Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Department of Physics

B.Sc. Physics

Programme Outcomes

1. Familiarize the fundamental knowledge in basic concepts of Science
2. Gain competence to communicate effectively
3. Develop critical thinking for innovations
4. Identify problems and suggest appropriate scientific, technological and environmental solutions
5. Function individually or as a team in the work environment
6. Gain hands on experience in handling measuring equipments and constructing circuits of purpose
7. Acquire research skills to inquire, synthesize and articulate solution for community development
8. Create and apply ICT tools for learning and technology development
9. Acquire professional ethics and norms for social development
10. Implement acquired knowledge in basic sciences for self directed and lifelong learning and promote entrepreneurial skills

Programme Specific Outcomes:

On completion of B.Sc. Physics Programme, the graduates will be able to

1. Comprehend the core concept in Physics and relate to daily life
2. Apply and verify theoretical concepts through laboratory experiments
3. Select a career efficiently in diverse fields

Scheme of Instruction & Examinations
(for students admitted from 2023-2024 & onwards)

Part	Subject Code	Name of paper / Component	Hours of instruction / week	Scheme Examination					
				Duration of exam	CIA	CE	Total	Credit	
		First Semester							
I	23BLT001/ 23BLH001/ 23BLF001	பொதுத்தமிழ்தாள் I – இக்காலஇலக்கியம்/ Prose and Non Detailed Texts / French I	2	3	50	50	100	2	
II	23BAEEC1	**Ability Enhancement Compulsory Course - I** English for Communication	4	3	50	50	100	4	
	Generic Elective								
		Generic Elective - I	5+1/4+4	3	50	50	100	6	
III	**Discipline Specific Core Courses**								
	23BPHC01	Mechanics	4	3	50	50	100	4	6
	23BPHC01P	Mechanics - Practical	4	3	50	50	100	2	
	23BPHC02	Waves and Optics	4	3	50	50	100	4	6
	23BPHC02P	Waves and Optics - Practical	4	3	50	50	100	2	
IV	23BVBNC1/ 23BVBNS1/ 23BVBSP1	**Skill Enhancement Course – Value Based Course Elective I-** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1	
		Games – Practical	1		-	-	-		
			29/31				**Total**	**28/25**	
		Second Semester							
I	23BLT002/ 23BLH002/ 23BLF002	பொதுத்தமிழ்தாள் II – அறஇலக்கியம்/ Grammar, Translation and General Essay / French II	2	3	50	50	100	2	
II	23BAEES1	**Ability Enhancement Compulsory Course - II** Environmental Studies	4	3	50	50	100	4	
	Generic Elective								
		Generic Elective II							
	23BENGE2A/ 23BENGE2B/ 23BENGE2C/ 23BENGE2D	**Introduction to Literature / British Literature / Modern Indian Literature / New Literatures in English**	5+1	3	50	50	100	6	
III	**Discipline Specific Core Courses**								
	23BPHC03	Mathematical Physics-I	4	3	50	50	100	4	6
	23BPHC03P	Mathematical Physics – I - Practical	4	3	50	50	100	2	
	23BPHC04	Thermal Physics	4	3	50	50	100	4	6
	23BPHC04P	Thermal Physics - Practical	4	3	50	50	100	2	
IV		**Skill Enhancement Course**							
	23BVBNC2/ 23BVBNS2/ 23BVBSP2	**Value Based Course Elective I -** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1	
		Games – Practical	1		-	-	-		
			29/31				**Total**	**28/25**	

Part	Subject Code	Name of paper / Component	Hours of instruction / week	Scheme Examination					
				Duration of exam	CIA	CE	Total	Credit	
		Third Semester							
I	23BLT003/ 23BLH003/ 23BLF003	பொதுத்தமிழ்தாள் III – சமயஇலக்கியம் / Ancient and Modern Poetry / French III	2	3	50	50	100	2	
II	**Generic Elective**								
		Generic Elective III	5+1/4+4	3	50	50	100	6	
III	**Discipline Specific Core Courses**								
	23BPHC05	Mathematical Physics - II	4	3	50	50	100	4	6
	23BPHC05P	Mathematical Physics - II - Practical	4	3	50	50	100	2	
	23BPHC06	Electricity, Magnetism and Electromagnetism	4	3	50	50	100	4	6
	23BPHC06P	Electricity, Magnetism and Electromagnetism - Practical	4	3	50	50	100	2	
IV	**Skill Enhancement Courses**								
	23BSBCS1	**Skill Based Compulsory Course I** Communication Skills	4P	3	50	50	100	2	
		Skill Based Elective Course II	4P	3	50	50	100	2	
	23BVBNC3/ 23BVBNS3/ 23BVBSP3	**Value Based Course Elective I -** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1	
		Value Based Course Elective II	2	-	100	-	100	2	
			34/36				**Total**	**30/27**	
		Fourth Semester							
I	23BLT004/ 23BLH004/ 23BLF004	பொதுத்தமிழ்தாள் IV – சங்கஇலக்கியம்/ Introduction to Functional Hindi and Journalism / French IV	2	3	50	50	100	2	
II	**Generic Elective**								
		Generic Elective IV	5+1/4+4	3	50	50	100	6	
III	**Discipline Specific Core Courses**								
	23BPHC07	Elements of Modern Physics	4	3	50	50	100	4	6
	23BPHC07P	Elements of Modern Physics - Practical	4	3	50	50	100	2	
	23BPHC08	Analog Systems and Applications	4	3	50	50	100	4	6
	23BPHC08P	Analog Systems and Applications – Practical	4	3	50	50	100	2	
IV	**Skill Enhancement Courses**								
	23BSBSS1	**Skill Based Compulsory Course III** Soft Skills	4P	3	50	50	100	2	
		Skill Based Elective Course IV	4P	3	50	50	100	2	
	23BVBNC4/ 23BVBNS4/ 23BVBSP4	**Value Based Course Elective I -** NCC/NSS/Sports	3/2	2	60	40	100	4/1/1	
		Value Based Course Elective III	2	-	100	-	100	2	
			34/36				**Total**	**30/27**	
	Internship during Summer Vacation for 30 days								

Part	Subject Code	Name of paper / Component	Hours of instruction/ week	Scheme Examination					
				Duration of exam	CIA	CE	Total	Credit	
		Fifth Semester							
Discipline Specific Core Courses									
III	23BPHC09	Quantum Mechanics and Applications	4	3	50	50	100	4	6
	23BPHC09P	Quantum Mechanics and Applications - Practical	4	3	50	50	100	2	
	23BPHC10	Solid State Physics	4	3	50	50	100	4	6
	23BPHC10P	Solid State Physics - Practical	4	3	50	50	100	2	
	23BPHC11	Nuclear and Particle Physics	5+1	3	50	50	100		6
	Discipline Specific Elective Courses								
	23BPHDE1	**DSE – I** Project/Internship	1	3	50	50	100		**6**
	23BPHDE2- 23BPHDE4	**DSE – II** Theory + Practical/ Theory + Tutorial	4+4/5+1	3	50	50	100		**6**
IV	**Skill Enhancement Courses**								
	23BVBNC5/ 23BVBNS5/ 23BVBSP5	**Value Based Course Elective I** - NCC/NSS/Sports	3/2	2	60	40	100		**4/1/1**
			31/28				**Total**		**34/31**
		Sixth Semester							
3	**Discipline Specific Core Courses**								
	23BPHC12	Digital Systems and Applications	4	3	50	50	100	**4**	**6**
	23BPHC12P	Digital Systems and Applications – Practical	4	3	50	50	100	**2**	
	23BPHC13	Statistical Mechanics	4	3	50	50	100	**4**	**6**
	23BPHC13P	Statistical Mechanics – Practical	4	3	50	50	100	**2**	
	Discipline Specific Elective Course								
	23BPHDE5 – 23BPHDE7	**DSE – III** Theory + Practical/ Theory + Tutorial	4+4/5+1	3	50	50	100		**6**
	23BPHDE8 – 23BPHDE10	**DSE – IV** Theory + Practical/ Theory + Tutorial	4+4/5+1	3	50	50	100		**6**
IV	**Skill Enhancement Courses**								
	23BVBNC6/ 23BVBNS6/ 23BVBSP6	**Value Based Course Elective I** - NCC/NSS/Sports	3/2	2	60	40	100		**4/1/1**
			28/32				**Total**		**28/25**
							Over all Total		**178/160**

