BODOLAND UNIVERSITY

Syllabus for
Under Graduate Programme with Multiple Entry and Exit Options
in
PHYSICS

For Colleges Affiliated to Bodoland University
Framed According to National Education Policy (NEP 2020)
Effective from Academic Year 2023-24

Abbreviations used:

MAJ: Major

MIN: Minor

IDC: Inter Disciplinary Course

AEC: Ability Enhancement Courses

SEC: Skill Enhancement Course

VAC: Value Added Course

DIS: Dissertation

REM: Research Methodology

ADL: Advance Learning

Minor papers option:

- Students with Physics Major have to opt Minor papers from List of Minor Papers from **Pool A**
- Students with Major other than Physics Major/any other discipline have to opt Minor papers from List of Minor Papers from **Pool B**

Syllabus structure of Four Year Undergraduate Programme in Physics (based on NEP 2020)

Sem	Major Course (4 credit)	Minor Course (4 credit)	IDC (3 credit)	AEC (2 credit)	SEC (3 credit)	VAC (4 credit)	Internship *(credit 4/2)		Total credit
I	PHYMAJ101-4 Mechanics	PHYMIN101-4A Bio-Physics PHYMIN101-4B Mechanics	PHYIDC101-3 Basics of Physical Bodies	AEC101-2 Language/ Regional Language	PHYSEC101-3 Instrumentation Skills in Physics-I	VAC101-4			20
II	PHYMAJ102-4 Mathematical Physics - I	PHYMIN102-4A Basic Plasma Physics PHYMIN102-4B Electricity, Magnetism and Electromagnetic Theory	PHYIDC102-3 Electricity, Magnetism and Electronics	AEC102-2 Language/ Regional Language	PHYSEC102-3 Instrumentation Skills in Physics-II	VAC102-4			20
Exit with a Certificate in Physics (40 credits and Internship of 4 credits)									
III	PHYMAJ201-4 Electricity and Magnetism PHYMAJ202-4 Waves and Optics	PHYMIN201-4A Atmospheric Physics PHYMIN201-4B Thermal Physics and Statistical Mechanics	PHYIDC201-3 Molecules, Photons and Nuclei	AEC201-2 Language/ Regional Language	PHYSEC201-3 Electrical Network and Loads				20
IV	PHYMAJ203-4 Mathematical Physics - II PHYMAJ204-4 Thermal and Statistical Physics PHYMAJ205-4 Analog systems and applications (Electronics -I)	PHYMIN202-4A Radiation Safety PHYMIN202-4B Waves and Optics		AEC202-2 Language/ Regional Language			Internship (2)		20
Exit with a Diploma in Physics (80 credits and Internship of 4 credits)									
V	PHYMAJ301-4 Classical Mechanics PHYMAJ302-4 Elements of	PHYMIN301-4A Advanced Mathematical Physics							20

	Modern Physics PHYMAJ303-4 Digital system and applications (Electronics -II) PHYMAJ304-4 Electromagnetic Theory	PHYMIN301-4B Mathematical Physics							
VI	PHYMAJ305-4 Quantum Mechanics -I PHYMAJ306-4 Solid State Physics - I PHYMAJ307-4 Nuclear and Particle Physics - I PHYMAJ308-4 Mathematical Physics -III	PHYMIN302-4A Material Physics & Nano Physics PHYMIN302-4B Elements of Modern Physics							20
Exit with a B.Sc. in Physics (120 credits)									
VII	PHYMAJ401-4 Advanced Statistical Mechanics PHYMAJ402-4 Atomic and Molecular Physics PHYMAJ403-4 Quantum Mechanics –II PHYMAJ404-4 Astronomy and Astrophysics (OR) PHYREM404-4	PHYMIN401-4A Physics of Thin Films and Applications PHYMIN401-4B Electronics and Astrophysics							20

	Research Methodology (For dissertation students)								
VII I	PHYMAJ405-4 Laser and Non-linear Optics PHYDIS406-12 Dissertation / Research Project	PHYMIN402-4A Physics of Low Temperature PHYMIN402-4B Quantum Mechanics and Solid State Physics						PHYDIS406-12 Dissertation / Research Project (OR) PHYADL401-4 Experimental Techniques in Physics PHYADL402-4 Solid State Physics -II PHYADL403-4 Nuclear and Particle Physics - II	20
	80	32	9	8	9	6	4	12	160
Exit with B.Sc. in Physics with Honours and Research (160 credits)									

Code Explanation:
MAJ= Major; MIN= Minor; ADL= Advanced Learning; DIS= Dissertation; IDC= Interdisciplinary; AEC= Ability Enhancement Course; SEC=Skill Enhancement Course, VAC= Value Added Course,
First digit= Course level; Second and Third digit=Sl. No. of course in the category (Paper Serial Number), and Last digit= Credits, e.g. MAJ101-4

Curriculum Framework for Four-Year Undergraduate Programme

<table>
<tr><th>Year</th><th>Objective</th><th>Nature of Courses</th><th>No. of courses</th><th>Outcome</th></tr>
<tr><td rowspan="6">1st year (1st & 2nd Semesters)</td><td rowspan="6">Understanding and Exploration</td><td>1. Major Core Courses</td><td>1+1=2</td><td rowspan="6">Understanding of Disciplines, Language Competency, Exposure to discipline beyond the chosen Subject, Gaining Basic skills to pursue any vocation</td></tr>
<tr><td>2. Minor/Related Discipline</td><td>1+1=2</td></tr>
<tr><td>3. Inter Disciplinary Courses</td><td>1+1=2</td></tr>
<tr><td>4. AEC/Languages</td><td>1+1=2</td></tr>
<tr><td>5. Skill Enhancement courses</td><td>1+1=2</td></tr>
<tr><td>6. Value Added Course</td><td>1+1=2</td></tr>
<tr><td colspan="5">Exit option: Certificate in Physics, upon the successful completion of the First Year (Two Semesters) along with internship of 4 credit.</td></tr>
<tr><td rowspan="6">2nd Year (3rd & 4th Semesters)</td><td rowspan="6">Focus and Immersion</td><td>1. Major Core Courses</td><td>2+3+5</td><td rowspan="6">Understanding of Disciplines, Language Competency, Exposure to discipline beyond the chosen Subject, Gaining skills for employability</td></tr>
<tr><td>2. Minor/Related Discipline</td><td>1+1=2</td></tr>
<tr><td>3. Inter Disciplinary Courses</td><td>1+0=1</td></tr>
<tr><td>4. AEC/Languages</td><td>1+1=2</td></tr>
<tr><td>5. Skill Enhancement courses</td><td>1+0=1</td></tr>
<tr><td>6. Internship</td><td>0+1=1</td></tr>
<tr><td colspan="5">Exit option: Diploma in Physics, upon the successful completion of the Second Year (Four Semesters) along with internship of 4 credit of the four year degree program.</td></tr>
<tr><td rowspan="2">3rd Year - (5th & 6th Semesters)</td><td rowspan="2">Real time Learning</td><td>1. Major Core Courses</td><td>4+4=8</td><td rowspan="2">In depth learning of major and minor disciplines</td></tr>
<tr><td>2. Minor/Related Discipline</td><td>4+4=8</td></tr>
<tr><td colspan="5">Exit option: Bachelor Degree in Physics, upon the successful completion of the Third Year (Six Semesters) of Four-year Undergraduate Programme</td></tr>
<tr><td rowspan="2">4th Year - (7th & 8th Semesters)</td><td rowspan="2">Deeper Concentration</td><td>1. Major Core Courses</td><td>4+4=8</td><td rowspan="2">Advanced and Deeper Learning of Major Discipline</td></tr>
<tr><td>2. Minor/Related Discipline</td><td>1+1=2</td></tr>
<tr><td colspan="5">Exit option: Bachelor Degree with Physics Honours, upon the successful completion of the Fourth Year (Eight Semesters) of Four-year Undergraduate Programme</td></tr>
<tr><td rowspan="4">4th Year - (7th & 8th Semesters)</td><td rowspan="4">Deeper Concentration</td><td>1. Major Core Courses</td><td>3+1=4</td><td rowspan="4">Advanced and Deeper Learning of Major Discipline, Developing Research competencies and Foundation for pursuing Doctoral Studies</td></tr>
<tr><td>2. Minor/Related Discipline</td><td>1+1=2</td></tr>
<tr><td>Research Methodology</td><td>1+0=1</td></tr>
<tr><td>Dissertation /Research Project</td><td>0+1=1</td></tr>
<tr><td colspan="5">Exit option: Bachelor Degree with Research, upon the successful completion of the Fourth Year (Eight Semesters) of Four-year Undergraduate Programme</td></tr>
</table>

