selection rules.

Unit II

Symmetry and conservation laws (10 hours)

Symmetry transformations-space translation and conservation of angular momentum-time translation and conservation of energy-rotation in space and conservation of angular momentum-space inversion-time reversal

Quantum theory of scattering (12 hours) HT/JC

Scattering cross section and scattering amplitude-partial wave analysis and scattering by a central potential-scattering by attractive square well potential-scattering length-expression for phase shifts-Born approximation-scattering by Coulomb potential-Laboratory and centre of mass coordinate transformations.

System of identical particles (14 hours) JC

Identical particles- Pauli's exclusion principle-inclusion of spin-spin function for a two electron system-Helium atom-central field approximation-Thomas Fermi model of an atom-Hartree and Hartree-Fock equations.

Unit III

Angular momentum (12 hours) JC

Angular momentum in operators and commutation relations-eigen values and eigen functions of L^2 and L_z -general angular momentum-eigen values of J^2 and J_z -angular momentum matrices-

spin angular momentum –spin vectors for a spin $\frac{1}{2}$ system-addition of angular momentum-
Clebsch-Gordan coefficients.

Relativistic quantum mechanics (24 hours)

JC

Klein-Gordon equations and its relevance-particle in a Coulomb's field-Dirac's relativistic theory-Dirac's equation for a free particle-Dirac matrices-covariant form of Dirac's equations-probability density-plane wave solutions-negative energy states-spin in Dirac's theory-magnetic moment of an electron-relativistic corrections of Hydrogen atom spectrum-spin orbit correction-Lamb shift

Course Outcome

- (i) To extend the use of approximation methods viz variation, WKB, time dependent and time independent perturbations.
- (ii) To summarize different types of symmetry, conservation laws and quantum theory of scattering.
- (iii) To distinguish different approximation methods, to study the structure and properties of many electron systems.
- (iv) To compute eigen values of angular momentum and evaluation of CG coefficients.
- (v) Infer the requirements of relativistic quantum mechanics.

Book for study

1. G.Aruldas,*Quantum Mechanics*, Second Edition, PHI learning Pvt Ltd (2009)
2. D.J.Griffiths,*Introduction to Quantum Mechanics*, Second Edition, Pearson Education Inc (2005)
3. J.J.Sakurai,*Advanced Quantum Mechanics*, Pearson Education Inc (2009)

References

1. P.M.Mathews and K.Venkatesan, *A Text Book of Quantum Mechanics*, TataMcGraw Hill (2010)
2. A.Ghatak and S.Lokanathan, *Quantum Mechanics Theory and Applications*, Kluwer Academic Publishers (2004)
3. V.K.Thankappan, *Quantum Mechanics*, Second Edition, New Age International Pvt Ltd (2003)
4. S.Devanarayanan, *Quantum Mechanics*, Sci Tech Publications (India) Pvt Ltd (2005)
5. L.H.Ryder, *Quantum Field Theory* Second Edition, Cambridge University Press (1996)
6. Steven Weinberg, *Quantum Theory of Fields(in Three Volumes)*, Cambridge University Press (2002)

PH 232: ATOMIC AND MOLECULAR SPECTROSCOPY (6L, 1T)

Objectives: This course provides an overview of symmetry of molecules, concepts of atomic spectra, Photoelectron and photo acoustic spectroscopy, Rotational, vibrational, electronic, Raman, Mossbauer, nuclear and electron spin resonance spectroscopic techniques.

Unit I

Atomic Spectroscopy (14 hours)

Spectra of Atoms - Spectroscopic terms- selection rules- exchange symmetry of wave functions- Pauli's exclusion principle. Many electron atoms- Building principle- the spectra of Li and hydrogen like elements, The L-S and j-j coupling schemes- total angular momentum - term symbols- The spectra of Helium-Zeeman effect - The magnetic moment of atom, Lande's g factor- The normal Zeeman effect- Emitted frequencies in anomalous Zeeman transitions- Nuclear spin and Hyperfine structure, Stark Effect, Paschen Bach effect

Molecular symmetry (10 hours)

Symmetry operations-symmetry elements-algebra of symmetry operations-multiplication tables-matrix representation of symmetry operators-molecular point groups-reducible and irreducible representations-great orthogonality theorem-character tables for C_{2v} and C_{3v} point groups, symmetry species of point groups-IR and Raman activity

Photoelectron and Photo-acoustic spectroscopy (12 hours)

Photoelectron spectroscopy-experimental methods-photoelectron spectra and their interpretation-Augur electron and X ray Fluorescence spectroscopy-Photo-acoustic effect-basic theory-experimental arrangement-applications.

