SHRI GURU RAM RAI UNIVESITY

(Estd. By Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 3 of 2017)

PATEL NAGAR, DEHRADUN-248001, UTTARAKHAND, INDIA

SYLLABUS

(2017)

Program/course: B.Sc. PHYSICS

B.Sc. PHYSICS (SEMESTER I)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BPHC101	Mechanics	4	30	70	100
BPHL101	Mechanics – Lab	2	30	70	100
	Total	6	60	140	200

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.Sc. PHYSICS (SEMESTER II)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BPHC201	Electricity and Magnetism	4	30	70	100
BPHL201	Electricity and Magnetism- Lab	2	30	70	100
	Total	6	60	140	200

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.Sc. PHYSICS (SEMESTER III)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BPHC301	Thermal Physics and Statistical Mechanics	4	30	70	100
BPHL301	Thermal Physics and Statistical Mechanics – Lab	2	30	70	100
BPHS302	Computational Physics	4	30	70	100
	Total	10	90	210	300

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.Sc. PHYSICS (SEMESTER IV)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BPHC401	Waves and Optics	4	30	70	100
BPHL401	Waves and Optics – Lab	2	30	70	100
BPHS402	Radiation Safety	4	30	70	100
	Total	10	90	210	300

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.Sc. PHYSICS (SEMESTER V)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BPHD501 OR BPHD502	Elements of Modern Physics OR Mathematical Physics	4	30	70	100
BPHL501 OR BPHL502	Elements of Modern Physics – Lab OR Mathematical Physics - Lab.	2	30	70	100
BPHS503	Electronics I (Network Theorems, Solid State Devices, Rectifiers and Filters)	4	30	70	100
	Total	10	90	210	300

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.Sc. PHYSICS (SEMESTER VI)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BPHD601 OR BPHD602	Solid State Physics OR Quantum Mechanics	4	30	70	100
BPHL601 OR BPHL602	Solid State Physics – Lab. OR Quantum Mechanics – Lab.	2	30	70	100
BPHS603	Electronics II (Amplifiers and Oscillators)	4	30	70	100
	Total	10	90	210	300

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

Syllabus of B.Sc. Physics from 2017 - 18

CBCS System - B. SC. PHYSICS Courses

	CORE COURSE 6 Credits each	ABILITY ENHANCEMENT COMPULSORY COURSE 4 Credits each	SKILL ENHANCEMENT COURSE 4 Credits each (maximum two)	DISCIPLINE SPECIFIC ELECTIVE 6 Credits each
Semester - I	BPHC101- Mechanics and BPHL101- Mechanics Lab.	AECC101/102/103 Environment / English/ MIL Communication		
Semester – II	BPHC201- Electricity and Magnetism and BPHL201- Electricity and Magnetism Lab.	AECC201/202/203 Environment / English/ MIL Communication		
Semester – III	BPHC301- Thermal Physics and Statistical Mechanics and BPHL301- Thermal Physics and Statistical Mechanics Lab.		BPHS302	

Semester – IV	BPHC401- Waves and Optics and BPHL401 - Waves and Optics Lab.		BPHS402	
Semester – V			BPHS503	BPHD501 OR BPHD502
Semester - VI			BPHS603	BPHD601 OR BPHD602

Physics Course (Core Courses) (Credit: 06 each)

Semester – I

BPHC101- Mechanics + BPHL101-Mechanics Lab.

Semester – II

BPHC201-Electricity and Magnetism+BPHL201- Electricity and Magnetism Lab.

Semester – III

BPHC301-Thermal Physics and Statistical Mechanics + BPHL301-Thermal Physics and Statistical Mechanics Lab.

Semester – IV

BPHC401-Waves and Optics + BPHL401 -Waves and Optics Lab.