Curriculum Structures
for
Four Year Undergraduate Programme (FYUGP)

Total Credits= 160

SEMESTER - I							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ101-4	Mechanics	4	(3+0+1)	50	30	20	100
PHYMIN101-4A	Bio-Physics	4	(4+0+0)	70	30	00	100
PHYMIN101-4B	Mechanics		(3+0+1)	50	30	20	
PHYIDC101-3	Basics of Physical Bodies	3	(3+0+0)	50	00	00	50
AEC101-2	Language	2	(2+0+0)	50	00	00	50
PHYSEC101-3	Instrumentation Skills in Physics-I	3	(2+0+1)	40	00	10	50
VAC101-4	VAC	4			30		100
Total credits		**20**					**450**

SEMESTER - II							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ102-4	Mathematical Physics - I	4	(3+0+1)	50	30	20	100
PHYMIN102-4A	Basic Plasma Physics	4	(4+0+0)	70	30	00	100
PHYMIN102-4B	Electricity, Magnetism and Electromagnetic Theory		(3+0+1)	50	30	20	
PHYIDC102-3	Electricity, Magnetism and Electronics	3	(3+0+0)	50	00	00	50
AEC102-2	Language	2	(2+0+0)	50	00	00	50
PHYSEC102-3	Instrumentation Skills in Physics-II	3	(2+0+1)	40	00	10	50
VAC102-4	VAC	4			30		100
Total credits		**20**					**450**

SEMESTER -III							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ201-4	Electricity and Magnetism	4	(3+0+1)	50	30	20	100
PHYMAJ202-4	Waves and Optics	4	(3+0+1)	50	30	20	100
PHYMIN201-4A	Atmospheric Physics	4	(4+0+0)	70	30	00	100
PHYMIN201-4B	Thermal Physics and Statistical Mechanics		(3+0+1)	50	30	20	
PHYIDC201-3	Molecules, Photons and Nuclei	3	(3+0+0)	50	00	00	50
AEC201-2	Language	2	(2+0+0)	50	00	00	50
PHYSEC201-3	Electrical Network and Loads	3	(2+0+1)	40	00	10	50
Total credits		**20**					**450**

SEMESTER - IV							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ203-4	Mathematical Physics - II	4	(3+0+1)	50	30	20	100
PHYMAJ204-4	Thermal and Statistical Physics	4	(3+0+1)	50	30	20	100
PHYMAJ205-4	Analog systems and applications (Electronics -I)	4	(3+0+1)	50	30	20	100
PHYMIN202-4A	Radiation Safety	4	(3+0+1)	50	30	20	100
PHYMIN202-4B	Waves and Optics		(3+0+1)	50	30	20	
AEC202-2	Language	2	(2+0+0)	50	00	00	50
Internship	Internship	2					
Total credits		**20**					**500**

SEMESTER - V							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ301-4	Classical Mechanics	4	(3+0+1)	50	30	20	100
PHYMAJ302-4	Elements of Modern Physics	4	(3+0+1)	50	30	20	100
PHYMAJ303-4	Digital System and Applications (Electronics -II)	4	(3+0+1)	50	30	20	100
PHYMAJ304-4	Electromagnetic Theory	4	(3+0+1)	50	30	20	100
PHYMIN301-4A	Advanced Mathematical Physics	4	(3+0+1)	50	30	20	100
PHYMIN301-4B	**Mathematical Physics**		(3+0+1)	50	30	20	
Total credits		**20**					**500**

SEMESTER - VI							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ305-4	Quantum Mechanics -I	4	(3+0+1)	50	30	20	100
PHYMAJ306-4	Solid State Physics - I	4	(3+0+1)	50	30	20	100
PHYMAJ307-4	Nuclear and Particle Physics -I	4	(3+0+1)	50	30	20	100
PHYMAJ308-4	Mathematical Physics -III	4	(3+0+1)	50	30	20	100
PHYMIN302-4A	Material Physics & Nano Physics	4	(4+0+0)	70	30	00	100
PHYMIN302-4B	**Elements of Modern Physics**		(3+0+1)	50	30	20	
Total credits		**20**					**500**

SEMESTER - VII							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ401-4	Advanced Statistical Mechanics	4	(3+0+1)	50	30	20	100
PHYMAJ402-4	Atomic and Molecular Physics	4	(4+0+0)	70	30	00	100
PHYMAJ403-4	Quantum Mechanics -II	4	(3+0+1)	50	30	20	100
PHYMAJ404-4	Astronomy and Astrophysics	4	(4+0+0)	70	30	00	100
	OR						
PHYREM404-4	Research Methodology (For dissertation students)		(4+0+0)	70	30	00	
PHYMIN401-4A	Physics of Thin Films and Applications	4	(4+0+0)	70	30	00	100
PHYMIN401-4B	**Electronics and Astrophysics**		(3+0+1)	50	30	20	
Total credits		**20**					**500**

SEMESTER - VIII							
Paper Code	**Paper title**	**Credit**	**Credit Distribution (L+T+P)**	**End Semester Marks**	**Internal Marks**	**Practical**	**Total Marks**
PHYMAJ405-4	Laser and Non-linear Optics	4	(4+0+0)	70	30	00	100
PHYDIS406-12	Dissertation / Research Project	12	(0+0+12)	210	90	---	300
PHYMIN402-4A PHYMIN402-4B	**P**hysics of Low Temperature Quantum Mechanics and Solid State Physics	4	(4+0+0) (4+0+0)	70 70	30 30	00 00	100
OR							
PHYMAJ405-4	Laser and Non-linear Optics	4	(4+0+0)	70	30	00	100
PHYADL401-4	Experimental Techniques in Physics	4	(3+0+1)	50	30	20	100
PHYADL402-4	Solid State Physics - II	4	(3+0+1)	50	30	20	100
PHYADL403-4	Nuclear and Particle Physics - II	4	(3+0+1)	50	30	20	100
PHYMIN402-4A PHYMIN402-4B	Physics of Low Temperature Quantum Mechanics and Solid State Physics	4	(4+0+0) (4+0+0)	70 70	30 30	00 00	100
Total credits		**20**					**500**