Unit II

Molecular rotational spectroscopy (12 hours)

Classification of molecules-rotational spectra of diatomic molecules-isotope effect and intensity of rotational lines-non rigid rotator-linear polyatomic molecules-symmetric and asymmetric top molecules-microwave spectrometer-analysis of rotational spectra.

IR spectroscopy (12 hours)

Vibrational spectra of diatomic molecules-characteristic IR spectra-vibrations of polyatomic molecules- anharmonicity- Fermi resonance-hydrogen bonding-normal modes of vibration in a crystal- interpretation of vibrational spectra- IR spectrometer- Fourier transform IR spectroscopy

Electronic spectra of molecules (12 hours)

Vibrational coarse structure and analysis of bound systems- Deslanders table-Frank-Condon principle-vibrational electronic spectra-rotational fine structure- Fortrat parabola-electronic angular momentum in diatomic molecules

Unit III

Raman spectroscopy (12 hours)

Theory of Raman scattering-rotational and vibrational Raman spectra-Raman spectrometer-structure determination using Raman and IR spectroscopy-nonlinear Raman effects-Hyper Raman effect-stimulated Raman scattering- coherent anti-stokes Raman scattering

ESR and NMR spectroscopy (16 hours)

Principle of NMR-ESR spectrometer-Hyperfine structure-ESR spectra of Free radicals-Magnetic properties of nuclei-resonance condition-NMR instrumentation-chemical shift-NMR spectra of solids-NMR imaging-interpretation of NMR spectra

Mossbauer spectroscopy (8 hours)

Recoilless emission and absorption-Mossbauer spectrometer-experimental techniques-isomer shift- quadrupole interaction-magnetic hyperfine interaction

Course Outcome

- (i) Explain different symmetry operations and deduction of molecular structure.
- (ii) Distinguish and classify the different spectra shown by atoms and molecules
- (iii) Illustrate the various spectroscopic experimental techniques.

Books for study

1. J.M. Hollas, *Modern Spectroscopy*, Fourth Edition, John Wiley & Sons (2004)
2. G. Aruldas, *Molecular Structure and Spectroscopy*, PHI learning Pvt Ltd (2007)
3. Suresh Chandra, *Molecular Spectroscopy*, Narosa Publishing Co (2009)
4. H E White, *Introduction to Atomic Spectroscopy* McGraw-Hill Inc. 1st Edition. (1934).

References

1. C.N. Banwell and E.M. McCash, *Fundamentals of Molecular Spectroscopy*, Fourth edition, Tata McGraw Hill (1995).
2. D.N. Satyanarayana, *Vibrational spectroscopy-Theory and applications*, New Age International Pvt Ltd (2004)
3. J.L. McHale, *Molecular Spectroscopy*, Pearson education Inc (2008).

SYLLABUS FOR SPECIAL PAPERS (SPECIAL PAPER I)

PH 233 E: ADVANCED ELECTRONICS -I (6L, 1T)

Objectives: To impart knowledge in advanced digital and analog communications systems and familiarize the concepts of digital signal processing.

Unit I

Analog radio frequency communications (16 hours)

Different types of analog continuous wave modulation-analog baseband signal transmission-signal distortions and equalization-linear continuous wave modulation schemes-amplitude modulation-DSB and SSB schemes-frequency conversion-angle modulation-spectra of angle modulated signals-power and bandwidth of FM signals-generation and demodulation of FM signals-commercial radio broadcasting techniques-AM and FM radio broadcasting and reception.