Physics Courses (Discipline Specific Elective)(Credits: 06 each)

Semester V (Any one)

1. BPHD501-Elements of Modern Physics (Credits - 04) + Lab (Credits - 02)
2. BPHD502-Mathematical Physics (Credits - 04) + Lab (Credits - 02)

Semester VI (Any One)

1.BPHD601-Solid State Physics (Credits - 04) + Lab (Credits - 02)
2. BPHD602-Quantum Mechanics (Credits - 04) + Lab (Credits - 02)

Physics Courses (Skill Enhancement Courses). (Any one of the following may be opted in Semester III or IV or V & one more course may be opted in VI Semester)(Credit: 04 each) -

1.BPHS302-Computational Physics
2. BPHS402-Radiation Safety
3. BPHS503-Electronics I – (Network Theorems, Solid State Devices, Rectifiers and Filters)
4. BPHS603-Electronics II – (Amplifiers and Oscillators)

Total Credits (Summary)

1. Core Courses (Th + Pr.) - 6 X 4 = 24 X 3 (Three Subjects in B.Sc.) =72
2. Discipline Specific Elective (Th + Pr.) – 6 X 2 = 12 X 3 (Three Subjects in B.Sc.) =36
3. Ability Enhancement Compulsory Courses – 4 X 2 = 8 (Common in all the three subjects) = 8
4. Skill Enhancement Courses – 4 X 4 = 16 (One course each from 03 Subjects + One course from any of the 03 subjects) = 16

Total = 72+36+8+16 = 132 Credits to be earned in B.Sc.

Semester I
BPHC101- MECHANICS

TOTAL LECTURES: 60 **CREDITS - 04**

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.
(4 Lectures)

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.
(6 Lectures)

Laws of Motion: Frames of reference.Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.
(10 Lectures)

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.
(6 Lectures)

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.
(5 Lectures)

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).
(8 Lectures)

Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a Capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication.
(6 Lectures)

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum- Determination of Rigidity modulus and moment of inertia - q, η by

Searles method.
(8 Lectures)

Special **Theory of Relativity:** Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

(7 Lectures)

Note: Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.

Suggested Readings:

- Integrated Mechanics, J.P. Agarwal, Pragati Publication
- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw-
  Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

BPHL101 - MECHANICS - LAB.

TOTAL HOURS : 60 **CREDITS - 02**

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine g and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.
- Practical Physics, Gupta Kumar, Pragati Publication.

Semester II

BPHC201-ELECTRICITY AND MAGNETISM

TOTAL LECTURES: 60 **CREDITS - 04**

Vector Analysis: Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).
(12 Lectures)

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric
(22 Lectures)

Magnetism: Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil,
solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.
Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.
(10 Lectures)

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.
(6 Lectures)

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity
of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.
(10 Lectures)

Suggested Readings:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, BenjaminCumming.
- Integrated Electricity and Magnetism, J.P. Agarwal, Pragati Publication.

BPHL201 - ELECTRICITY AND MAGNETISM - LAB.

TOTAL HOURS : 60 **CREDITS - 02**

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.

2. Ballistic Galvanometer:
(i) Measurement of charge and current sensitivity
(ii) Measurement of CDR
(iii) Determine a high resistance by Leakage Method
(iv) To determine Self Inductance of a Coil by Rayleigh's Method.

3. To compare capacitances using De'Sauty's bridge.

4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).

5. To study the Characteristics of a Series RC Circuit.

6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor

7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q

8. To determine a Low Resistance by Carey Foster's Bridge.

9. To verify the Thevenin and Norton theorem

10. To verify the Superposition, and Maximum Power Transfer Theorem

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers
- Practical Physics, Gupta Kumar, Pragati Publication

Semester III

BPHC301-THERMAL PHYSICS AND STATISTICAL MECHANICS

TOTAL LECTURES: 60 **CREDITS - 04**

Laws of Thermodynamics: Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP&
CV, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.
(22 Lectures)

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.
(10 Lectures)

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.
(10 Lectures)

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.
(6 Lectures)Statistical Mechanics: Maxwell-Boltzmann law - distribution of velocity - Quantum
statistics - Phase space - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.
(12 Lectures)

Suggested Readings:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.

- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole
- Integrated Thermal Physics and Statistical Mechanics, J.P. Agarwal, Pragati Publication

BPHL301 - THERMAL PHYSICS AND STATISTICAL MECHANICS - LAB.

TOTAL HOURS: 60 **CREDITS - 02**

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publication.
- Practical Physics, Gupta Kumar, Pragati Publication

Semester IV

BPHC401-WAVES AND OPTICS

TOTAL LECTURES: 60 **CREDITS - 04**

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition
Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).**(4 Lectures)**

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. **(2 Lectures)**

Waves Motion- General: Transverse waves on a string. Travelling and standing waves
on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity. **(7 Lectures)**

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.**(6 Lectures)**

Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.**(6 Lectures)**

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(3 Lectures)**

Interference: Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change onreflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shapedfilms. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness
(Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.**(10 Lectures)**

Michelson's Interferometer: (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength,(3) Wavelength difference,(4) Refractive index, (5)Visibility of fringes. **(3 Lectures)**

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(14 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(5 Lectures)**

Suggested Readings:

- Integrated Wave and Optics, J.P. Agarwal, Pragati Publication.
- Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
- University Physics. FWSears, MWZemanskyand HDYoung13/e, 1986.Addison-

BPHL401 - WAVES AND OPTICS - LAB.

TOTAL HOURS: 60 **CREDITS -02**

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2– T Law.
3. To study Lissajous Figures.
4. Familiarization with Schuster`s focusing; determination of angle of prism.
5. To determine the Height of a Building using a Sextant.
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light.
8. To determine the value of Cauchy Constants of a material of a prism.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium & (2) Mercury light using plane diffraction Grating.
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Suggested Readings:

- Practical Physics, Gupta Kumar, Pragati Publication.
- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.

Semester V

Physics - (Discipline Specific Elective)

(Select any one course)

BPHD501-ELEMENTS OF MODERN PHYSICS

TOTAL LECTURES: 60 **CREDITS - 04**

Planck's quantum, Planck's constant and light as a collection of photons; Photo-electriceffect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment.**(8 Lectures)**

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels forhydrogen like atoms
and their spectra.**(4 Lectures)**

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertaintyprinciple; Energy-time uncertainty principle.**(4 Lectures)**

Two slit interference experiment with photons, atoms and particles; linear superpositionprinciple as a consequence; Matter waves and wave amplitude; Schrodinger equation fornon-relativistic particles; Momentum and Energy operators;

stationary states; physicalinterpretation of wavefunction, probabilities and normalization; Probability andprobability current densities in one dimension. **(11 Lectures)**

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions,normalization; Quantum dot as an example; Quantum mechanical scattering andtunnelling in one dimension - across a step potential and across a rectangular potentialbarrier. **(12 Lectures)**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.**(6 Lectures)**

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life;αdecay; βdecay - energy released, spectrum and Pauli's prediction of neutrino; - ray emission.**(11 Lectures)**

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting withUranium 235; Fusion and thermonuclear reactions**(4 Lectures)**

Suggested Readings:

- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
- Modern Physics, John R.Taylor, Chris D.Zafiratos, Michael A.Dubson,2009, PHI Learning
- Six Ideas that Shaped Physics:Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
- Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

BPHL501 - ELEMENTS OF MODERN PHYSICS - LAB.

TOTAL HOURS: 60 **CREDITS -02**

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.

2. To determine work function of material of filament of directly heated vacuum Diode

3. To determine value of Planck's constant using LEDs of at least 4 different colours.

4. To determine the ionization potential of mercury.

5. To determine the wavelength of H-alpha emission line of Hydrogen atom.

6. To determine the absorption lines in the rotational spectrum of Iodine vapour.

7. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light.

8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.

9. To determine the value of e/m by magnetic focusing.

10. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.