List of minor courses in physics for students having major in Physics

Pool A

Semester	Paper code	Credit	Paper title
I	PHYMIN101-4A	4+0+0=4	Bio Physics
II	PHYMIN102-4A	4+0+0=4	Basic Plasma Physics
III	PHYMIN201-4A	4+0+0=4	Atmospheric Physics
IV	PHYMIN202-4A	3+0+1=4	Radiation safety
V	PHYMIN301-4A	3+0+1=4	Advanced Mathematical Physics
VI	PHYMIN302-4A	4+0+0=4	Material Physics & Nano Physics
VII	PHYMIN401-4A	4+0+0=4	Physics of Thin Films and Applications
VIII	PHYMIN402-4A	4+0+0=4	Physics of Low Temperature

List of minor courses in physics for students of other major/departments:

Pool B

Semester	Paper code	Credit	Paper title
I	PHYMIN101-4B	3+0+1=4	Mechanics
II	PHYMIN102-4B	3+0+1=4	Electricity, Magnetism and Electromagnetic Theory
III	PHYMIN201-4B	3+0+1=4	Thermal Physics & Statistical Mechanics
IV	PHYMIN202-4B	3+0+1=4	Waves & Optics
V	PHYMIN301-4B	3+0+1=4	Mathematical Physics
VI	PHYMIN302-4B	3+0+1=4	Elements of Modern Physics
VII	PHYMIN401-4B	3+0+1=4	Electronics & Astrophysics
VIII	PHYMIN402-4B	4+0+0=4	Quantum Mechanics and Solid State Physics

List of SEC:

Semester	Paper code	Credit	Paper title
I	PHYSEC101-3	2+0+1=3	Instrumentation Skills in Physics-I
II	PHYSEC102-3	2+0+1=3	Instrumentation Skills in Physics-II
III	PHYSEC201-3	2+0+1=3	Electrical Network and Loads

List of IDC:

Semester	Paper code	Credit	Paper title
I	PHYIDC101-3	2+0+1=3	Basics of Physical Bodies
II	PHYIDC102-3	2+0+1=3	Electricity, Magnetism and Electronics
III	PHYIDC201-3	2+0+1=3	Molecules, Photons and Nuclei

Semester 1
Paper Title: Mechanics
Paper Code: PHYMAJ101-4
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:

- *To give an idea of various frame of references.*
- *To give concept of work, energy, conservation laws.*
- *To offer knowledge of mechanical properties of matter.*
- *To give basic concept of theory of relativity.*

Course outcome:

On successful completion of the course students will be able to understand about the fundamental concept of dynamics, work and energy, Elasticity, motion under central force, waves & oscillations & special theory of relativity.

Unit I

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 and Laboratory frames, Principle of conservation of momentum.

(6 Lectures)

Work and Energy: 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. Law of conservation of Energy.

(3 Lectures)

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. **(7 Lectures)**

Unit II

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

(2 Lectures)

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **(2 Lectures)**

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.

(3 Lectures)

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. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **(5 Lectures)**

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution.

Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(6 Lectures**)

Unit III

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

(4 Lectures)

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Kinematics. **(7 Lectures)**

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Paper title: Mechanics Lab
Paper code: PHYMAJ101-4
Class: 30 Hrs. Lab class

A minimum of 8 experiments is to be performed by the students during the semester

1. Measurements of length (or diameter) using vernier caliper, screw gauge and traveling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
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 of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water 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 Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Semester 1
Paper Title: Bio-Physics
Paper Code: PHYMIN101-4A
Credit: 04 (4+0+0)
Lecture: 60

Course Objectives:

The main purpose of this course is to provide students with insight and direction into various aspects of Biophysics.

***Course outcomes*:** On successful completion of the course students will be able to:

- *Understand the interface between physical science and biological sciences.*
- *Explain Building Blocks & Structure of Living State.*
- *Discuss the chemical thermodynamics phenomena.*
- *Understand the fluid dynamics of circulatory systems*

Unit I

Building Blocks & Structure of Living State: Atoms and ions, molecules essential for life, what is life. Living state interactions: Forces and molecular bonds, electric & thermal interactions, electric dipoles, casimir interactions, domains of physics in biology. **(18 Lectures)**

Unit II

Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue. Living State Thermodynamics: Thermodynamic equilibrium, fIrst law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding. **(19 Lectures)**

Unit III

Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, HemoglobinDiffusion and transport Maxwell-Boltzmann statistics. **(13 Lectures)**

Unit IV

Fluids: Fluid dynamics of circulatory systems, capillary action. Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria. **(10 Lectures)**

Reference Books:

- Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
- Aspects of Biophysics, Hughe S W, John Willy and Sons.
- Essentials of Biophysics by P Narayanan, New Age International

Semester 1
Paper Title: Mechanics
Paper Code: PHYMIN101-4B
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:
The objective of the course is to impart a good foundation of the concepts of vector algebra and differential equations. This course begins with Newton's Laws of Motion and ends with the Special Theory of Relativity. The students will acquire knowledge of the mechanical properties of matter in the solid. It is designed to enhance the understanding of the Concept of Gravitation, rotational motion, and central forces. They will learn about Simple Harmonic Motion and energy associated with a body executing SHM. They will have a basic idea of the Special Theory of Relativity.

Course Outcomes :
Upon completion of this course, students will be able to,

- *Learn basics vector, vector algebra, and its Product.*
- *Learn 1st and 2nd order differential equations.*
- *Understand the concepts of laws of motion and their application to various dynamical situations. And their applications to the conservation of momentum, angular momentum, and energy.*
- *Understand rotational motion and associated parameters.*
- *Apply Kepler's laws to describe the motion of planets and satellites in a circular orbit.*
- *The concept of geosynchronous orbits*
- *Understand Simple Harmonic Motion and energy associated with SHM*
- *Learn mechanical properties of matter and elastic constants*
- *Concept of stress and strain and the relation between elastic constants*
- *Understand Einstein's postulates of special relativity.*
- *Apply Lorentz transformations to describe simultaneity, time dilation, and length contraction*

Unit I

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**
Ordinary Differential Equations:1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(4 Lectures)**
Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(4 Lectures)**
Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy.

Motion of rockets. **(4 Lectures)**

Unit II

Rotational Motion: Angular velocity and angular momentum, Torque. Conservation of angular momentum. **(3 Lectures)**

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

Unit III

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

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants-Poisson's Ratio- Expression for Poisson's ratio in terms of elastic constants- Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum- Determination of Rigidity modulus and moment of inertia by Searles method **(7 Lectures)**

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. **(5 Lectures)**

Reference books:

- University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison- Wesley
- Mechanics Berkeley Physics course, Vol1:Charles Kittel, et. al. 2007, Tata Mc Graw- Hill.
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Paper title: Mechanics Lab

Paper code: PHYMIN101-4B

Class: 30 Hrs Lab class

A minimum of 8 experiments is to be performed by the students during the semester

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

Reference books:

- Advanced Practical Physics for students, B.L.F lintand H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Semester 1

Paper Title: Basics of Physical Bodies
Paper Code: PHYIDC101-3
Paper Credit: 03 (3+0+0)
Lecture: 45

Course Objective:

To familiar the students of other discipline the concept of motion from the points of view of two observers one in inertial and other in non inertial frame of reference. The law of universal gravitation and interpretation of lunar tides and various geophysical phenomena have been incorporated. Indian space programme also highlighted.