Microwave radio communications (10 hours)

Advantages and disadvantages of microwave radio communications-digital and analog systems-frequency and amplitude modulation techniques-FM microwave radio system-FM microwave repeaters-FM microwave radio stations-line of sight path characteristics

Pulse modulation (10 hours)

Different types of pulse modulation-pulse amplitude modulation (PAM)-PAM spectrum-pulse code modulation (PCM)-sampling and quantization of analog signals-quantization error-signal to noise ratio-differential PCM delta modulation-other pulse modulation schemes-applications of pulse modulation.

Unit II

Digital communications (16 hours)

Basics of information theory-ideas of digital codes –noise in information carrying channel-Digital carrier modulation -binary ASK,PSK and FSK schemes-bandwidth and power requirements-synchronization methods-ideas of error control coding and error corrections-digital transmission of analog signals-transmission using PCM – frequency and time division multiplexing (TDM) –TDM in PCM telephone system.

Optical fiber communications (20 hours)

Overview of the optical communication system and its components-optical communication receiver and its equivalent circuit-direct and coherent detection systems- digital modulation and

demodulation schemes for coherent optical communication receivers-heterodyne and homodyne detection – principles of wavelength division and code division multiplexing in optical communication-optical solitons- soliton based optical communication systems

Unit III

Mobile cellular communications (10 hours)

Mobile telephone services-cellular telephone-frequency reuse-cell splitting-sectoring, segmentation and dualisation-cellular system topology-roaming and handoffs-cellular telephone network components and call processing-first and second generation cellular telephone services-digital cellular telephone system-global system for mobile communication-personal satellite communication system

Basics of signals and systems (6 hours)

Classification of signals-amplitude and phase spectra-classification of system-simple manipulations of discrete time signals-representation of systems-analog to digital conversion of signals

Fourier analysis of signals and systems (12 hours)

Trigonometric Fourier series-exponential form-Parseval's identity-power spectrum of a period function-Fourier transform-properties of Fourier transform-Fourier transform of important signals-Fourier transform of power and energy signals-Discrete time fourier transform - Fast Fourier transform (FFT).

Z-transforms (8 hours)

Definition of z transform-properties of z-transform-evaluation of the inverse z-transform

Course Outcome

- (i) To summarize various techniques of digital and analog communication systems.
- (ii) Generalize the idea of information theory
- (iii) Illustrate various techniques for digital signal processing based Fourier and Z transform.

Books for study

1. K. Sam Shanmugam, *Digital and Analog communication systems*, John Wiley & Sons (2006).
2. W. Tomasi, *Electronic communications systems: Fundamentals through Advanced*, Dorling Kinderley (India) Pvt. Ltd (2009).
3. G. Kennedy and B. Davis, *Electronic communication systems*, Fourth Edition, Tata McGraw Hill (2003)
4. G. Keiser, *Optical Fibre Communication*, 3rd edition, McGraw Pub (2000).
5. G. P. Agrawal, *Fibre optic communication systems*, John Wiley & Sons (1993)
6. S. Salivahanan and G. Ganapriya, *Digital Signal Processing*, Tata McGraw Hill (2011).

References

- 1 H. Taub ,D. Schilling and G. Saha, Principle of Communication systems, 3rd Edition, Tata McGraw Hill (2008).
- 2 W.C.Y. Lee, Mobile Communications- design, Fundamentals, Second Edition, John Wiley & Sons (1993).
- 3 .J.S. Chitode, Digital Communications, Technical Publications Pune (2008)
- 4 J.M. Senior, Optical Fibre Communications-Principles and Practice, Second Edition, Pearson Education (2006).
- 5 J.J. Carr, Microwave and Wireless communications Technology, Butterworth-Heinemann (1996).

PH 241: CONDENSED MATTER PHYSICS (6L, 1T) HT, JE

Objectives: To understand and familiarize fundamentals of crystals, lattice vibrations, band theory, dielectric, magnetic and superconducting properties of materials. To introduce the synthesis and characterization techniques of nanomaterials.