BPHD502-MATHEMATICAL PHYSICS

TOTAL LECTURES: 60 **CREDITS - 04**

The emphasis of the course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.
(6 Lectures)

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. **(10 Lectures)**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations. **(16 Lectures)**

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(4 Lectures)**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.
(10 Lectures)

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula.**(14 Lectures)**

Suggested Readings:

- Mathematical Physics, B.S. Rajput, Pragati Publication
- Mathematical Physics, H.K. Dass, S.Chand Publication
- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books.

BPHL502- MATHEMATICAL PHYSICS - LAB

TOTAL HOURS: 60 **CREDITS -02**

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- Use of computer language as a tool in solving physics problems (applications)
- The course will consist of lectures (both theory and practical) in the Computer Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved

Students can use anyone operating system Linux or Microsoft Windows

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow emphasize the importance of making equations in terms

	of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While-Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D&2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs: using C/C++ language	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending-descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of Pi (π)

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan\alpha$; $I = I_o[(\sin\alpha)/\alpha]^2$ in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. sin θ, cos θ, tanθ, etc.
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice-versa. Find the area of B-H Hysteresis loop

- Attempt following problems using Runge- kutta fourth order method:
- Solve the coupled first order differential equations:
  ;

for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4.
Plot x vs y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$.

2. The differential equation describing the motion of a pendulum is $d^2v/dt^2 = -\sin(v)$. The pendulum is released from rest at an angular displacement α i.e. v (0) = α, v'(0) = 0. Solve the equation for α = 0.1, 0.5 and 1.0 and plot v as a function of time in the range $0 \leq t \leq 8\,\pi$**.** Also, plot the analytic solution valid for small v (sin(v)) = v.

Suggested Readings:

- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt.Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 20 00, McGraw-Hill Publications.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., 2007, Cambridge University Press.
- A first course in Numerical Methods, Uri M. Ascher and Chen Greif, 2012, PHILearning
- Elementary Numerical Analysis, K.E.Atkinson,3rdEdn. , 2007 , Wiley IndiaEdition.
- Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, CourierDover Pub.
- An Introduction to Computational Physics, T.Pang, 2ndEdn., 2006, CambridgeUniv. Press

Semester VI

(Select any one course)

BPHD601-SOLID STATE PHYSICS

TOTAL LECTURES: 60 **CREDITS - 04**

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.
(12 Lectures)

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.
T^3law
(10 Lectures)

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.
(12 Lectures)

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons.
(10 Lectures)

Elementary band theory: Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.
(10 Lectures)

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth.
Isotope effect.
(6 Lectures)

Suggested Readings:

- Introduction to Solid State Physics, Charles Kittel, 8thEd., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2ndEd., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid-state Physics, H.Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

BPHL601 - SOLID STATE PHYSICS - LAB

TOTAL HOURS: 60 **CREDITS -02**

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four probe
   method (from room temperature to 150 ^{o}C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Suggested Readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEd., 2011, Kitab Mahal, New Delhi

- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

BPHD602-QUANTUM MECHANICS

TOTAL LECTURES: 60 **CREDITS - 04**

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigen values and Eigen functions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.
(6 Lectures)

Time independent Schrodinger equation-Hamiltonian, stationary states and energy Eigen values; expansion of an arbitrary wave function as a linear combination of energy Eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian Wave packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.
(10 Lectures)

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method.
(12 Lectures)

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d, shells (idea only). **(10 Lectures)**

Atoms in Electric and Magnetic Fields:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.
(8 Lectures)

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect.
(4 Lectures)

Many electron atoms:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and
J-J couplings.
(10 Lectures)

Suggested Readings:

- A Text book of Quantum Mechanics, P.M.Mathews & K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum mechanics, SatyaPrakash, Swati Saluja, Kedar Nath, Ram Nath &Co.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

BPHL602 - QUANTUM MECHANICS - LAB.