Course Outcome:

Students are expected to learn the basic physics. They are also expected to get the holistic scientific reason for different geophysical phenomena. Also it is expected that they will be interested to learn the contribution of ISRO has made so far for building India as a self reliant nation in Space research.

Unit I

Basic concepts: The units Centimetre and the Second, Weight and Mass. The SI systems and standards of measurement. Density. The law of conservation of mass. Action and Reaction. Addition of velocities. Force is a vector. Motion in inclined plane. **(5 Lectures)**

Laws Of Motion: Different points of view about motion. The law of Inertia. The motion is relative. Celestial observer's point of view. Acceleration and Force. Rectilinear motion with constant acceleration. Path of a bullet. Circular motion. Life at g=0. Motion from an unreasonable point of view. Centrifugal forces. Coriolis forces. **(8 Lectures)**

Unit II

Conservation Laws: Recoil. The law of conservation of momentum. Jet propulsion. Motion under the action of gravity. The law of conservation of mechanical energy. Work. Units of measurement of work and energy. Power and efficiency of machines. Energy loss. Collisions.

(5 Lectures)

Oscillations: Equilibrium. Simple oscillations. Displaying (demonstration of) oscillations. Force and potential energy in oscillations. Spring vibrations. Resonance. **(5 Lectures)**

Motion Of Solid Bodies: Torque. Lever. Energy loss in path. Very simple machines. Method of addition of parallel forces acting on a body. Centre of gravity and centre of mass. Angular momentum. Law of conservation of angular momentum. Angular momentum as a vector. Tops. Flexible shaft. **(7 Lectures)**

Unit III

Gravitation: What holds the Earth up!. Law of universal gravitation. Weighing the earth. Measurement of g in the service of mankind. Weight underground. Gravitational energy. How planets move. Interplanetary travel. If there were no moon! India's Space Programme. ISRO's contribution in space exploration, communication and remote sensing. **(9 Lectures)**

Pressure: Atmospheric Pressure. How Atmospheric Pressure was discovered. Atmospheric pressure and weather. Change of weather with altitude. Archimedes' principle. Extremely low pressure. Vacuum. Pressure of millions of atmosphere. Hydrostatic pressure, Hydraulic press.

(6 Lectures)

Reference:

- Physics for Everyone. (BOOK1): PHYSICAL BODIES. L D Landau, A. I. Kitaigorodsky. Mir Publishers, Moscow. Translated from the Russian by (Martin Greendlinger, D. Sc., Math)
- The Feynman Lectures on Physics (I, II & III) (Pearson Education Publication)

Semester 1
Paper Title: Instrumentation Skills in Physics-I
Paper Code: PHYSEC101-3
Credit: 03 (2+0+1)
Lecture: 30

Course objective:

The objective of the course is to provide a basic understanding of electrical measurements and their applications in experimental physics. The course focuses on the principles, techniques, and instruments used for measuring and analysing electrical quantities.

Learning outcome:

Students will gain theoretical and hands-on experience on the important electronic measurements and will learn about basic circuit analysis, electronic components, multimeters, oscilloscopes, and sensors etc.

Unit I

Introduction to Instrumentation and Measurement: Importance of instrumentation in physics research, Overview of different measurement techniques, units, standards, instruments accuracy, precision, sensitivity, and resolution range. **(3 Lectures)**

Electrical Measurements: Basic components and circuit, voltage, current, and resistance measurements, colour code of resistance, Multimeters: Specifications of a multimeter and their significance. Analogue and Digital, Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Amplifier-rectifier, and rectifier- amplifier. **(6 Lectures)**

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

(8 Lectures)

Unit II

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. **(8 Lectures)**

Sensors and Transducers: Principles of sensor operation**,** Types of sensors (temperature, pressure, strain, etc.)**,** Selection and calibration of sensors**,** Sensor interfacing and signal conversion.

(5 Lectures)

Paper Title: Instrumentation Skills in Physics-I Lab

Paper code: PHYSEC101-3

Class: 30 Hrs. Lab. Class

A minimum of 5 experiments is to be performed by the students during the semester

1. Analog voltmeters and ammeters in a simple electrical circuits to measure voltage and current.
2. Digital panel meters in electrical circuits for current and voltage measurement.
3. Identifying resistance and capacitance from colour code/item code and compare the values using digital multimeter.
4. Use soldering iron to secure an electrical connection joint.
5. Design a LED chaser circuit using IC.
6. Determine the characteristics (frequency, peak to peak voltage, rms voltage) of a continuous signal using analog (CRO) /digital (DSO) oscilloscope.
7. Use an electrical drill machine to make a hole (6mm) on a wall/wood/metal plate.

Reference Books:

- A text book in Electrical Technology; B L Theraja,
- Electronic Devices and Circuits; S. Salivahanan & N. S.Kumar,
- Electrical Measurements And Measuring Instruments; R.K. Rajput, (S. Chand)
- Electrical And Electronics Measurements And Instrumentation; R.K. Rajput, (S. Chand)
- Cathode Ray Oscilloscope: A Course for Students of Science, Medicine and Engineering; David T. Rees
- Performance and design of AC machines; M G Say
- Basic Electronics; J.B. Gupt

Semester 2
Paper Title: Mathematical Physics - I
Paper Code: PHYMAJ102-4
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:
The main objective of this course is to offer the basic concepts of Calculus, differential equation, vector algebra & probability.

Course outcome:
This part of the course includes mathematics so that students could understand Calculus, Vectors & their applications in various fields of physics, Differential Equation & its application, different coordinate systems & concept of probability & error. This will be helpful to students for their higher studies.

Unit I

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). **(2 Lectures)**

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(9 Lectures)**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(5 Lectures)**

Unit II

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. **(3 Lectures)**

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(6 Lectures)**

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). **(10 Lectures)**

Unit III

Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(6 Lectures)**

Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. **(2 Lectures)**

Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing. **(2 Lectures)**

Reference books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press

Paper title: Mathematical Physics - I Lab
Paper code: PHYMAJ102-4
Class: 30 Hrs. Lab class

- The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.
- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
  Students can use any one operating system Linux or Microsoft Windows

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++/Python/Matlab/Mathematica Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, cin and cout, Manipulators for data formatting, Control statements (decision making and looping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs	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 $\alpha = \tan\alpha$; $I = I_0\left(\frac{\sin\alpha}{\alpha}\right)^2$ 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. Find the area of B-H Hysteresis loop
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 $0 \le t \le 15$ The differential equation describing the motion of a pendulum is $\frac{d^2\nu}{dt^2} = -\sin(\nu)$. The pendulum is released from rest at an angular displacement α, i. e. υ(0)= α and $\upsilon'(0)=0$. Solve the equation for α = 0.1, 0.5 and 1.0 and plot υ as a function of time in the range $0 \le t \le 8\pi$. Also plot the analytic solution valid for small υ (sin(υ)= υ

Reference Books:

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

Semester 2
Paper Title: Basic Plasma Physics
Paper Code: PHYMIN102-4A
Credit: 04 (4+0+0)
Lecture: 60

Course Objective:

Plasma state of matter is commonly known as the fourth state of matter. Study of the subject is concerned with the properties of matter in the ionized state and its applications. The plasma state is characterized by complex interaction among atomic, electric, mechanical and fluid dynamic processes. So, it is connected to large parts of physics, mathematics and electrical engineering and offers interesting possibilities for cross-field studies. Plasma physics forms the basis of space research, fusion research and a large number of growing number of industrial application e.g microelectronic fabrications. Modern plasma physics is a very active field with large international collaboration.