Unit I

Crystal physics (10 hours) JE GL-2

Lattice points and space lattice-basis and crystal structure-unit cells and lattice parameters-symmetry elements in crystals-space groups-Bravais lattice-density and lattice constant relation-crystal directions, planes and Miller indices-reciprocal lattice-allotropy and polymorphism in crystals-imperfections in crystals.

Lattice vibrations and thermal properties (10 hours) JE, GL-2

Dynamics of identical atoms in crystal lattice-dynamics of linear chain-experimental measurement of dispersion relation-anharmonicity and thermal expansion-specific heat of solids-classical model-Einstein's model-Debye model-thermal conductivity of solids-role of electrons and phonons-thermal resistance of solids.

Free electron and band theory (16 hours) X

Electrons moving in one dimensional potential well-Fermi-Dirac statistics-effect of temperature on Fermi distribution-electronic specific heat-electrical conductivity of metals-Wiedmann- Franz- Lorentz law-electrical resistivity of metals-Hall effect-energy bands in solids-Kronig- Penny model-construction of Brillouin zones-nearly free electron model-conductors, semiconductors and insulators-elementary ideas of Fermi surfaces

Unit II

Semiconductors (12 hours) HT

Free carrier concentration in semiconductors-mobility of charge carriers-temperature effects-electrical conductivity of semiconductors-Hall effect in semiconductors - semiconductor junction properties.

Dielectric and magnetic properties of materials (24 hours) HT

Dipole moment-polarisation-local electric field in an atom-dielectric constant and its measurement-polarizability-classical theory-Peizo, Pyro and Ferro electric properties of Crystals-Ferroelectric domains-classification of magnetic materials-atomic theory of magnetism- Langevin's theory-paramagnetism and quantum theory-Weiss molecular exchange field-ferromagnetic domains-anti ferromagnetism-Ferrites.

Unit III

Superconductivity (20 hours) HC GL-1

Experimental attributes to superconductivity-critical temperature, critical current and critical magnetic field of superconductors-effects of magnetic field on superconductors-Type I and II superconductors-intermediate and vortex states-thermal conductivity, specific heat and energy gap in superconductors-microwave and IR properties-coherence length-Theories of superconductivity-London equations-Ginzberg-Landau theory-BCS theory-AC and DC Josephson effects in superconductors- Examples and properties of High Temperature Superconductors.

Introduction to nano science and technology (16 hours) HC GL-1

Introduction to nanomaterials, properties, classification of nanomaterials, quantum confinement effects, Density of states-nano material preparation techniques-sputtering-chemical vapor deposition-pulsed laser deposition-sol-gel technique-characterization of nano materials-X-Ray diffraction- Scanning Probe Microscopy-atomic force microscopy-SEM and TEM techniques-carbon nano structures-elements of nano electronics.

Course Outcome

- (i) Discuss crystal physics, lattice vibrations, models of thermal properties and band theory of solids.
- (ii) Explain the theoretical concepts of semiconductors, dielectric, magnetic and superconducting materials.
- (iii) To describe the synthesis and characterization techniques of nanomaterials.
- (iv) To apply the concepts in condensed matter physics to meet the challenges.

Books for study

1. N.W. Ashcroft and N.D. Merwin, *Solid State Physics*, Cenage Learning India (2001)
2. Charles.C. Kittel, *Introduction to Solid State Physics*, wiley Student Edition (2007)
3. M. Ali Omar, *Elementary Solid State Physics*, Pearson Education Inc (1999)
4. K.K. Chattopahyay, A.N. Banerjee, *Introduction to Nano Science and NanoTechnology*, Prentice Hall, India (2000)

5. Gabor L Hornyak, H F Tibbals and Joydeep Dutta, *Introduction to Nanoscience and Nanotechnology*, CRC press (2009)

References

- 1 S.O. Pillai, *Solid State Physics*, Third Edition New Age International Pvt. Ltd (1999).
2. M.A. Wahab, *Solid State Physics*, Narosa Publishing House (1999).
- 3 R.J. Singh, *Solid State Physics*, Dorling Kindersley (India) Pvt Ltd (2012).
- 4 P. Phillips, *Advanced Solid State Physics*, Second Edn, Cambridge University Press (2012).