TOTAL HOURS: 60 **CREDITS -02**

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$d^2y/dr^2=A(r)u(r)$, $A(r) = 2m/\hbar^2 [V(r) – E]$ where $V(r) = -e^2/r$

Here, m is the reduced mass of the electron. Obtain the energy eigen values and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is -13.6 eV. Take $e = 3.795$ $(eVÅ)^{1/2}$, $\hbar c = 1973$ (eVÅ) and m

$= 0.511x10^6 eV/c^2$.

2. Solve the s-wave radial Schrodinger equation for an atom:

$d^2y/dr^2=A(r)u(r)$, $A(r) = 2m/\hbar^2 [V(r) – E]$

Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -e^2(1/r)e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 $(eVÅ)^{1/2}$, m = $0.511x10^6 eV/c^2$, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$d^2y/dr^2=A(r)u(r)$, $A(r) = (2m/\hbar^2) [V(r) – E]$

For the anharmonic oscillator potential

$V(r) = k r^2 + br^3$

for the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = $940MeV/c^2$, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen Molecule:
$d^2y/dr^2=A(r)u(r)$, $A(r) = (2\mu/\hbar^2) [V(r) – E]$
where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} – e^{-\alpha r'}) ,$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
Take: m = $940x10^6 eV/C2$, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting

7. To study the quantum tunneling effect with solid state device, e.g. tunneling current in backward diode or tunnel diode.

Suggested Readings:

- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C: The Art of Scientific Computing, W.H.Press et al.,3rdEdn., 2007, Cambridge University Press.
- Elementary Numerical Analysis, K.E.Atkinson, 3rdEd n. , 2007 , Wiley India Edition.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf2012ISBN: 978-1479203444
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Company, New Delhi ISBN: 978-8121939706
- Scilab Image Processing: Lambert M. Surhone. 2010Betascript Publishing ISBN: 978-6133459274A
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

Skill Enhancement Courses

BPHS302-COMPUTATIONAL PHYSICS

TOTAL LECTURES: 60 **CREDITS - 04**

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- Use of computer language as a tool in solving physics problems (applications)
- Course will consist of hands on training on the Problem solving on Computers.

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution**.** Usage of linux as an Editor.

Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series,
Calculation of sin (x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL,

COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:
1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and otherfloating bodies, Lining in columns- Tabbing and tabular environment, Generating tableof contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.

Hands on exercises:
1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

Suggested Readings:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3 r d E d n. 2007 , Wiley India Edition

BPHS402-Radiation Safety

TOTAL LECTURES: 60 **CREDITS - 04**

The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma andNeutron and their sources, sealed and unsealed sources, **Interaction of Photons** – Photoelectriceffect, Compton Scattering, Pair Production, Linear and Mass AttenuationCoefficients,

Interaction of Charged Particles: Heavy charged particles - Beth-BlochFormula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling andCherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung).

Interaction of Neutrons- Collision, slowing down and Moderation.

Radiation detection and monitoring devices:
Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC).
Radiation detection: Basic concept and working principle of *gas detectors* (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry

Radiation safety management: *Biological effects of ionizing radiation*, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. *Industrial Uses:* Tracing, Gauging, Material Modification, Sterization, Food preservation.

Experiments:

1.Study the background radiation levels using Radiation meter.
2) Study of characteristics of GM tube and determination of operating voltage and plateau
length using background radiation as source (without commercial source).
3) Study of counting statistics using background radiation using GM counter.
4) Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
5) Study of absorption of beta particles in Aluminum using GM counter.
6) Detection of α particles using reference source & determining its half life using spark counter
7) Gamma spectrum of Gas Light mantle (Source of Thorium)

Suggested Readings:

1. W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
2. G.F.Knoll, Radiation detection and measurements
3. Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7. A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
8. NCRP, ICRP, ICRU, IAEA, AERB Publications.
9. W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981

BPHS503-ELECTRONICS –I (Network Theorems, Solid state Devices, Rectifiers and Filters)

TOTAL LECTURES: 60 **CREDITS - 04**

The aim of the papers for Electronics I is to make the student aware about the working of different Electronic devices used in daily life being used in different electronic appliances.