- **Ability Enhancement Compulsory Courses**
    - English for Communication
    - Environmental Studies
- **Skill Enhancement Courses,** are Skill Based and / or Value Based which are aimed at providing hands on training, competencies, skills etc. and may be opted by the students from the electives offered by the departments or from SWAYAM MOOCs / NPTEL

Skill Based Courses offered by Department of Physics

- **Skill Based Compulsory Courses I - 23BSBCS1-Communication Skills** during 3rd semester
- **Skill Based Compulsory Courses III – 23BSBSS1 – Soft Skills** during 4th semester
- **Skill Based Courses (II/IV) offered by Department of Physics**

S. No	Skill Based Elective Courses		Semester	Hours of Instruction	Credit/ Course
1.	23BPHSE1	Electrical Circuit and Network Skills	3	4P	2
2.	23BPHSE2	Applied Optics			
3.	23BPHSE3	Weather Forecasting			
4.	23BPHSE4	Renewable Energy and Energy Harvesting	4		2
5.	23BPHSE5	Computational Physics Skills			
6.	23BPHSE6	Basic Instrumentation Skills			

- **Value Based Courses –Elective I**

Value Based Courses	Subject Code	Semester	No. of Credits
NCC/	23BVBNC1-6/	1-6	24
NSS/	23BVBNS1-6/		6
Sports	23BVBSP1-6		6

- **Value Based Courses –Elective II/III offered by Department of Physics**

Value Based Courses	Subject Code	Semester	Hours of Instruction	No. of Credits
Geographic Information System	**23BPHVB1**	**3&4**	**2**	**2**

➢ **Discipline Specific Elective Courses** should be related to their own core which may be from SWAYAM MOOCs / NPTEL also

- All the courses have 6 credits with 4 hours of theory and 4 hours of practical or 5 hours of theory and 1 hour of Tutorials.

S.No	DSE Courses		Semester	Hours of Instruction Theory + Practical / Theory + Tutorial	Credits/ Course	
	Discipline Specific Elective (DSE) - I					
1.	23BPHDE1	Project / Internship	5	1	6	
	Discipline Specific Elective (DSE) - II					
2.	23BPHDE2	Experimental Techniques	5	4	4	6
	23BPHDE2P	Experimental Techniques-Practical	5	4	2	
3.	23BPHDE3	Physics of Earth	5	5+1	6	
4.	23BPHDE4	Medical Diagnostic Equipments	5	5+1	6	

S.No	DSE Courses		Semester	Hours of Instruction Theory + Practical / Theory + Tutorial	Credits/ Course	
	Discipline Specific Elective (DSE) - III					
5.	**23BPHDE5**	Biological Physics	6	5+1	6	
6.	**23BPHDE6**	Physics of Devices and Communication	6	4	4	6
	23BPHDE6P	Physics of Devices and Communication –Practical	6	4	2	
7.	**23BPHDE7**	Nanomaterials and Applications	6	5+1	6	
	Discipline Specific Elective (DSE) - IV					
8.	**23BPHDE8**	Materials Science	6	4	4	6
	23BPHDE8P	Materials Science-Practical	6	4	2	
9.	**23BPHDE9**	Spectroscopy	6	5+1	6	
10.	**23BPHDE10**	Embedded Systems: Introduction to Microcontroller	6	5+1	6	

- **Generic Elective Courses** offered for other disciplines / departments
  - A Core Course offered in a Discipline / Subject may be offered as a Generic Elective for other departments.

S. No	Generic Elective Courses		Semester	Hours of Instruction Theory + Practical / Theory + Tutorial	Credits
1.	**23BPHGE1**	Applied Physics	1	4+4	6
2.	**23BPHGE2**	Basics of Physics	3	4+4	6
3.	**23BPHGE3**	Microprocessor and its Interfacing	3/4	5+1	6
4.	**23BPHGE4**	Materials Science	3/4	5+1	6

A core course offered in a Discipline/subject may be offered as a Generic Elective for other departments.

Total credits to earn the degree

1. Part I components - 8 Credits (Languages)
2. Part II components – 32 Credits (Ability Enhancement Compulsory Courses – 8 Credits and Generic Elective Courses – 24 Credits)
3. Part III components - 102 Credits (Discipline Specific Core Courses – 78 Credits and Discipline Specific Elective Courses - 24 Credits)
4. Part IV Components –36 /18 Credits (Skill Enhancement Courses – Skill Based Courses – 8 Credits, Value Based Courses Elective I (NCC/NSS/Sports) –24 / 6 / 6, Value Based Elective Courses II& III – 4)
5. **Minimum One Course should be from SWAYAM MOOCs/ NPTEL.**

One to 4 Courses may be from SWAYAM MOOCs/NPTEL for Credit Transfer in DSE/ Generic Elective Courses.

Mechanics

SEMESTER I | **Hours of Instruction/week : 4**
23BPHC01 | **No. of Credits: 4**

Course Objectives:

1. To enable the students to understand the basic concepts of dynamics, energy conservation
2. To understand the concepts of gravitation and elasticity
3. To acquire the knowledge on simple harmonic motion

Unit 1 Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse — 12

Unit 2 Energy and its conservation: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. — 12

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit 3 Elasticity

Stress, Strain, Elastic limit, Hooke's law, Moduli of Elasticity, Torsion, Expression of torque per unit twist of a cylinder, Determination of rigidity modulus, Static torsion method, Work done in twisting a wire, Bending Moment, Expression for bending moment, Cantilever, Bending of beams of a rectangular Bar - Uniform and Non uniform bending, Koening's method for 'q' Uniform and Non uniform bending. — 12

Unit 4 Rotational Dynamics: Angular momentum of a particle and system of particles. Torque, Principle of conservation of angular momentum. Rotation about a fixed axis, Moment of Inertia, Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. — 12

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube

Unit 5 Gravitation and Central Force Motion: Law of gravitation, Gravitational Potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. — 12

Total Hours — 60

Course Outcomes:

1. Understand laws of motion and their application to various dynamical situations, notion of inertial frames and concept of Galilean invariance.
2. Learn the concept of conservation of energy and apply them to basic problems.
3. Understand the principles of elasticity through the study of Young Modulus and rigidity modulus.
4. Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping.
5. Apply Kepler's law to describe the motion of planets and satellite in circular orbit, through the study of law of Gravitation.

Text Books:

1. An Introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, Vol.1, C.Kittel, W.Knight, M. A. Ruderman, 1973, McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning Pvt Ltd.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education.

Reference Books:

1. Mechanics, D.S. Mathur,2000, S. Chand and Company Limited.
2. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
3. Physics for Scientists and Engineers with Modern Physics, J.W. Jewett, R.A. Serway, 2010, Cengage Learning Pvt Ltd.
4. Theoretical Mechanics, M.R. Spiegel, 2008, Tata McGraw Hill.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	H	L	H	H	-	H	H	-	-	H	H	H	H
CO2	H	L	H	H	-	H	H	-	-	H	H	H	H
CO3	H	L	H	H	-	M	H	-	-	H	H	H	H
CO4	H	L	H	H	L	H	H	-	-	H	H	H	H
CO5	H	L	M	H	L	M	H	-	-	H	H	H	H

Mechanics - Practical

SEMESTER I
23BPHC01P

Hours of Instruction/week : 4
No. of Credits: 2

Course Objectives :

1. To demonstrate the effect of magnetic field on current carrying conductors
2. To calibrate a voltmeter or ammeter
3. To analyze the effects of refractive index of a medium using optical instruments

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. Young's Modulus, Non -Uniform Bending, Koening's method
3. Young's Modulus, Uniform Bending, Koening's method
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia /Torsional Pendulum.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water/liquid by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by static torsion.
10. To determine the Youngs modulus of a beam using cantlilever static/dynamic methods.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Total Hours 60

Course Outcomes:

1. Measure length, diameter using vernier caliper, screw gauge and travelling microscope
2. Measure Young's modulus and rigidity modulus of the materials using different techniques method.
3. Determine the rigidity modulus of the wires using different methods
4. Find the viscosity of liquids
5. Determine the g using different methods

Reference Books:

1. Advanced Practical Physics for Students, B.L. Flint and H.T. Worsnop, 1971, Asia, Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted, 1985, Heinemann Educational Publishers.
3. Engineering Practical Physics, S.Panigrahi, B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
4. A Text Book of Practical Physics, Indu Prakash and Ram Krishna, 11th Edition, 2011, Kitab, Mahal, New Delhi.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	H	M	H	H	H	H	M	M	L	H	H	H	M
CO2	H	M	H	H	H	H	M	M	-	H	H	H	M
CO3	H	M	H	H	H	H	M	M	-	H	H	H	M
CO4	H	M	H	H	H	H	M	H	-	H	H	H	M
CO5	H	M	H	H	H	H	M	M	-	H	H	H	M

Waves and Optics

SEMESTER I **Hours of Instruction/week : 4**
23BPHC02 **No. of Credits: 4**

Course Objectives:

1. To understand superposition principle and analyze Lissajous figures
2. To learn about wave motion, and its properties
3. To explain the Physics of polarization, interference and diffraction.