Course outcome:

Completing the course the students should be able to:

- *define plasma state, give example of different kind of plasma and explain the parameters characterizing them*
- *analyse the motion of charge particles in electric and magnetic fields, explain concept of quasineutrality and describe the plasma interaction with surface, formulate kinetic and fluid descriptions of plasma, and understand the applicability of the appropriate approximations (ideal MHD, single fluid description, many fluid model).*
- *linearize equations describing plasma and derive differential equations for various types of waves in plasma and their dispersion relation*
- *discuss interaction between particles and waves, Landau damping*
- *explain the use of thermonuclear fusion for energy production, and discuss problems with plasma confinement and current directions of research*
- *show understanding of plasma processed relevant for the near-Earth environment, interplanetary space and astrophysical objects*
- *discuss technical applications of plasma; explain the most important methods for production and diagnostics of plasma in the laboratory*

Unit I

Definition of plasma: Criteria for plasma, Concept of temperature, Debye shielding, Quasi-neutrality, Plasma parameters, Occurrence of plasmas. **(8 Lectures)**

Charged particle motion: Charged particle motion in uniform and non-uniform E and B fields, Guiding centre drifts, Adiabatic invariants. **(10 Lectures)**

Unit II

Microscopic and macroscopic description of plasma: Fluid equation of motion, Plasma approximation. **(12 Lectures)**

Waves in plasmas: General description of wave propagation in plasmas. Plasma instabilities. Wave particle interaction (Landau damping). **(10 Lectures)**

Unit III

Technical plasma physics: Plasma surface interaction, sheath, PECVD, Nitriding, Sputtering process **(10 Lectures)**

Unit IV

Plasma applications: Thermonuclear fusion. Fusion reactor design. Plasma confinement. Plasma in space. **(10 Lectures)**

Reference Books:

- D. A Gurnett and A. Bhattacharjee, Introduction to Plasma Physics, Cambridge UniversityPress, 2005
- Francis F. Chen, Introduction to Plasma Physics and Controlled Fusion, Plenum Press, Indian paperback edition.
- P. M. Bellan, Fundamentals of Plasma Physics, Cambridge University Press, 2006

Semester 2
Paper Title: Electricity, Magnetism and Electromagnetic Theory
Paper Code: PHYMIN102-4B
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:
The objective is to help the students to acquire the conceptual knowledge of electricity, Electric field, potential, Capacitance, and di-electric material. The student will have an idea of magnetism,the magnetic effect of current and magnetic materials.This course will facilitate to develop of the concept of electromagnetic induction and electromagnetic wave equations.

Course Outcomes :
At the end of this course, students will be able to

- *Enhance the idea of vector operation further.*
- *Understand the concept of electric field and electric flux.*
- *Learn to apply Gauss's theorem to find electric fields for different types of charge distribution.*
- *Will develop the concept of capacitors and How to calculate the capacity of various types of capacitors.*
- *Learn about magnetism due to current.*
- *Will grasp the idea of Magnetic materials and their properties.*
- *Understand the core concept of electromagnetic induction and Propagation of electromagnetic waves.*

Unit I

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **(6 Lectures)**

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

(9 Lectures)

Unit II

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

(15 Lectures)

Unit III

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

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement Maxwell Equations Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium,transverse nature of EM waves, polarization. **(9 Lectures)**

Reference books:

- ElectricityandMagnetism,EdwardM.Purcell,1986,McGraw-HillEducation.
- Electricity and Magnetism, J.H. Fewkes& J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- ElectricityandMagnetism,DCTayal,1988,HimalayaPublishingHouse.
- University Physics, Ronald Lane Reese, 2003, ThomsonBrooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings

Paper title: Electricity, Magnetism and Electromagnetic Theory LAB
Paper code: PHYMIN102-4B
Class: 30 Hrs. Lab class

A minimum of 8 experiments is to be performed by the students during the semester

1. To use a Multimeter for measuring (a) Resistances (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
   i. Measurement of charge and current sensitivity
   ii. Measurement of CDR
   iii. Determine a high resistance by LeakageMethod
   iv. To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem
10. To verify the Superposition, and Maximum Power Transfer Theorem

Reference books:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, NewDelhi.
- EngineeringPractical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt.Ltd.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

Semester 2
Paper Title: Electricity, Magnetism and Electronics
Paper Code: PHYIDC102-3
Credit: 03 (3+0+0)
Lecture: 45

Course Objective:
This paper has been designed to give the students basic understanding of electricity, magnetism and electronics. The applications of electromagnetism; and it also includes Maxwell's equations which will be perfect for the students to understand the connectivity or similarity between electricity and magnetism. The paper also deals with microelectronics circuits, radio, television, radar, radio wave propagation etc.

Course Outcome:
After successful completion of this paper students of other discipline will be able to comprehend the basics of electric current and magnetism. They will have the idea of electron flow in conductor, semiconductor. The students will also be able to gain ideas of working of Radio, television and some microelectronic devices.

Unit I

Electricity: Stationary Electricity. Electric Current. What is basic? Electric Fields. Evolution of Electricity Theory. **(6 Lectures)**

Electrical Structure Of Matter: Minimum quantity of Electricity. Electron beam. Millikan's Experiment, Model of the atom. Quantizing energy. Dielectrics. Conduction in gases, Ion flow. Self maintained discharge. Matter in the Plasma State. Metals, Electron emission from metals. Thermoelectric Phenomena. Semiconductors. p-n junction. **(8 Lectures)**

Unit II

Electromagnetism: Measure of magnetic field intensity. Effect of Uniform Magnetic Field. Effect of non uniform magnetic field. Amperian currents. Electron cloud of the atom. Magnetic moments of the particles. Electromagnetic induction. Direction of induced current. Discovery of the law of electromagnetic induction. Induced Eddy Currents. Diamagnetic, Paramagnetic and Ferromagnetic materials. Earth's magnetic field. Magnetic fields of the star. **(14 Lectures)**

Unit III

Electromagnetic Fields: Maxwell's equations. Electromagnetic field. Photo-electric effect. Hertz's experiment. Mechanical model of radiation. Classification of electromagnetic radiation. **(10 Lectures)**

Radio: Some history. Vacuum tube triode and transistor. Radio transmission. Radio reception. Radio-wave propagation. J. C. Bose's contribution on wireless communication, Radar. Television. **(7 Lectures)**

Reference Books:

- Physics for Everyone. (BOOK3): ELECTRONICS. A. I. Kitaigorodsky. Mir Publishers, Moscow. Translated from the Russian by (Nicholas Weinstein)
- The Feynman Lectures on Physics (I, II & III) (Pearson Education Publication)

Semester 2
Paper Title: Instrumentation Skills in Physics-II
Paper Code: PHYSEC102-3
Credit: 03 (2+0+1)
Lecture: 30

Course objective:

This course provides a scientific understanding of optical measurements and their applications in experimental physics. It explores the principles, techniques, and instruments used for optical analysis and measurements.

Course Outcome:

Students will be able to learn about the fundamental concepts of geometrical and physical optics, light sources, detectors, and fiber optic sensors. After completion of this course, students will also be able to comprehend the practical skills in setting up optical experiments, collecting and analysing data, and interpreting experimental results.