Network analysis and Network Theorem

Kirchhoff's Law, Series parallel corrections, Network Theorems, Superposition, Reciprocity,
Theremins, Norton's Maximum power, Transfer Theorem, Low pass and High pass filters,
Four terminal Network, Electronic Measuring Instruments: VTVM, CRO.

Solid State Devices

Electronics Devices: General idea of Diode, Triode, Tetrode, Pentode and their characteristics,

intrinsic and extrinsic n-type and p-type semiconductors, P-N junction, Semiconductor junction diode, point contact, Zener, varactor, Tunnel diode , Photodiode, Light emitting diode, Junction.
Transistors, Transistor operation, characteristic Curves, common emitter, common base and common collector configurations, current amplification, Field effect transistor.

Rectifiers and Filters

HW,FW and bridge rectifiers, Filter circuits(Series L, Shunt C.L-Section-II).Unregulated PS Regulated PS Voltage regulation by Zener diode, Voltage multiplier, Binary ,Decimal, Hexadecimal and Octal number systems and interconversions, BCD, Elementary idea of logic gate and Boolean algebra.

Suggested Readings:

1. Basic Electronics, B.L. Theraja, S.Chand Publication.
2. Principles of Electronics, V.K. Mehta, Rohit Mehta, S.Chand Publication.
3. Handbook of Electronics, Gupta Kumar, Pragati Publication
4. Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill.
5. Electronic Devices and Circuits, S. Salivahanan & N. S.Kumar, 3rdEd.,2012, Tata McGraw Hill.
6. Digital Principles and Applications, A.P. Malvino , D.P. Leach & Saha,7th Ed., Tata McGraw Hill
7. Fundamentals of Digital Circuits , A. Anand kumar, 2nd Edition,2009, PHI Learning Pvt. Ltd.

BPHS603-ELECTRONICS-II (Amplifiers and Oscillators)

TOTAL LECTURES: 60 **CREDITS - 04**

The aim of the papers for Electronics II is to make the student aware about the working of different Electronic devices used in daily life being used in different electronic appliances.

Transistor Amplifier

Classification, Basic Amplifier, Load Line, Transistor biasing, Transistor equivalent circuit (h-Parameter). Single stage transistor amplifier, (common emitter, common base) FET amplifier,R.C coupled transistor amplifier, Impedance coupled and Transformer coupled

amplifier, Noise and distortion in amplifiers, Power amplifiers(Class A Push pull class B and class C) Decibel, Frequency response bandwidth.

Feedback Amplifiers and Oscillators

Classification, Negative feedback and its advantages, Feedback amplifiers (Voltage and current) Positive feedback oscillators(RC phase shift and Wein bridge, Hartley, Colpit, tuned
collector, tuned base)Oscillator, Negative resistance(tuned diode oscillator),Crystal oscillators,
Stability, Relaxation oscillators-Multivibrators (astable, monostable and bistable)

Suggested Readings:

1. Basic Electronics, B.L. Theraja, S.Chand Publication
2. Principles of Electronics, V.K. Mehta, Rohit Mehta, S.Chand Publication
3. Handbook of Electronics, Gupta Kumar, Pragati Publication
4. Handbook of Electronics, Gupta Kumar, Pragati Publication
5. Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill.
6. Electronic Devices and Circuits, S. Salivahanan & N. S.Kumar, 3rdEd.,2012, Tata McGraw Hill.
7. Digital Principles and Applications, A.P. Malvino , D.P. Leach & Saha,7th Ed., Tata McGraw Hill
8. Fundamentals of Digital Circuits , A. Anand kumar, 2nd Edition,2009, PHI Learning Pvt. Ltd.