Unit 1 Oscillations: Simple Harmonic Oscillations. : Linearity & Superposition Principle, Beats, Lissajous and their uses Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values.	12
Unit 2 Wave Motion: 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. nature of light. Definition and Properties of wave front. Huygens Principle.	12
Unit 3 Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). **Michelson's Interferometer:** Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.	14
Unit 4 Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and 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	12
Unit 5 Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization	10
Total Hours	**60**

Course Outcomes:

1. Understand the principle of superposition of waves, so thus describe the formation of standing waves
2. Apply basic knowledge of principles and theories about the behavior of light and the physical environment to conduct experiments
3. Use the principles of wave motion and its interference and understand the working of Michelson Interferometer, its use.
4. Explain the Physics of diffraction
5. Explain the Physics of polarization and transverse nature of light

Text Books:

1. A Text Book of Optics,Brijlal & Subramaniam, 2006,S.Chand & Co.
2. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill.
3. Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
4. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications.
5. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	M	L	M	H	M	-	M	H	H	L	M
CO2	H	L	M	L	M	L	M	-	M	H	H	L	M
CO3	H	L	M	M	M	H	M	-	M	H	H	M	M
CO4	H	L	M	M	M	H	M	-	M	H	H	M	M
CO5	H	L	M	M	M	L	M	-	M	H	H	M	M

Waves and Optics -Practical

SEMESTER I | **Hours of Instruction/week : 4**
23BPHC02P | **No. of Credits: 2**

Course Objectives :

1. To determine properties of light using prism and grating
2. To find the resolving power of prism and grating
3. To study superposition of light waves

1. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda^2 - T$ Law.
2. To study Lissajous Figures
3. To determine the Refractive Index of the Material of a Prism using Sodium Light.
4. To determine Dispersive Power of the Material of a Prism using Mercury Light
5. To determine the value of Cauchy Constants.
6. To determine the Resolving Power of a Prism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the wavelength of Laser light using Diffraction of Single Slit.
9. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
10. To determine the Resolving Power of a Plane Diffraction Grating.

Total Hours 60

Course Outcomes:

1. Gain hands-on experience of using various optical instruments
2. Measure wavelength of light using various methods
3. Measure resolving power of optical equipment such as prism and grating
4. Analyze Lissajous Figures
5. Verify laws of vibration

Reference Books:

1. Advanced Practical Physics for Students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, Indu Prakash and Ram krishna, 11th Edition, 2011, Kitab Mahal.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO 8	PO9	PO10	PSO1	PSO2	PSO3
CO1	H	-	M	L	L	H	M	-	L	H	H	H	H
CO2	H	-	M	L	L	H	M	-	L	H	H	H	H
CO3	H	-	M	L	L	H	M	-	L	H	H	H	M
CO4	H	-	M	L	L	H	M	-	L	H	H	H	L
CO5	H	-	M	L	L	H	M	-	L	H	H	H	L

Mathematical Physics - I

SEMESTER II | **Hours of Instruction/week : 4**

23BPHC03 | **No. of Credits: 4**

Course Objectives:

1. To gain knowledge of vector calculus in order to solve Physics problems.
2. To gain knowledge of vectors, vector calculus in order to solve Physics problems.
3. To learn about the curvilinear coordinates, probability distribution functions and Dirac delta functions.

Unit 1 Calculus: **Recapitulation:** Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions, Intuitive ideas of continuous and differentiable functions and Plotting of curves. Approximation: Taylor and binomial series (statements only). First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Particular Integral.	12
Unit 2 Vector Calculus: **Vector Differentiation:** Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **Vector Integration:** Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	12
Unit 3 Orthogonal Curvilinear Coordinates: Curvilinear coordinates, Transformation of coordinates, Orthogonal Curvilinear coordinates, Unit vectors in curvilinear systems, cylindrical coordinates, Spherical coordinates, Curl, divergence and gradient in cylindrical and spherical coordinates.	14
Unit 4 Introduction to Probability: Independent random variables: Probability distribution functions; Binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.	12
Unit 5 Dirac Delta function and its properties and Special Functions: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.	10
Total Hours	**60**

Course Outcomes:

1. Distinguish homogeneous and non-homogeneous equation, solve homogeneous first and second order differential equation.
2. Knowledge on vector calculus and its physical significance, to solve various problems in Physics.
3. Transform coordinates from Cartesian to cylindrical or spherical coordinates and solve problems in curvilinear coordinates.
4. Analyse probability distribution function.
5. Knowledge on Dirac delta function

Text Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An Introduction to Ordinary Differential Equations, E.A. Coddington, 2009, PHI learning Pvt. Ltd.
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical Methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.

Reference Books:

1. Advanced Engineering Mathematics, D.G. Zill, W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
2. Mathematical Physics, Goswami, 1st edition, Cengage Learning Pvt. Ltd.
3. Engineering Mathematics, S.Pal, S.C. Bhunia, 2015, Oxford University Press
4. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
5. Essential Mathematical Methods, K.F.Riley, M.P.Hobson, 2011, Cambridge Univ. Press.
6. Mathematical Physics, H.K. Dass and R. Verma,1997, S. Chand & Company

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PSO 1	PSO 2	PSO 3
CO1	H	L	M	M	L	L	M	M	-	H	H	L	M
CO2	H	L	M	M	L	L	M	M	-	H	H	L	M
CO3	H	L	M	M	L	L	M	M	-	H	H	L	M
CO4	H	L	M	M	L	L	M	M	-	H	H	L	M
CO5	H	L	M	M	L	L	M	M	-	H	H	L	M

Mathematical Physics – I - Practical

SEMESTER II — **Hours of Instruction/week : 4**

23BPHC03P — **No. of Credits: 2**

Course Objectives :

1. To learn computer architecture and basics of scientific computing.
2. To learn basics of programming in C/C++.
3. To solve simple problems and differential equations using programming.

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. Go to 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:	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 $\alpha = tan\alpha; I = I_0(\frac{sin\alpha}{\alpha})^2$ 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, tan θ, 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.
Solution of Ordinary Differential Equations (ODE),First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $\frac{dx}{dt} = y + x - \frac{x^3}{3}; \frac{dy}{dx} = -x$ 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 $0 \leq t \leq 15$

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

Total Hours 60

Course Outcomes:

1. Learn basics of computation.
2. Learn fundamentals of programming in C/C++.
3. Write and execute simple programs.
4. Solve trigonometric functions.
5. Understand to solve first order differential equations using programming.