Unit I

Optical Measurements: Importance of optical measurements in physics research,Units and standards in optical measurements, Geometrical and physical optics: Reflection, refraction, and dispersion of light, Laws of geometrical optics, Optical systems: lenses, mirrors, and prisms, Ray tracing and image formation, Light sources and detectors, Interferometry and spectroscopy, Fibre optic sensors.

(9 Lectures)

Detectors and Photodetection: Principles of photodetection, Photodetector types: photodiodes, photomultiplier tubes (PMTs), etc., Photodetector characteristics: sensitivity, response time, noise, etc., Photodetection circuitry and signal amplification. **(6 Lectures)**

Unit II

Error Analysis and Measurement Uncertainty: Types of errors in measurements, Propagation of errors and error analysis, Statistical methods in data analysis, Estimation and reporting of measurement uncertainty. **(4 Lectures)**

Instrument Maintenance and safety measurements: Common issues in instrument operation, Troubleshooting techniques, Preventive maintenance and calibration schedules, Safety considerations in instrumentation. **(4 Lectures)**

Calibration and Metrology: Principles of optical metrology and precision measurements, Traceability and calibration standards, Techniques for measuring length, angle, and displacement.

(7 Lectures)

Paper Title: PHYSEC102-3: Instrumentation Skills in Physics-II Lab

Paper Code : PHYSEC102-3

Class: 30 Hrs. Lab. Class

A minimum of 5 experiments is to be performed by the students during the semester

1. Using a DSO, do the fast Fourier transform (FFT) of a sinusoidal continuous signal.
2. Generate an amplitude modulated signal using DSO and signal generator.
3. Generate a frequency modulated signal using DSO and signal generator.
4. Use data storage option of the DSO to transfer the digital data to computer and reproduce the signal using any available software (MS Excel/Origin etc.)
5. Reflection, refraction and total internal reflection using laser source.
6. Diffraction of light through grating.
7. Designing a simple microscope using lenses.
8. Designing a simple telescope using lenses.

Reference Books:

- Optics; Ajay Ghatak
- Optics; Eugene Hecht and A. R. Ganesan
- Lasers and Optical Instrumentation; N. Sathyanarayana S. Nagabhushana
- Photonics: Optoelectronics, S L Kakani, S Kakani, CBS Publisher.
- A text book on light, B Ghosh and K G Mazumdar

Semester 3
Paper Title: Electricity and Magnetism
Paper Code: PHYMAJ201-4
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:
The objective of this paper is to give the basic concept of electricity, dielectric properties of matter, magnetic field & magnetic properties of matter, electrical circuits etc.

Course outcome:
After completion of this paper students will be able to understand the electric & magnetic fields & their application ,Electromagnetic induction, applications of Kirchhof's laws in electrical circuits.

Unit I

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. **(3 Lectures)**

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. **(4 Lectures)**

Electrostatic energy of system of charges: Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. (**6 Lectures)**

Unit II

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. **(6 Lectures)**

Magnetic Field: Magnetic force between current elements and definition of magnetic field. 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 (1) Solenoid and (2) Toroid. 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.

(8 Lectures)

Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity (**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis. **(3 Lectures)**

Unit III

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. **(4 Lectures)**

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

(4 Lectures)

Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

(4 Lectures)

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

(3 Lectures)

Reference Books:

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

Paper title: Electricity and Magnetism Lab
Paper code: PHYMAJ201-4
Class: 30 Hrs. Lab class

A minimum of 10 experiments is to be performed by the students during the semester

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. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. 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.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Semester 3
Paper Title: Waves and Optics
Paper Code: PHYMAJ202-4
Credit: 04 (3+0+1)
Lecture: 45

Objectives:

The main objective of the paper is to give basic concepts of Simple Harmonic Motion, Wave Motion, Vibration of strings & air column. The paper also includes the concept of wave properties of light through interference & diffraction.

Course outcome:

The outcome of the paper includes the knowledge of vibrations, propagation of waves , vibration of air column, harmonics of strings. The paper has another outcome of offering knowledge of wave properties of light & corresponding phenomena.

Unit I

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **(4 Lectures)**

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(2 Lectures)**

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. **(3 Lectures)**

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **(4 Lectures)**

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. **(6 Lectures)**

Unit II

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **(2 Lectures)**

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringees of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(7 Lectures)**

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer. **(3 Lectures)**

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only). **(2 Lectures)**

Unit III

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **(5 Lectures)**

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

(7 Lectures)

Reference Books:

- Waves:Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications, 2011, R. Chand Publications.

Paper title: Waves and Optics Lab
Paper code: PHYMAJ202-4
Class: 30 Hrs. Lab class

A minimum of 8 experiments is to be performed by the students during the semester

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 – T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Semester 3
Paper Title: Atmospheric Physics
Paper Code: PHYMIN201-4A
Credit: 04 (4+0+0)
Lecture: 60

Course Objectives:

This course will provide students with a knowledge of introduce the physics of Earth's atmospheres. It also will provide students with knowledge of the atmospheric dynamics, different atmospheric waves and their properties, basics of Radar and Lidar, aerosols.

Course Outcomes:

On completion of the course, the student should be able to:

- *Understand the composition of Earth's atmosphere and various meteorological processes.*
- *Apply the concepts of atmospheric Dynamics.*
- *Explain the properties of atmospheric waves.*
- *Understand how aerosols interact with solar and terrestrial radiation.*
- *Discuss the concepts of Radar, Lidar and their applications*

Unit I

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms.

(12 Lectures)

Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics. **(12 Lectures)**

Unit II

Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration. **(12 Lectures)**

Unit III

Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques. **(12 Lectures)**

Unit IV

Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars. **(12 Lectures)**

Reference Books:

- Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
- The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edn. 2002.
- An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
- Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

Semester 3
Paper Title: Thermal Physics and Statistical Mechanics
Paper Code: PHYMIN201-4B
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:

T*his course is divided into two main parts. The first part deals with Thermal Physics and the second part pertains to Statistical Mechanics. The objective of the first part of the course is to infuse ideas of Thermodynamic systems, Thermodynamic variables, Thermodynamic processes, and allied phenomenons. It is designed to familiarise students with thermodynamic potentials, the Kinetic theory of gases, and the Theory of radiation. While the second part is devoted to givinga basic introduction to Statistical Mechanics and various types of Statistics.*

Course Outcomes:

Upon completion of this course, students will be able,

- To grasp the idea of 1st law of thermodynamics and its applications.
- To learn different laws of thermodynamics and their significance.
- To understand Maxwell's relations, Joule-thompson effect and Caussius-Clapeyron equation.
- To learn the derivation of Maxwell's Law of distribution of velocities, Various Transport phenomena, and also the application of the law of equipartition of energy.
- To understand Blackbody radiation and its Spectral distribution.
- To learn to derive Plank's law and also derivation other laws like Wien's distribution law, Rayleigh-Jeans law,etc from Plank's Law.
- To understand the basics of Statistical mechanics and the significance and applications of various types of statics.

Unit I

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

(15 Lectures)

Unit II

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (C_P – C_V), C_P/C_V, TdS equations. **(8 Lectures)**

KineticTheoryofGases: Derivationof Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gasses; mono-atomicanddiatomic gasses. **(8 Lectures)**

Unit III

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. **(5 Lectures)**

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law photon gas comparison of three statistics. **(9 Lectures)**

Reference books:

- Thermal Physics, S.Garg, R.Bansal and C.Ghosh,1993,Tata McGraw-Hill.
- A treatise on Heat, Meghnad Saha, and B.N. Srivastava,1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W. Zemasky and R. Dittman,1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears & G.L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, Rich and Publications.