PH 242. NUCLEAR AND PARTICLE PHYSICS (6L, 1T)

Objectives: To familiarize the fundamental properties of nucleus, its structure, models, nuclear reactions, nuclear detectors and accelerators. To introduce the concept of elementary particles and their interactions.

Unit I

Nuclear forces (10 hours) AA JL

Deuteron-neutron -proton scattering and proton-proton scattering at low energies-non central forces- nuclear exchange force-meson theory of nuclear forces

Nuclear models (12 hours) AA JL

Detailed studies on liquid drop, shell and collective models of the nuclei.

Nuclear reactions (14 hours) AA JL

Conservation laws-energetic nuclear reactions-Q value equation-partial wave analysis of nuclear reaction cross section- compound nuclear hypothesis-resonance reactions-Born-Wigner one level formula-optical model-theory of stripping reactions.

Unit II

Nuclear fission (20 hours) JJ

Mechanism of nuclear fission-calculation of critical energy based on liquid drop model-fission products and energy release-fission chain reactions-neutron cycle and four factor formula-general features and classification of nuclear fission reactors.

Nuclear fusion (16 hours) JJ

Nuclear fusion in stellar interiors-proton-proton reactions-carbon-nitrogen cycle-thermo nuclear reactions in the laboratory-conditions for the construction of nuclear fusion reactor-critical ignition temperature-Lawson criterion-plasma confinement in fusion- principles of pinch, magnetic and inertial confinements.

Unit III

Nuclear detectors and particle accelerators (20 hours)

JJ GL-2

Gas filled detectors-ionization chamber and proportional counters-GM counter-scintillation detectors-semiconductor detectors- Cerenkov detector-bubble chamber. Particle accelerators-electrostatic accelerators-cyclotron accelerators-synchrotrons-linear accelerators-colliding beam accelerators.

Elementary particle physics (16 hours)

AA JC

Elementary particle interactions-symmetries and conservation laws-quark model of elementary particles-colored quarks and gluons-ideas of charm, beauty and truth-quark dynamics-ideas of grand unified theories of fundamental forces

Course Outcome

- (i) To describe and analyze nuclear structure, models and reactions.
- (ii) To illustrate the mechanisms of nuclear fission and fusion reactions.
- (iii) Discuss various nuclear detectors and particle accelerators.
- (iv) To classify elementary particles and discuss their interactions.

Books for study

- 1 D.C. Tayal, *Nuclear Physics*, 5th Edition, Himalaya Publishing Co (2008)
- 2 J. Verma, R.C.Bhandari, D.R.S.Somayajulu, *Fundamentals of Nuclear Physics*, CBS Publishers and Distributors (2005).
3. K.S. Krane, *Introductory Nuclear Physics*, Wiley India Pvt. Ltd (1988)

References

- 1 S.B. Patel, *Nuclear Physics-An Introduction*, New Age International Pvt. Ltd (1996).
2. B.R. Marhu, *Nuclear and Particle Physics- an Introduction*, Second Edition, Wiley (2012)
3. S.N. Ghoshal, *Nuclear Physics*, S. Chand Ltd (1997)
4. M.P. Khanna, *Introduction to Particle Physics*, PHI (2011)
5. J. Freidberg, *Plasma Physics and Fusion Energy*, Cambridge University Press (2007)
6. FF.Chen, *Introduction to Plasma Physics*, Springer, London (2002)

SPECIAL PAPER SYLLABUS: SPECIAL PAPER

243 E: ADVANCED ELECTRONICS-II (6L, 1T)

Objectives: The course introduces microprocessors and interfacing devices, embedded systems, artificial intelligence and neural networks. It also provides fundamental data communication codes, RADAR and Satellite communications.