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill.
3. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.
4. A First Course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning Pvt. Ltd.
5. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007 , Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to Computational Physics, T.Pang, 2nd Edition, 2006,Cambridge Univ. Press.
8. Computational Physics, Darren Walker, 1st Edition, 2015, Scientific International Pvt. Ltd.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	H	L	H	H	H	L	M	L	L	H	H	H	H
CO2	H	L	H	H	H	M	M	L	L	H	H	H	H
CO3	H	L	H	H	H	M	M	L	L	H	H	H	H
CO4	H	L	H	H	H	H	M	L	L	H	H	H	H
CO5	H	L	H	H	H	M	M	L	L	H	H	H	H

Thermal Physics

SEMESTER II | **Hours of Instruction/week : 4**
23BPHC04 | **No. of Credits: 4**

Course Objectives:

1. To understand various thermo dynamical concepts
2. To learn about Maxwell's thermodynamic relations
3. To learn about the real gas equations

Unit 1

Introduction to Thermodynamics: Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work and Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, Applications of First Law: General Relation between C_P and C_V, Work done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. **12**

Unit 2

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of work into heat and heat into work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, second Law of Thermodynamics: Kelvin Planck and Clausius Statements and their equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **12**

Unit 3

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of increase in Entropy. Entropy changes in reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **14**

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy - their definitions, properties and applications. First and second order Phase Transitions with examples

Unit 4 Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations: Maxwell's Relations, Clausius Clapeyron equation, Values of Cp-Cv, T dS Equations, Joule-Kelvin coefficient for Ideal and Van der Waal Gases, Energy equations, Change of Temperature during Adiabatic Process. **12**

Unit 5 Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Boyle Temperature. Van der Waal's Equation of State for real Gases. Values of Critical Constants P-V Diagrams. Joule's Experiment. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Inversion Temperature , Joule-Thomson Cooling. **10**

Total Hours **60**

Course Outcomes:

1. Comprehend the basic concepts Zeroth and First Law of Thermodynamics and its applications
2. Understand the second law of thermodynamics and its applications.
3. Learn about entropy, its properties, the thermodynamic potentials and their physical interpretations.
4. Understand Maxwell's thermodynamic relations and their applications .
5. Learn about the real gas equations, Van der Waal equation of state, the Joule Thomson effect.

Text Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Heat and Thermodynamics, D.S.Mathur , 2021, S.Chand and Sons
3. A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press.

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill.
2. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
3. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PSO 1	PSO 2	PSO 3
CO1	H	L	M	M	L	-	M	M	-	H	H	L	M
CO2	H	L	M	M	L	-	M	M	-	H	H	L	M
CO3	H	L	M	M	L	-	M	M	-	H	H	L	M
CO4	H	L	M	M	L	-	M	M	-	H	H	L	M
CO5	H	L	M	M	L	-	M	M	-	H	H	L	M

Thermal Physics - Practical

SEMESTER II **Hours of Instruction/week : 4**

23BPHC04P **No. of Credits: 2**

Course Objectives :

1. To understand the heat flow-conduction
2. To measure thermal conductivity of different materials using different experiments/set-ups
3. To understand heat flow-radiation

    1. Specific Heat Capacity of a Liquid- Joule's Calorimeter.
    2. Thermal Conductivity of a bad conductor-Lee's Disc.
    3. Thermal conductivity of Copper rod – Searle's Apparatus.
    4. Newton's law of cooling.
    5. To study the variation of Thermo-emf of a Thermocouple with difference of temperature of its two junctions.
    6. Viscosity of a Hot liquid-Red Wood Viscometer.
    7. Coefficient of apparent expansion of a liquid by pyknometer.
    8. Determination of Stefan's constant.
    9. Determination of specific heat of water
    10. Heat Dissipation Through a Copper Plate or How to Speed up Cooling of Tea
    11. Comparing Thermal Conductivity of Copper, Aluminium and Brass
    12. Change in Internal Energy by Performing Work: Drilling in Wood

Total Hours 60

Course Outcomes:

1. Learn to verify Joule's Law
2. Learn to verify Newton's Law of cooling
3. Determine Thermal conductivity of bad conductors
4. Determine Thermal conductivity of good conductor
5. Understand the working of a thermocouple

Reference Books:

1. Advanced Practical Physics for Students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
4. Engineering Practical Physics, S.Panigrahi, B.Mallick, 2015, Cengage Learning Pvt Ltd.
5. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Pub.
6. A Text book of Practical Physics-Part-I, Ouseph, RangaRajan, S.Viswanathan, 2003, Printers & Publishers Pvt. Ltd.
7. http://physicsexperiments.eu/1767/experimental-determination-of-specific-heat-of-water

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	H	M	H	M	H	H	H	H	-	M	H	H	M
CO2	H	M	H	M	H	H	H	H	-	M	H	H	M
CO3	H	M	H	M	H	H	H	H	-	M	H	H	M
CO4	H	M	H	M	H	H	H	H	-	M	H	H	M
CO5	H	M	H	M	H	H	H	H	-	M	H	H	M

Mathematical Physics -II

SEMESTER III **Hours of Instruction/week : 4**

23BPHC05 **No. of Credits: 4**

Course Objectives:

1. To learn the basic concepts of Fourier series and special functions
2. To understand the concepts of theory of errors
3. To acquire the knowledge on partial differential equation

Unit 1 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.	12
Unit 2 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 and Bessel, Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and $J_1(x)$) and Orthogonality.	12
Unit 3 Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).	14
Unit 4 Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.	12
Unit 5 Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes, Diffusion Equation.	10
Total Hours	**60**

Course Outcomes:

1. Learn Fourier analysis of periodic functions.
2. Learn about the special function such as Legendre and Bessel functions
3. Understand the Beta, Gamma function and their applications
4. Know about basic theory of errors, analysis, estimation with examples in Physics
5. Acquire knowledge on methods to solve partial differential equations in Physics

Text Books:

1. Mathematical Physics with Classical Mechanics,Satya Prakash, 2014,Sultan Chand & Sons
2. Mathematical Physics B.D.Gupta, 2009, Vikas Publishing House Pvt Ltd
3. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
4. Fourier Analysis, M.R.Spiegel, 2004, Tata McGraw-Hill.
5. Mathematics for Physicists , Susan M. Lea, 2004, Thomson Brooks/Cole.
6. Differential Equations, George F.Simmons, 2006, Tata McGraw-Hill.

Reference Books:

1. Partial Differential Equations for Scientists & Engineers, S.J.Farlow, 1993, DoverPub.
2. Engineering Mathematics, S.Pal and S.C.Bhunia,2015, Oxford University Press
3. Mathematical Methods for Scientists & Engineers, D.A.McQuarrie, 2003, VivaBooks

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	H	H	-	L	L	H	-	H	M	H	H
CO2	H	L	H	H	-	H	H	M	-	H	M	H	H
CO3	H	L	H	H	-	H	H	M	-	H	M	H	H
CO4	H	L	H	H	-	H	H	-	-	H	H	H	H
CO5	H	L	M	H	-	H	H	M	-	H	H	H	H

Mathematical Physics-II - Practical

SEMESTER III | **Hours of Instruction/week : 4**

23BPHC05P | **No. of Credits: 2**

Course Objectives:

1. To learn the basics of the Scilab software
2. To analyze the curve fitting using Scilab software
3. To solve special functions and ODE using Scilab software

Topics	Description with Applications
Introduction to Numerical Computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, initializing variables in Scilab, Multidimensional arrays, Sub-array, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Ohms law to calculate R, Hooke's law to calculate spring Constant Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions using User defined functions in Scilab	Generating and plotting Legendre Polynomials Generating and plotting Bessel function

Solution of ODE
First order Differential equation Euler, modified Euler and Runge-Kutta second order methods
Second order differential equation Fixed difference method
Partial differential equations

First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DC source
- Newton's law of cooling
- Classical equations of motion

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Overdamped
- Critical damped
- Oscillatory
- Forced Harmonic oscillator
- Transient and Steady state solution

Apply above to LCR circuits also

Solve $x^2\frac{d^2y}{dx^2} - 4x(1+x)^2\frac{dy}{dx} + 2(1+x) = x^3$ with the boundary conditions at $x = 1, y = 1e^2, \frac{dy}{dx} = -3e^2 - 0.5$, in the range $1 \le x \le 3$. Plot y and $\frac{dy}{dx}$ against x in the given range on the same graph.

Partial Differential Equation:

- Wave equation
- Heat equation
- Poisson equation
- Laplace equation

Using Scicos/xcos

- Generating squarewave, sinewave, sawtooth wave
- Solution to harmonic oscillator
- Study of beat phenomenon
- Phase space plots

Total Hours 60

Course Outcomes:

1. Learn the basics of the Scilab software, their utility, advantages and disadvantages.
2. Solve the curve fitting using Scilab
3. Plot the Special functions using Scilab
4. Solve the Partial Differential Equations using Scilab.
5. Learn to generate square wave, sine wave, solution to harmonic oscillator.