Paper title: Thermal Physics and Statistical Mechanics Lab
Paper code: PHYMIN201-4B
Class: 30 Hrs Lab class

A minimum of 8 experiments is to be performed by the students during the semester

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

Reference books:

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

Semester 3
Paper Title: Molecules, Photons and Nuclei
Paper Code: PHYIDC201-3
Credit: 03 (3+0+0)
Lecture: 45

Course Objective:

This paper will explain the historical development of the building block of the universe to the physics of the universe. It includes energy and its conservation, discovery of laws of thermodynamics. The paper gives the basic ideas of soft and hard electromagnetic radiations. The nuclei, the mass energy equivalence. Preliminary ideas of radioisotopes, nuclear reactions, solar energy, wind energy. The nature of the universe, expanding , stars at their different ages, cosmic rays etc.

Course Outcome:

Students are expected to understand the concept of energy and its conservation and different forms. They will also be able to understand the theory of relativity and the equivalence of mass and energy; the electromagnetic radiation, Solar energy and the thermonuclear reactions that are going on in the Star. They will also understand the Expansion of the Universe, the origin of cosmic rays etc.

Unit I

Structure of Matter: Elements. Atoms and molecules. Intermolecular Bonds. Physical and Chemical properties. Interaction of molecules. What thermal motion looks like? Crystals and their shape. Structure of crystals. Polycrystalline substances. **(6 Lecture)**

Law of Thermodynamics: Conservation of energy at the molecular level. How heat is converted into work. Entropy. Fluctuations. 1st and 2nd laws of thermodynamics. **(6 Lecture)**

Electromagnetic Radiation (Soft And Hard): Exchange of energy by radiation. The theory of thermal radiation. Optical spectra. Laser radiation. Luminescence. The discovery of X-rays and applications. Radiography of materials. **(10 Lecture)**

Unit II

THE STRUCTURE OF ATOMIC NUCLEI: Properties of atomic nuclei, the mass and energy of an atomic nucleus. Isotopes. Radioactivity. Radioactive decay. Nuclear reactions and the discovery of neutron. The energy of nuclear reactions. A nuclear chain reaction.

(10 Lecture)

Unit III

Energy Around Us: Sources of energy. Fuel. Electric power plants. Nuclear reactors. Thermonuclear energy. Solar energy. Power from the wind. **(6 Lecture)**

The Physics of the Universe: Measuring distance to the stars. The expanding universe. Basic theory of relativity. Life cycle of Stars: Chandrasekhar's contribution. Radio astronomy. Cosmic rays.

(7 Lecture)

Reference Books:

1. Physics for Everyone. (BOOK2): MOLECULES. L. D. Landau, A. I. Kitaigorodsky. Mir Publishers, Moscow. Translated from the Russian by (Martin Greendlinger, D. Sc., Math)
2. Physics for Everyone. (BOOK4): PHOTONS & NUCLEI . A. I. Kitaigorodsky. Mir Publishers, Moscow. Translated from the Russian by (George Yankovosky)
3. The Feynman Lectures on Physics (I, II & III) (Pearson Education Publication)

Semester 3
Paper Title: Electrical Network and Loads
Paper Code: PHYSEC201-3
Credit: 03 (2+0+1)
Lecture: 30

Course objective: *The objective of this course is to provides a broad understanding on electrical networks and loads, focusing on the principles, analysis techniques, and practical applications.*

Learning outcome:*Students will be able to gain the skills necessary to analyze and design electrical networks, select appropriate loads, and understand the interplay between electrical systems and loads in various applications. Students will also acquire fundamental professional skills related to electrical wiring, splicing techniques, and shunting methods.*

Unit I

Introduction to electrical network: Introduction to electrical Power, Ohm's law. Passive and active components in electrical networks. AC and DC electricity.Understanding electrical circuits: Kirchhoff's laws and circuit analysis techniques, Series, parallel, and series-parallel combinations. Applications of series and parallel circuits in practical systems. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Three-phase power generation and transmission, Advantages and applications of three-phase systems. **(10 Lecture)**

Network Theorems: Thevenin's theorem and Norton's theorem, Superposition theorem and maximum power transfer theorem, Application of network theorems in circuit simplification and analysis, Theoretical and practical limitations of network theorems. **(5 Lecture)**

Unit II

Power, Energy and Loads: Active, reactive, and apparent power, Power factor and its significance, Energy consumption and efficiency calculations, Power measurement techniques and instruments. Types of electrical loads: resistive, inductive, capacitive, and mixed loads. Power electronic loads: rectifiers, inverters, and motor drives, Load selection and matching in practical applications.

(10 Lecture)

Power Distribution Systems: Overview of power distribution systems. Types of transformers, Distribution transformers and substations. Transmission and distribution losses, Safety considerations and protective devices in power distribution. **(5 Lecture)**

Paper Title: Electrical Network and Loads Lab
Paper code: PHYSEC201-3
Class: 30 Hrs. Lab. class

1. Design a remote control ON/OFF switch for light using IR LED.
2. Design an extension board (4 nos. of 5/15 Amp socket) with switch, fuse and spike protection.
3. Design a prototype electrical connection for household AC power line distribution with circuit breakers, switches, LED tube, Led Bulb, 15/5 Amp socket.
4. Design a low pass and high pass filter circuit.
5. Measure the power consumption in a typical household AC operated load. Determine the current configuration for the main circuit breaker (MCB) for a typical laboratory hall/room when in full load.
6. Design a step-up/step-down transformer and measure the input/output voltage.

Reference Books:

1. Principles of Electronics; VK Mehta.
2. Handbook of Repair and Maintenance of Domestic Electronics Appliances, Shashi Bhushan Sinha
3. Modern Basic Electrical & House Wiring Servicing, M. Lotia
4. Performance and design of AC machines; M G Say
5. Op-Amp and Linear Integrated Circuits, R Gayakwad, Pearson Education.

Semester 4
Paper Title: Mathematical Physics - II
Paper Code: PHYMAJ203-4
Credit: 04 (3+0+1)
Lecture: 45

Objectives: *The main objective of this paper to give concepts about Fourier series, method of solution of ordinary and partial differential equations, special integrals and errors.*

Course outcomes: *After successful completion of this course, students will be able to:*

1. *Expand functions in terms of Fourier series.*
2. *Solve second order ordinary differential equations using Frobenius method*
3. *Find the solutions of Legendre, Bessel, Hermite and Laguerre Differential Equations and their application in various problems related to physics.*
4. *Solve partial differential equations like Laplace's equation in various co-ordinate systems using separation of variables method.*
5. *Explain the properties of Beta and Gamma Functions and express integrals in terms of them.*

Unit I

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non- periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. **(7 Lectures)**

Unit II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, 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 ($J_o(x)$ and $J_1(x)$) and Orthogonality.

(20 Lectures)

Unit III

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

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.