Unit I

Microprocessor 8086: Introduction and Programming (22 hours)

Internal architecture of 8086-pin configuration of 8086-memory organization of 8086-addressing modes of 8086-minimum and maximum mode configurations-instructions set of 8086-data movement instructions-arithmetic and logic instructions-programming of 8086-flow charts and programming steps- Simple programs- One's complement of a 16-bit number - BCD to ASCII, ASCII to BCD - addition of 2-16 bit numbers - generation of Fibonacci series.

Microprocessor interfacing devices and advanced microprocessors (14 hours)

Programmed I/O -direct memory access-micro controllers-8251A USART-8257 DMA controller-8259A programmable interrupt controller-8279 programmable keyboard/display interface-analog to digital and digital to analog converters-advanced microprocessors-80186/80188 high integration 16-bit microprocessors-80386 and 80386 processors-RISC processors.

Unit II

Elements of embedded systems (6 hours)

Example of an embedded system-processor chips for embedded applications-a simple micro controller using embedded systems-embedded processor families

Introduction to artificial intelligence and expert systems (20 hours)

Overview of artificial intelligence (AI)-knowledge representation in AI-problem solving in AI- search methods-predicate and propositional logic-Formal symbolic logic-LISP and PROLOG basics-network representations of knowledge-natural language study in AI-Fuzzy sets and Fuzzy logic- Expert systems-rule based expert systems-nonproduction system architectures-examples of expert systems.

Artificial Neural Networks (10 hours)

Basic concepts of artificial neural networks -neural network architectures- neural network systems- ADALINE and MADALINE networks-advantages and disadvantages of artificial neural networks- neural network application domains- basics of neuro fuzzy systems.

Unit III

Radar (12 hours)

Basic principles of radar-Radar equation-MTI, Pulse and Doppler Radars-Radar signal analysis- ideas of Radar transmitters and receivers-hyperbolic systems for navigation-LORAN and DECCA systems.

Satellite communications (10 hours)

Satellite orbits-Geosynchronous satellites-antenna look angles-satellite classifications-spacing and frequency allocations-satellite antenna radiation patterns-satellite system link models - satellite system parameters and link equations.

Fundamental Concepts of Data Communication (12 hours)

Data communication codes - Baudot code, ASCII code, EBCDIC code, Bar codes - Code 39, Universal product code, Error control, Error detection- Redundancy checking, Error correction-retransmission, Forward error correction, Character synchronization- Asynchronous serial data and Synchronous serial data, Data communication hardware- Data communication circuits- line control unit- universal synchronous Receiver/Transmitter.

Course Outcome

- (i) Demonstrate microprocessor architecture, programing and interfacing devices.
- (ii) Outline the basic concepts of embedded systems, artificial intelligence and neural networks.
- (iii) Illustrate fundamental data communications codes, radar and satellite communication systems.

Books for study

1. Sunil Mathur, *Microprocessor 8086-Architecture, Programming and Interfacing*, PHI learning Pvt Ltd (2011)
2. Abishek Yadav, *Microprocessor 8085 8086*, University Science Press, New Delhi (2008)
3. Carl Hamacher, Z.G. Vranesic, S.G. Zaky, *Computer organization*, 5th Edition, McGraw Hill Education (2002).
4. B. Ram, *Fundamentals of microprocessors and microcontrollers*, Dhanpat Rai Publications, New Delhi (2016).
5. Robert J Schalkoff, *Artificial Neural Networks*, Mc Graw Hill International Edition (1997).
6. V.S. Janakiraman, K. Sarukesi and P. Gopalakrishnan, *Foundations of Artificial Intelligence and Expert systems*, Macmillan Publishers India Ltd (2011).
7. E. Rich and K. Knight, *Artificial Intelligence*, Second Edition, Tata McGraw Hill Pub Co (2006).
8. W. Tomasi, *Electronic communications systems: Fundamentals through Advanced*, Dorling Kinderley (India) Pvt. Ltd (2009).