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.FRiley, M.P.Hobson and S.J.Bence, 3rd ed., 2006, Cambridge University Press
2. Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
3. First course in complex analysis with applications, D.G.Zill and P.D.Shanahan, 940, Jones & Bartlett.
4. Computational Physics, D.Walker, 1st Edn.,2015, Scientific International Pvt. Ltd.,.

5. A Guide to MATLAB, B.R.Hunt, R.L.Lipsman, J.M.Rosenberg, 2014, 3rd Edn., Cambridge University Press.
6. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P.Saucez, C.V.Fernández, 2014, Springer
7. Scilab byexample, M.Affouf, 2012, Create Space Independent Publishing. Platform ISBN:978-1479203444
8. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair,2011, S.Chand & Company
9. Scilab Image Processing: Lambert M.Surhone,2010, Betascript Publishing

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	H	M	-	L	M	H	L	H	M	H	H
CO2	H	L	H	L	-	H	L	H	M	H	M	H	H
CO3	H	L	H	M	-	H	H	H	L	H	M	H	H
CO4	H	L	H	L	-	H	L	H	M	H	H	H	H
CO5	H	L	M	M	-	H	L	H	L	H	H	H	H

Electricity, Magnetism and Electromagnetism

SEMESTER III
23BPHC06

Hours of Instruction/week : 4
No. of Credits: 4

Course Objectives:

1. To learn the basic concepts of electricity and magnetism and their applications
2. To learn the prerequisites to understand electrodynamics phenomena
3. To gain knowledge about electromagnetism

Unit 1 Electric Field and Electric Potential Electric field: Electric field lines. Electric flux. Gauss' Law with applications to Charge distributions - spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.	**12**
Unit 2 Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.	**12**
Unit3 Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to Solenoid. Properties of **B**: curl and divergence, Vector Potential, Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.	**12**
Unit4 Electromagnetic Induction: Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.	**12**
Unit 5 Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.	**12**
Total Hours	**60**

Course Outcomes:

1. Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges
2. Understand the dielectric properties, magnetic properties of materials and the phenomena of electromagnetic induction.
3. Describe how magnetism is produced and list examples where its effects are observed
4. Describe the magnetic field produced by magnetic dipoles and electric currents and explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields
5. To relate the electric and magnetic field to each other and the electric charges to the current

Text Books:

1. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill.
2. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
3. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education.
5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J.H.Fewkes, J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill.
3. Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	M	M	L	M	M	L	M	M	H	L	L
CO2	H	L	M	M	L	M	M	L	M	M	H	L	L
CO3	H	L	M	M	L	M	M	L	M	M	H	L	L
CO4	H	L	M	M	L	M	M	L	M	M	H	L	L
CO5	H	L	M	H	L	M	M	L	M	M	H	L	L

Electricity, Magnetism and Electromagnetism - Practical

SEMESTER III **Hours of Instruction/week :4**

23BPHC06P **No. of Credits: 2**

Course Objectives :

1. To learn to use multimeter
2. To measure resistance, capacitance, inductance using different experiments/set-ups
3. To apply network theorems and Kirchoff's laws to study the electrical circuits

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Superposition, and Maximum power transfer theorems.
7. To determine coercivity and retentivity using Hysteresis
8. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
10. To determine self-inductance of a coil by Rayleigh's method.

Total Hours 60

Course Outcomes:

1. Learn to verify various laws in electricity and magnetism such as Lenz's law, Faraday's law
2. Learn about the construction, working of various measuring instruments
3. Able to verify various laws of circuit.
4. Determine coercive force and receptivity of a solenoid using Hysteresis
5. Determine resistance, capacitance and inductance using Potentiometer/Carey Foster bridge/LCR meter

Reference Books:

1. Advanced Practical Physics for Students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I.Prakash, Ram Krishna, 11th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
4. Engineering Practical Physics, S.Panigrahi, B.Mallick, 2015, Cengage Learning Pvt.Ltd.
5. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publishers.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	H	-	M	M	H	H	L	-	-	H	H	H	M
CO2	H	-	M	H	H	H	L	-	-	H	H	H	M
CO3	H	-	M	H	H	H	-	-	-	H	H	H	M
CO4	H	-	M	H	H	H	M	-	-	H	H	H	M
CO5	H	-	M	H	H	H	M	-	-	H	H	H	M

Elements of Modern Physics

SEMESTER IV — **Hours of Instruction/week : 4**

23BPHC07 — **No. of Credits: 4**

Course Objectives:

1. To acquire knowledge on the theory of relativity
2. To understand concept of quantum mechanics and wave packets
3. To understand the spontaneous , stimulated emission of radiation and basic lasing action

Unit 1 Relativity Special Theory of Relativity , Frames of reference , Postulates, Time Dilation, Doppler effect, Length contraction, Twin Paradox, relativistic momentum, relativistic mass, addition of velocities Variation of mass with velocity, Mass energy equivalence, energy and momentum, mass less particles , space-time .		**12**
Unit 2 Structure of Atom - I Bohr atom model, Postulates, Expression for energy of an electron, Bohr's theory of hydrogen spectrum, Energy levels and spectral series, effect of nuclear motion on atomic spectrum, Ritz combination principle, Bohr's correspondence principle, Excitation and ionization potential, Frank Hertz experiment.		**12**
Unit 3 Structure of Atom - II Sommerfeld's relativistic atom model, Modification in Bohr's theory, Fine structure of H line, Vector atom model, Coupling schemes, Magnetic dipole moment due to orbital motion of the electron, Magnetic dipole moment due to spin, Stern Gerlach experiment, Stark effect, Zeeman effect and Paschen Back effect (qualitative only).		**12**
Unit 4 Quantum Concepts Electromagnetic waves , Black body radiation, Photoelectric effect, light, X-rays, X-ray diffraction, Compton effect, Pair production, Photons and gravity , Gravitational red shift, Black holes. De Broglie waves, waves of probability , Wave description of particles by wave packets Phase velocity, group velocity and relation between them, Davisson-Germer experiment, group and Phase velocities Probability, Wave amplitude and wave functions		**12**
Unit 5 Lasers Absorption, Spontaneous and Induced emission, Population inversion, active medium, active centre, Characteristics of a Laser: Coherence length and Coherence time, Pumping mechanism, Gas lasers: He-Ne, Solid state lasers: Ruby, Dye laser: Rhodamine 6G.	**Total Hours**	**12** **60**

Course Outcomes

1. Analyze the effects of Relativity by Special Theory of Relativity
2. Understand the central concepts of quantum mechanics
3. Understanding of Bohr's theory
4. Gain knowledge Sommerfeld's relativistic atom model, vector atom model and splitting of energy levels
5. Understand the spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in detail

Text Books:

1. Concepts in Modern Physics, Arthur Beiser, 6th Edition, 2002, Tata McGraw Hill Publishers.
2. Spectroscopy-Atomic and Molecular, Gurudeep Chatwal and Shyam Anand,1987, Himalaya Publishing House.
3. A Text Book of Applied Physics, A.K.Jha, 2009, JK International Publishing House Pvt. Ltd
4. Molecular Structure and Spectroscopy, G. Aruldhas, 2004, Prentice, Hall of India Pvt.Ltd.

Reference Books:

1. Modern Physics, Murugeshan R, 2005, S.Chand and Company.
2. Fundamentals of Optics, Francis A. Jenkins and Maxvey E.White, 2000, McGraw Hill Book Co.
3. Physics for Engineers, M.R.Srinivasan, 1996, New Age International Pvt. Ltd. Publishers.