(4 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation. **(10 Lectures)**

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

Paper Title: Mathematical Physics – II Lab
Paper Code: PHYMAJ203-4
Class: 30 Hrs. Lab class

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem

Topics	**Description with Applications**
Introduction to Numerical computation softwares	Introduction to Scilab/Mathematica/Matlab/Python, Advantages and disadvantages, Scilab/Mathematica/Matlab/Python environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab/Mathematica/Matlab/Python, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab/Mathematica/Matlab/Python functions, Introduction to plotting, 2D and 3D plotting
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
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	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/Mathematica/Matlab/Python	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	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 · Over damped · Critical damped · Oscillatory · Forced Harmonic oscillator · Transient and Steady state solution · Apply above to LCR circuits also · Solve $x^2\frac{d^2y}{dx^2}-4x(1+x)\frac{dy}{dx}+2(1+x)y=x^3$ with the boundary conditions at $x=1$, $y=\frac{1}{2}e^2$, $\frac{dy}{dx}=-\frac{3}{2}e^2-0.5$ 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 equations	Partial Differential Equation: · Wave equation · Heat equation · Poisson equation · Laplace equation

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer

- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- www.**scilab**.in

Semester 4
Paper Title: Thermal and Statistical Physics
Paper Code: PHYMAJ204-4
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:
This course is designed in view to give extensive knowledge about the relation among Heat energy , internal energy, Work done , Entropy . About different thermodynamic processes, about distribution of classical particles . This course also contains topics about the distribution of energy radiation and momentum.

Course Outcome:
After successful completion of this course students are able to understand about the first and second laws of Thermodynamics, how heat, energy and work are related , about Isothermal and adiabatic processes about specific heat . about Heat engine and its efficiency, Concept of Entropy and the change of Entropy for different thermodynamic processes .
From Maxwell's Thermodynamics student will be able to learn about the distribution of classical particles , for Ideal and real gas and the Maxwell equation in thermodynamics are set of relations which is used in deriving the dependence of thermodynamic variables as the state variables of P,V and T.
After study of Classical theory of radiation , students will learn about the time angular distribution of the radiation of energy and momentum connecting various laws like ,Kirchhoff's law , Stefan-Boltzmann's law, Rayleigh-Jean's law etc.

Unit I
Introduction to Thermodynamics: First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. **(3 Lectures)**
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, 2^{nd} Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. **(5 Lectures)**

Unit II
Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **(7 Lectures)**
Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **(7 Lectures)**

Unit III

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.

(14 Lectures)

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. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. **(9 Lectures)**

Reference books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Paper Title: Thermal and Statistical Physics Lab
Paper Code: PHYMAJ204-4
Class: 30 Hrs. Lab class

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference books:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House

- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

Semester 4
Paper Title: Analog Systems and Applications (Electronics -I)
Paper Code: PHYMAJ205-4
Credit: 04 (3+0+1)
Lecture: 45

Course Objective:
This course is introduced to give knowledge about Semiconductors , Diodes, Transistors and their circuits as an application . In this course students can learn about RC-Coupled amplifiers, Feedback-amplifiers, Operational Amplifiers, Oscillators . This course will help the students to switch to Digital World.

Course Outcome:
After successful completion of this course students will learn about Semiconductor and their types P and N. About PN junction Diode , their characteristic . Application of Diode as rectifier, stabilized power supply, different types of diode, LED, Photodiode etc. Students will learn about PNP and NPN transistors, their characteristics and application as an Amplifier.
In this course students learn about different types of amplifiers RC-Coupled amplifiers and their frequency response , Feedback-amplifier-positive and negative type, Operational amplifier and their applications like, Adder, Substractor, Differentiator ,Integrator. This course also gives fear knowledge about Oscillators.

Unit I

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. Barrier Potential, Barrier width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode. **(6 Lectures)**

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. **(6 Lectures)**

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.

(4 Lectures)

Unit II

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 & C Amplifiers. **(7 Lectures)**

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(3 Lectures)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(3 Lectures)**

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **(4 Lectures)**

Unit III

Operational Amplifiers (Black Box approach): 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. **(4 Lectures)**

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. **(5 Lectures)**

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation). **(3 Lectures)**

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Paper Title: Analog systems and applications (Electronics -I) Lab
Paper Code: PHYMAJ205-4
Class: 30 Hrs. Lab class

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.

7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a $1^{st}/2^{nd}$ order differential equation.

Reference books:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

Semester 4
Paper Title: Radiation Safety
Paper Code: PHYMIN202-4A
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:*The aim of this course is for awareness and understanding regarding radiation hazards and safety. This course is designed to familiarize students with the various sources of natural and man-made radiation, the risks of working in areas with relatively high radiation levels, and safety measures to protect personal health. .*

Course Outcomes:*After completing the course, the students will acquire a basic knowledge of types and sources of radiations, interactions of radiations with matter, risks involved and safety measures to be taken.*

Unit I

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

(10 Lectures)

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons – Photo-electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons: Collision, slowing down and Moderation.

(10 Lectures)

Unit II

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermoluminescent Dosimetry**.** **(10 Lectures)**

Unit II

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

(8 Lectures)

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

(7 Lectures)

Paper Title: Radiation Safety Lab

Paper Code: PHYMIN202-4A

Class: 30 Hrs. Lab class

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

Reference Books:

- W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
- G.F.Knoll, Radiation detection and measurements
- Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook
- W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”. John Wright and Sons, UK, 1989.
- J.R. Greening, “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book Series,

No.6, Adam Hilger Ltd., Bristol 1981.

- Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
- Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
- NCRP, ICRP, ICRU, IAEA, AERB Publications.
- W.R. Hendee, “Medical Radiation Physics”, Year Book – Medical Publishers Inc. London, 1981

Semester 4
Paper Title: Waves and Optics
Paper Code: PHYMIN202-4B
Credit: 04 (3+0+1)
Lecture: 45

Course Objectives:

This paper reviews the concept of waves and optics learned at the school level from a more advanced perspective and builds new concepts. This course is divided into two main parts. The first part deals with Sound and waves. The second part pertains to optics and provides the details of interference, diffraction, and polarization.

Course Outcomes:

After the completion of this course, the students shall be able to learn the following-

- *The concept of superposition of waves and phenomena thus originated.*
- *Learn waves traveling through different mediums and parameters involved.*
- *Simple harmonic motion, superposition principle, and its application to find the resultant of superposition of harmonic oscillations.*
- *Concepts of vibrations in strings.*
- *Interference phenomenon arose out of the superposition of waves from coherent sources.*
- *Basic concepts of Diffraction: Fraunhofer and Fresnel Diffraction.*
- *Elementary concepts of the polarization of light.*
- *Michelson's Interferometer and its Applications.*

Unit I

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

(3 Lectures)

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

(2 Lectures)

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

Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to sawtooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. **(7 Lectures)**

Unit II

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

Interference: Interference: Division of amplitude and division of wave front. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. 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). Newton's Rings: measurement of wavelength and refractive index. **(9 Lectures)**

Unit III

Michelson's Interferometer: Idea of form fringes (no derivation needed), Determination of wavelength, Wavelength difference, Refractive Index and Visibility of fringes. **(3 Lectures)**

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zone Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(8 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(3 Lectures)**

Reference books:

- Principle of optics, B.K. Mathur, 1995, Gopal Printing
- FundamentalsofOptics,FAJenkinsandHEWhite, 1976,McGraw-Hill Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
- University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison-Wesley

Paper Title: Waves and Optics Lab
Paper Code: PHYMIN202-4B
Class: 30 Hrs. Lab class

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

Reference books:

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

****