9. D.W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, Prentice Hall of India Pvt Ltd (2001).
10. S. Rajasekharan and G.A. VijalekshmiPai, *Neural Networks Fuzzy logic and Geneticalgorithms*, PHI learning Pvt Ltd (2010).
11. S.N. Sivanandan, S.Sumathi and S.N. Deepa, *Introduction to Fuzzy logic using MATLAB*, Springer (2007).
12. A.Veera Lakshmi and R.Srivel, *Television and Radio engineering*, Ann Books Pvt Ltd (2010)
13. Skolini. M.I, *Introducion to Radar systems*, Third editon, Tata Mc Graw Hill (2001)
14. Nagaraja, *Elements of Electronic navigation*, Second Edition, Tata Mc GrawHill (2006)

PH 251: GENERAL PHYSICS PRACTICALS

(Total of 10 experiments to be done from Section A and B)

Section A *(atleast 5 experiments to be done in this section)*

1. Determination of elastic constants by Cornu's method *(elliptical and hyperbolic fringes)*
2. Analysis of absorption spectra of liquids using spectrometer
3. Study of ultrasonic waves in liquids
4. Determination of e/k using Ge and Si transistors
5. Anderson Bridge –determination of self and mutual inductance
6. Michelson Interferometer experiments
7. Identification of Fraunhofer lines in solar spectra
8. Verification of Richardson's equation using diode valve
9. LED experiments (a) wavelength determination (b) I-V characteristics (c) output power variations with applied voltage etc.
10. Thermal diffusivity of brass

Section B *(atleast 2 experiments to be done from this section)*

1. BH curve-anchor ring
2. Study of photoelectric effect and determination of Planck's constant
3. Determination of Stefan's constant
4. Experiments using Laser:
 - (a) Laser beam characteristics (b) Diffraction grating (c) Diffraction at different types of slits and apertures (d) refractive index of liquids (e) particle size determination
5. Young's modulus of different materials using strain gauge
6. Determination of magnetic force in a current carrying conductor
7. Optical fibre characteristics – numerical aperture, attenuation and bandwidth of given specimen.

8. Variation of dielectric constant with temperature of ferroelectric material.
9. Dielectric constant of non-polar liquid.
10. Cauchy's constants of liquids and liquid mixtures using hollow prism and spectrometer
11. Surface tension of a liquid using Jaeger's method
12. Experiments using Phoenix Kit
 - (a) Capacitor charging/discharging experiments
 - (b) Dielectric constant of glass

PH 252 ELECTRONICS AND COMPUTER SCIENCE PRACTICALS

Unit I – Electronics Experiments (A total of 10 experiments to be done)

Section A (atleast 5 experiments to be done)

- ✓ 1. Single stage CE amplifier –Design and study of frequency response
- ✓ 2. Study of RC Phase shift oscillator circuits using Transistors
- ✓ 3. Construction and study of astablemultivibrator and VCO circuits using Transistors
4. Study of OP Amp circuits (a) summing amplifier (b) difference amplifier
- ✓ 5. OP Amp as an integrator and differentiator ✓
6. Characteristics of JFET and MOSFET
7. Characteristics of SCR
- ✓ 8. Design and study of negative feedback amplifier circuits
- ✓ 9. Study of Clipping and Clamping circuits
10. UJT Characteristics and UJT relaxation Oscillator

Section B (atleast 3 experiments to be done)

- ✓ 1. Emitter follower and source follower circuits
2. Weinberg oscillator using OP Amp
3. SR and JK Flip Flops -construction using Logic Gates and study of truth tables
4. Study of the frequency response of a tuned amplifier
5. Study of power amplifier circuits

PH 261 ADVANCED PHYSICS PRACTICALS

(A total of 10 experiments to be done)

Unit I: Physics experiments

Section A *(at least 5 experiments to be done)*

1. e/m of an electron-Thompson's method
2. Charge of an electron-Millikan's method
3. Determination of Fermi energy of Copper
4. Study of variation of resistance of a semiconductor with temperature and determination of band gap
5. Magnetic Susceptibility of a liquid using Quincke's method
6. Ferromagnetic studies using Guoy's method
7. Hall effect in a semiconductor
8. Rydberg constant determination using grating, spectrometer and discharge tubes.
9. Thermo-emf of bulk samples like Al, Cu, Brass etc.
10. Zeeman effect using Fabry-Perot Interferometer.