CO / PO	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	H	L	H	M	-	M	L	H	L	H	H	H	H
CO2	H	M	H	H	-	M	L	-	-	H	H	H	M
CO3	H	L	M	M	-	M	-	M	-	-	H	H	M
CO4	H	M	M	H	-	M	M	-	-	H	H	H	M
CO5	H	H	H	H	M	M	M	M	H	H	H	H	M

Elements of Modern Physics - Practical

SEMESTER IV
23BPHC07P

Hours of Instruction/week :4
No. of Credits: 2

Course Objectives :

1. To acquire knowledge on the diffraction
2. To familiarize quantum simulation
3. To verify the quantum concepts

1. To détermine work function of LED
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine the wavelength of laser source using diffraction of single slit.
4. To determine the value of e/m by Bar magnet.
5. To determine the wavelength of laser source using diffraction of double slits
6. Simulation of black body radiation
7. Simulation on construction of wavepackets
8. Simulation on Photo-electric effect
9. Simulation of mass variation with velocity
10. Influence of coherence in superposition of waves

Total Hours 60

Course Outcomes:

1. Learn to construct wave packet
2. Working with workfunction of LED
3. Understanding on LASER diffraction
4. Simulation of black body radiation and coherence
5. Understanding of photoelectric effect

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11^{th}Edn, 2011,Kitab Mahal

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO 8	PO9	PO10	PSO1	PSO 2	PSO 3
CO1	H	-	M	H	H	H	L	-	-	H	H	H	M
CO2	H	-	M	H	H	H	L	-	-	H	H	H	M
CO3	H	-	M	H	H	H	-	-	-	H	H	H	M
CO4	H	-	M	H	H	H	M	-	-	H	H	H	M
CO5	H	-	M	H	H	H	M	-	-	H	H	H	M

Analog Systems and Applications

SEMESTER IV
23BPHC08

Hours of Instruction/week : 4
No. of Credits: 4

Course Objectives:

1. To understand semiconductor diodes and their applications
2. To learn about transistors, their characteristics and their applications
3. To gain knowledge on opamp., it's characteristics and applications

Unit1: Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current flow mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.	10
Unit 2 Two-terminal Devices and their Applications: Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, Zener Diode , Voltage Regulation. Principle and structure of LEDs, Photodiode and Solar cell. **Bipolar Junction transistors:** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.	12
Unit 3 Amplifiers Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B and C Amplifiers. **Coupled Amplifier:** Two stage RC-coupled amplifier and its frequency response.	14
Unit 4 Feedback and Oscillators Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **Sinusoidal Oscillators:** Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley and Colpitts oscillator.	12
Unit 5 Operational Amplifiers and its applications Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **Applications**: Inverting and non-inverting amplifiers, Adder, Subtractor, Differentiator, Integrator, Wein bridge oscillator.	12
Total Hours	**60**

Course Outcomes:

1. Gaining knowledge in N- and P- type semiconductors and their properties.
2. Understanding formation of diodes, NPN and PNP transistors, their basic configurations.
3. Learning the biasing and equivalent circuits, and also about current and voltage gain coupled amplifiers.
4. Explain feedback, oscillatory circuits and their working.
5. Describe the fundamentals of operational amplifiers, different configurations, characteristics and applications

Text Books:

1. Principles of Electronics, V.K.Mehta, Rohit Mehta, 2008, S.Chand & Company.
2. A Textbook of Applied Electronics, R. S Sedha, 2006, S.Chand & Company Ltd.
3. Electronics: Analog & Digital, I. J. Nagrath, 2006, Prentice Hall of India.

Reference Books

1. Operational Amplifier and Linear Integrated Circuits, Ramakant A. Gayakwad, 2000, Prentice Hall of India.
2. Electronic Circuits: Handbook of Design & Applications, U.Tietze, C.Schenk, 2008, Springer.
3. Basic Electronics , B.L.Theraja,2006, S.Chand & Company.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO3
CO1	H	H	H	M	H	H	M	M	L	M	H	H	H
CO2	H	H	H	M	H	H	M	M	L	M	H	H	H
CO3	H	H	H	M	H	H	M	M	L	M	H	H	H
CO4	H	H	H	M	H	H	M	M	L	M	H	H	H
CO5	H	H	H	M	H	H	M	M	L	M	H	H	H

Analog Systems and Applications - Practical

SEMESTER IV **Hours of Instruction/week : 4**

23BPHC08P **No. of Credits: 2**

Course Objectives :

1. To construct and study frequency response of amplifier
2. To construct sinusoidal oscillator and measure frequency of oscillations
3. To study the characteristics and applications of op. amp.

1. To study the frequency response of voltage gain of a RC-coupled transistor amplifier
2. To design a Wien bridge oscillator for given frequency using an op-amp.
3. To study the Colpitt`s oscillator
4. To design a digital to analog converter (DAC) of given specifications.
5. To study the analog to digital convertor (ADC) IC.
6. To design an inverting amplifier using Opamp (741,351) for dc voltage of given gain
7. To design inverting amplifier using Opamp (741,351) and study its frequency response
8. To design non-inverting amplifier using Opamp (741,351) & study its frequency response
9. To add two dc voltages using Opamp in inverting and non-inverting mode
10. To investigate the use of an Opamp as a Differentiator.
11. To investigate the use of an Opamp as an Integrator.

Total Hours **60**

Course Outcomes:

1. Understanding working of amplifiers
2. Construct oscillators and study its performance
3. Construct inverting and non-inverting amplifiers using Opamp.
4. Construct differentiator and integrators using Opamp.
5. Construct DAC and ADC convertors

Reference Books:

1. Basic Electronics: A Text Lab Manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & Circuit Theory, R.L. Boylestad, L.D. Nashelsky, 2009, Pearson.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	H	M	H	L	M	H	M	L	M	M	H	H	H
CO2	H	M	H	L	M	H	M	L	M	M	H	H	H
CO3	H	M	H	L	M	H	M	L	M	M	H	H	H
CO4	H	M	H	L	M	H	M	L	M	M	H	H	H
CO5	H	M	H	L	M	H	M	L	M	M	H	H	H

Quantum Mechanics and Applications

SEMESTER V — **Hours of Instruction/week : 4**

23BPHC09 — **No.of Credits: 4**

Course Objectives:

1. To learn the basic concepts of Schrodinger equation
2. To understand the concepts of arbitrary potential and hydrogen-like atoms
3. To acquire the knowledge atoms in magnetic and electric fields

Unit 1 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 and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle, General solution of the time dependent Schrodinger equation, Position-momentum uncertainty principle.	**12**
Unit 2 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; Hermite polynomials; ground state, zero point energy & uncertainty principle.	**12**
Unit3 Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s,p, d,.. shells.	**12**
Unit 4 Atoms in Electric & 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. **Atoms in External Magnetic Fields**: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).	**12**
Unit 5 Many electron atoms: Pauli's Exclusion Principle. Symmetric & 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-Jcouplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).	**12**
Total Hours	**60**

Course Outcomes:

1. Understand the quantum theory formulation through Schrodinger equation.
2. Understanding the behavior of quantum particle encountering a barrier potential
3. Applications of Schrodinger equation to hydrogen atom
4. Learn the concept of electric and magnetic fields on atoms and understand the Stark effect and Zeeman Effect respectively.
5. Understand the basic concepts of quantum many body problems

Text Books:

1. A Textbook of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Leonard I.Schiff, 3rd Edn. 2010, Tata McGraw Hill.
3. Quantum Mechanics, G.Aruldhas, 2nd Edn.2002, PHI Learning of India.
4. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
5. Advanced Quantum Mechanics, Sathya Prakash, 5th edition, 2021, Kedar Nath and Ram Nath
6. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education.

Reference Books:

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

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	M	L	-	M	H	-	-	-	H	L	-
CO2	H	L	M	L	-	M	H	-	-	-	H	L	-
CO3	H	L	M	L	-	M	H	-	-	-	H	L	-
CO4	H	L	M	L	-	M	H	-	-	-	H	L	-
CO5	H	L	M	L	-	M	H	-	-	-	H	L	-

Quantum Mechanics and Applications-Practical

SEMESTER V
23BPHC09P

Hours of Instruction/week : 4
No.of Credits: 2

Course Objectives:

1. To understand the Schrodinger equation
2. To solve Schrodinger equation for ground state and the first excited state of an atom
3. To solve Schrodinger equation of molecule

Use C/C++/Scilab for solving the following problems based on quantum mechanics

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

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

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 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m= $0.511x10^6$ eV/c^2.

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

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

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

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 eVin all three cases.

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

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

For the anharmonic oscillator potential $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100MeV 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:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

Where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), r' = \frac{r - r_o}{r}$$

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=$940x10^6 eV/C^2$, D= 0.755501 eV,α = 1.44, r_o=0.131349Å

Total Hours **60**

Course Outcomes:

1. Solve Schrodinger equation for ground state of an atom
2. Understand the Schrodinger equation and its solution in first excited state of an atom
3. Solve Schrodinger equation for screened coulomb potential
4. Solve Schrodinger equation for an anharmonic oscillator potential
5. Determine the solution of Schrodinger equation for the vibrations of hydrogen

Reference Books:

1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-Hill Publication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H.Pressetal., 3rdEdn., 2007, Cambridge University Press.
3. An Introduction to Computational Physics,T.Pang,2ndEdn.,2006,CambridgeUniv.Press
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A.Vande Wouwer, P.Saucez, C.V. Fernández. 2014 Springer.
5. Scilab (A Free Software to Matlab): H.Ramchandran, A.S.Nair, 2011, S.Chand & Co.
6. A Guide to MATLAB, B.R.Hunt, R.L.Lipsman, J.M.Rosenberg, 2014, 3rd Edn., Cambridge University Press
7. Scilab Image Processing: L.M.Surhone,2010, Betascript Publishing ISBN:978-6133459274.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	H	H	L	H	H	L	-	H	H	H	M
CO2	H	L	H	H	L	H	H	L	-	H	H	H	M
CO3	H	L	H	H	L	H	H	L	-	H	H	H	M
CO4	H	L	H	H	L	H	H	L	-	H	H	H	M
CO5	H	L	M	H	L	H	H	L	-	H	H	H	M

Solid State Physics

Semester V | **Hours of Instruction/week : 4**

23BPHC10 | **No. of Credits: 4**

Course Objectives:

1. To understand the types of solids and their classifications
2. To gain knowledge on Magnetic and Dielectric properties based on Band theory
3. To acquire knowledge on Superconductivity and its theory

Unit 1 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.	**10**
Unit 2 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^3 law.	**10**
Unit 3 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.	**15**
Unit 4 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.	**15**
Unit 5 Elementary Band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (Four probe method) & Hall coefficient	**10**
Total Hours	**60**

Course Outcomes:

1. Distinguish between Amorphous and Crystalline solids.
2. Explain thermal, acoustic and optical properties of solids.
3. Explain symmetry elements, Bruilloin zone and comment on elementary lattice dynamics.
4. Distinguish magnetic material with relevant theories.
5. Explain semiconductors based Band theory

Text Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning Pvt. Ltd.

Reference Books

1. Solid State Physics, H. Ibach, H. Luth, 2009, Springer.
2. Fundamentals of Solid State Physics, B.S.Saxena, R.C, Gupta,P.N. Saxena, J.N.Mandal,28/e, 2016 Pragathy Prakashan.
3. Elementary Solid State Physics Principles and Applications, M. Ali Omar, 1999, Pearson India.
4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	H	M	M	L	H	M	M	H	M	M	H	H	M
CO2	H	M	M	L	H	M	M	H	M	M	H	H	M
CO3	H	M	M	L	H	M	H	H	M	M	H	H	M
CO4	H	M	M	L	H	M	H	H	M	M	H	H	M
CO5	H	M	M	L	H	M	H	H	M	M	H	H	M

Solid State Physics - Practical

SEMESTER V **Hours of Instruction/week : 4**

23BPHC10P **No. of Credits: 2**

Course Objectives :

1. To determine the magnetic properties of a material.
2. To determine the dielectric properties of a material.
3. To find the resistivity and Hall coefficient of a semiconductor.

1. Measurement of susceptibility of paramagnetic solution (Quincke`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 Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150°C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Total Hours 60

Course Outcomes:

1. Classify magnetic material based on susceptibility.
2. Measure electrical and optical dielectric constant of a material.
3. Experience hysteresis behavior of ferroelectric and ferromagnetic material.
4. Determine energy loss from hysteresis.
5. Distinguish p and n semiconductor through Hall coefficient and determine band gap.

Reference Books:

1. Advanced Practical Physics for Students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ram Krishna, 11th Ed., 2011, Kitab Mahal.
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO 2	PSO 3
CO1	H	M	M	L	H	M	-	-	-	M	H	H	M
CO2	H	M	M	L	H	M	-	-	-	M	H	H	M
CO3	H	M	M	L	H	M	-	-	-	M	H	H	M
CO4	H	M	M	L	H	M	-	-	-	M	H	H	M
CO5	H	M	M	L	H	M	-	-	-	M	H	H	M

Nuclear and Particle Physics

SEMESTER V
23BPHC11

Hours of Instruction/week : 5+ Tutorial :1
No. of Credits: 6

Course Objectives:

1. To gain knowledge on general properties of a nucleus, nuclear decay and nuclear reactions
2. To learn about semi-empirical mass formula, its applications and nuclear models
3. To study about principle, working of detectors and to learn about the elementary particles, quantum numbers and their conservation

Unit 1 General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.	**18**
Unit 2 Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.	**18**
Unit 3 Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) Beta decay: energy kinematics for beta decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **Nuclear Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, Concept of compound and direct Reactions	**20**
Unit 4 Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors for charge particle and photon detection (concept of charge carrier and mobility). **Particle Accelerators:** Van-de Graff Generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	**18**
Unit 5 Particle Physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.	**16**
Total Hours	**90**

Course Outcomes:

1. Learn the ground state properties of a nucleus such as radius and the mass number, average density, range of force, saturation property, stability curve, the concepts of packing fraction and binding energy, binding energy per nucleon vs. mass number graph, explanation of fusion and fission from the nature of the binding energy graph.
2. Know about the nuclear models and their roles in explaining the ground state properties of the nucleus.

3. Learn about the process of radioactivity, the radioactive decay law, the emission and properties of alpha, beta and gamma rays and Geiger-Nuttal law
4. Learn the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws
5. Learn some basic aspects of interaction of nuclear radiation with matter and to learn about the detectors of nuclear radiations- the Geiger-Mueller counter, the scintillation counter, the photo-multiplier tube, the solid state and semiconductor detectors.

Text Books:

1. Introductory Nuclear Physics, Kenneth S. Krane, Wiley India Pvt. Ltd.,.
2. Concepts of Nuclear Physics, Bernard L. Cohen, 1998,Tata Mcgraw Hill.
3. Introduction to the Physics of Nuclei &Particles, R.A. Dunlap., 2004, Thomson Asia.
4. Introduction to High Energy Physics, D.H. Perkins, 2000, Cambridge Univ. Press.
5. Introduction to Elementary Particles, D. Griffith, 1987, John Wiley & Sons.

Reference Books:

1. Quarks and Leptons, F. Halzen and A.D. Martin, 2008, Wiley India.
2. Basic ideas and concepts in Nuclear Physics - An Introductory Approach, K. Heyde, 2004, IOP Institute of Physics Publishing.
3. Radiation Detection and Measurement, G.F. Knoll, 2000, John Wiley & Sons, 2000.
4. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed, 2007, Academic Press, Elsevier.
5. Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf, 1991, Dover Pub.Inc.,.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	H	L	H	H	-	H	H	-	-	H	H	H	H
CO2	H	L	H	H	-	H	H	-	-	H	H	H	H
CO3	H	L	H	H	-	M	H	-	-	H	H	H	H
CO4	H	L	H	H	L	H	H	-	-	H	H	H	H
CO5	H	L	M	H	L	M	H	-	-	H	H	H	H

Digital Systems and Applications

SEMESTER VI **Hours of Instruction/week : 4**

23BPHC12 **No. of Credits: 4**

Course Objectives:

1. To study Number systems and Boolean algebra
2. To learn about minimization techniques and codes
3. To gain knowledge on sequential circuits and memory devices