Section B *(at least two experiments to be done)*

1. Electrical characteristics of a solar cell
2. Studies using UV visible spectrophotometer
3. Refractive index of liquids and liquid mixtures using Abbe's refractometer
4. Optical activity studies using Polarimeters
5. Determination of temperature characteristics of a Flame
 - (a) Candle flame using digital photography and image analysis
 - (b) Sodium flame in comparison with incandescent lamp using a spectrometer
6. LDR and photodiode characteristics

6. Frequency multiplier using PLL
- 7 Study of Schmitt trigger circuits using transistors
8. Construction and study of cascade amplifier circuit using transistors.
9. Simple electronics experiments using Phoenix and Python based Kits.

Unit II Computer Programming

(A minimum of 8 experiments to be done, programs should be written in C++ language)

1. Least square fitting
2. First derivative of tabulated function by difference table
3. Numerical integration (Trapezoidal rule and Simpson method)
4. Solution of algebraic and transcendental equations using Newton-Ralphson method
5. Solution of algebraic equations using bisection method
6. Numerical interpolation using Newton and Lagrangian methods
7. Monte Carlo simulation
8. Evaluation of Bessel and Legendre functions
9. Matrix addition, multiplication, trace, transpose and inverse.
10. Fourier series analysis
11. Study of motion of projectile in a central force field
12. Study of Planetary motion and Kepler's laws

7. Simple experiments using GM counter

8. Determination of dielectric constant of materials

9. Experimental determination of Avogadro's number using an electrochemical cell

10. Study of arc spectra and hydrogen spectra using an imager (CCD) and photoelectric/electronic recorder.

Unit II: Data Analysis (Five experiments to be done)

1. Analysis of the given band spectrum
2. Analysis of given rotation-vibration spectrum
3. Interpretation vibration spectra of simple molecules using Raman and IR spectra
4. Dissociation energy of diatomic molecules
5. Analysis of powder XRD data
6. Study of stellar spectral classification from low dispersion stellar spectra
7. Study of HR diagram of stars
8. Radioactive material counting statistics
9. Interpretation of UV- visible spectra of materials
10. Weather and astronomy related image processing

PH 262 E ADVANCED ELECTRONICS PRACTICALS

Unit I- ELECTRONICS (a total of seven experiments to be done)

Section A (at least 5 experiments to be done)

1. Study of active filters using OP amps (a) low pass (b) high pass (c) band pass for both first order and second order-gain/ roll off determination
2. Wave form generation using OP amp circuits:
(a) astable and monostable multivibrators (b) square, triangular and saw-tooth wave generation
3. IC 555 timer experiments (a) monostable and astable multivibrators (b) VCO
4. D/A convertor circuits using OP Amp 741

5. Differential amplifier circuits using transistors
6. Design of series pass voltage regulators using
 - (a) transistors with load and line regulation (b) OP Amp

Section B (at least 2 experiments to be done)

1. Study of IF tuned amplifier and Amplitude modulation (generation and detection) using transistors and diode etc.
2. Frequency modulator and detector circuits.
3. Pulse modulation circuits using 555 timer (a) PAM (b) PWM
4. Digital modulation circuits (a) BPSK generation using 555 timer (b) BPSK detection using timer and PLL (c) BPSK generation
5. Shift register and ring counter circuits using flip flops
6. Miscellaneous transistor applications (a) automatic night light with LDR (b) inverter circuit (transistors as a switch) (c) time delay circuit using SCR
7. BCD to decimal decoder and seven segment display using IC
8. Design of Electronic counters (up and down counters)

Unit II: Microprocessor Based Experiments (Five experiments to be done)

1. 8085 /8086 program to find out largest from a group of 8bit/16 bit numbers
2. Square wave generation using 8255A interface using 8085/8086
3. 8086 program for block addition.
4. Interfacing LED display board with 8085/8086
5. 8086 program to convert binary to ASCII and ASCII to BCD
6. 8086 program to arrange a given data in ascending and descending order
7. 8086-simple traffic light controller
8. 8086 program for binary to BCD conversion and vice versa