Unit 1 Number Systems Number Systems used in digital electronics, Decimal Number Systems, Binary Number Systems, Octal Number Systems, Hexadecimal Number Systems, Binary addition, subtraction, multiplication and division, Conversion Algorithms.	**10**
Unit 2 Boolean Algebra And Arithmetic Circuits Boolean Laws and Algebra, Truth functions, AND operator, OR operator, NOT operator, NAND operator, Boolean expressions, Reducing Boolean expressions and logic circuits, NAND and NOR Gates as Universal building blocks, Exclusive OR gate, Half adder and full adder, Half Subtractor and Full Subtractor.	**13**
Unit 3 Minimization Techniques And Codes Sum of Product method, Product of sum method, Karnaugh Map, Binary Codes, Weighted and Non-Weighted Codes, Error Detecting Codes, ASCII Code, Gray Code and Excess3 Code.	**12**
Unit 4 Sequential circuits Flip flops, RS flip flop, Cocked RS flip flop, D flip flop, JK flip flop, JK Master/Slave flip flop, Counters, Asynchronous counters, Synchronous counters, MOD 5 counter and wave forms, Decade counters and waveforms, Shift Register, Serial-In, Serial-Out Shift Register (SISO), Serial-In, Parallel-Out Shift Register (SIPO), Ring counter.	**15**
Unit 5 Memory Devices Read Only Memory (ROM), Random Access Memory (RAM), Programmable Read Only Memory (PROM), Electrically Programmable Read Only Memory (EPROM), Electrically Erasable Programmable Read Only Memory (EEPROM).	**10**
Total Hours	**60**

Text Books:

1. Digital Electronics, Malvino and Leach, 2004, Tata Mc Graw Hill Publishers IV Edition.
2. Digital Electronics and Micro Computers, R.K.Gaur, 2005,Dhanpat Rai Publications.
3. Digital Electronics, V.K.Puri, 2016, McGraw Hill Publishers.

Reference Books:

1. Digital Electronics, William Gothman,2001, Prentice Hall of India Pvt Ltd.
2. Digital Logic and Computer Design, M.Morris Mano,2007, Prentice Hall of India Pvt. Ltd.
3. Digital Electronics: Principles and Integrated Circuits, Anil K. Maini, 2007, John Wiley and Sons.

Course Outcomes:

1. Conversion between various number systems
2. Employ Logic gates for carrying out logic operations
3. Apply the concept of Boolean laws and employ a Karnaugh Map to reduce Boolean expressions.
4. Design various combinational and sequential circuits using flipflops.
5. Explain different types of memory used in computers

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	H	H	H	M	H	H	H	H	H	H	L	H	H	L
CO2	H	H	H	M	H	H	M	H	H	M	-	H	H	M
CO3	H	H	H	H	H	M	H	M	H	L	H	H	H	M
CO4	H	H	H	H	M	M	H	L	H	H	M	H	H	M
CO5	H	H	H	H	H	H	H	H	H	H	H	H	H	H

Digital Systems and Applications - Practical

SEMESTER VI
23BPHC12P

Hours of Instruction/week : 4
No. of Credits: 2

Course Objectives:

1. To gain knowledge on logic gates
2. To understand flip flop functioning
3. To design logic gates using transistor

1. To design NOT gate using transistor
2. To design AND gate using transistor
3. To design OR gate using transistor
4. Verification of NAND as Universal building blocks
5. Verification of NOR as Universal building blocks
6. To measure voltage and time period of a periodic waveforms using CRO
7. Verification of Demorgan's Theorem
8. To generate sum of products and product of sum.
9. Verification of Associative law and distributive law, AND, OR Gates.
10. Gates, Half and Full adder.
11. Gates, Half and Full Subtractor.
12. Flip flops R-S, D and J-K.

Total Hours 60

Course Outcomes:

1. Construction of logic gates using transistors
2. Design and verifiy Flip-flops
3. Design circuits using universal gates such as NAND and NOR
4. Verification of deMorgan's theorem and SOP, POS.
5. Familiarization of CRO

Reference Books:

1. Digital Electronics, Malvino and Leach,2004, Tata Mc Graw Hill Publishers IV Edition.
2. Digital Electronics and Micro Computers, R.K.Gaur, 2005, Dhanpat Rai Publications.
3. Digital Electronics, V.K.Puri, 2016, McGraw Hill Publishers.
4. Digital Electronics, William Gothman,2001, Prentice Hall of India Pvt Ltd.
5. Digital Logic and Computer Design, M.Morris Mano, 2007,Prentice Hall of India Pvt. Ltd.
6. Digital Electronics: Principles and Integrated Circuits, Anil K. Maini, 2007, John Wiley and Sons.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	H	H	H	L	M	M	-	L	H	L
CO2	H	H	M	L	M	H	M	-	M	L	-	H	H	L
CO3	H	H	H	H	H	H	H	M	H	M	-	H	H	M
CO4	M	M	H	H	M	H	M	-	M	M	-	H	H	L
CO5	H	H	H	H	H	H	H	H	H	M		H	H	M

Statistical Mechanics

SEMESTER VI
23BPHC13

Hours of Instruction/week :4
No. of Credits: 4

Course Objectives:

1. To learn the basic concepts and definition of physical quantities in classical statistics and classical distribution law.
2. To understand Bose Einstein statistics and its applications to radiation.
3. To learn Fermi-Dirac statistic and its applications to quantum systems.

Unit 1 Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.	**15**
Unit 2 Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Rayleigh-Jean's Law.	**12**
Unit 3 Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.	**9**
Unit 4 Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.	**12**
Unit 5 Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit	**12**
Total Hours	**60**

Course Outcomes:

1. Understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function. Learn the concept of conservation of energy and apply them to basic problems.
2. Learn to derive classical radiation laws of black body radiation. Wiens law, Rayleigh Jeans law, ultraviolet catastrophe. Saha ionization formula.
3. Understand the concepts of Quantum Theory of Radiation
4. Learn to calculate the macroscopic properties of degenerate photon gas using BE distribution law
5. Understand the application of F-D statistical distribution law to derive thermodynamic functions of a degenerate Fermi gas, electron gas in metals and their properties.

Text Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford, University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.

Reference Books:

1. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
2. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
3. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	H	L	H	H	-	H	H	-	-	H	H	H	H
CO2	H	L	H	H	-	H	H	-	-	H	H	H	H
CO3	H	L	H	H	-	M	H	-	-	H	H	H	H
CO4	H	L	H	H	L	H	H	-	-	H	H	H	H
CO5	H	L	M	H	L	M	H	-	-	H	H	H	H

Statistical Mechanics - Practical

SEMESTER VI — **Hours of Instruction/week : 4**
23BPHC13P — **No. of Credits: 2**

Course Objectives:

1. To learn computer simulation and verify Stefan's Law of radiation and determine Stefan's constant.
2. To learn specific heat of solids by comparing, Dulong-Petit, Einstein's and Debye's Laws
3. To understand Maxwell-Boltzmann distribution, Bose-Einstein distribution, Fermi-Dirac distribution

Use C/C++/Scilab/other numerical simulations

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
b) Study of transient behavior of the system (approach to equilibrium)
c) Relationship of large N and the arrow of time
d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
e) Computation and study of mean molecular speed and its dependence on particle mass
f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
a) Study of how $Z(\beta)$, average energy , energy fluctuation ΔE, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
b) Ratios of occupation numbers of various states for the systems considered above
c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T
3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
5. Plot the following functions at different temperatures a) Maxwell-Boltzmann distribution b) Fermi-Dirac distribution c) Bose-Einstein distribution

Total Hours 60

Course Outcomes:

1. Learn computational analysis of behavior of a collection of particles
2. Learn computation of the partition function
3. Verification of Planck's law for Black Body radiation
4. Understand the Specific Heat of Solids
5. Understand the differences between Maxwell-Boltzmann distribution, Fermi-Dirac distribution, Bose-Einstein distribution

Reference Books:

1. Elementary Numerical Analysis, K.E.Atkinson, 3rdEdn . 2 0 0 7, Wiley India Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2ndEdn.,1996, Oxford University Press.
3. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
1. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan
2. Tobochnik, Princeton University Press, 2010
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientificand
4. Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014Springer ISBN: 978-3319067896
5. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
6. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO1	H	L	H	H	-	H	H	-	-	H	H	H	H
CO2	H	L	H	H	-	H	H	-	-	H	H	H	H
CO3	H	L	H	H	-	M	H	-	-	H	H	H	H
CO4	H	L	H	H	L	H	H	-	-	H	H	H	H
CO5	H	L	M	H	L	M	H	-	-	H	H	H	H