Parvatibai Chowgule College of Arts and Science
Autonomous

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Best affiliated College-Goa University Silver Jubilee Year Award

F.133C/ 1165

October 27, 2015

All the members of the Board of Studies in Physics

Sub: Minutes of the second meeting of the Board of Studies in Physics held on 10th October, 2015

Sir/Madam,

I am forwarding the minutes of the second BoS in Physics meeting held on October 10, 2015 at the Parvatibai Chowgule College of Arts and Science (Autonomous), Margao. If no exception is taken by any member of BoS to the correctness of the minutes of the meeting within 5 days of the dispatch of the minutes, they shall be deemed to be correct.

Yours Sincerely,

Ananya Das

Dr. Ananya Das
Chairman
Board of Studies in Physics

Enlc: Minutes of the meeting.

Parvatibai Chowgule College of Arts & Science
(Autonomous)
Margao - Goa

MINUTES OF MEETING OF THE BOARD OF STUDIES IN PHYSICS

HELD ON 10th October 2015 AT 10:00 am.

Vide Chowgule College notice (F.133(C)/996 dated 25th September, 2015) a meeting of this BoS was convened on 10th October, 2015 at 10:00 am at the Conference Room, Parvatibai Chowgule College of Arts & Science, Margao – Goa. Since the members present represented the Quorum, the BoS began its proceedings.

Minutes are presented in the format.

Members present:

1. Dr. Ananya Das (Chairman)
2. Mrs. Malati Dessai
3. Mr. Yatin Desai
4. Dr. Reshma Raut Dessai
5. Ms. Placida Pereira
6. Prof. Kaustubh Priolkar (Academic Council Nominee)
7. Prof. A.V. Kulkarni (Academic Council Nominee)
8. Mr. Pramod Maurya (Industry Representative)
9. Mr. Deepak Kumar (Postgraduate Alumni)
10. Dr. Ashish M. Desai (Member Secretary)

Members Absent with Intimation

1. Dr. Preeti Bhobe (Vice-Chancellor Nominee)

Proceedings

The Chairperson welcomed the members of the Board of Studies (BoS). The Chairperson introduced and explained the agenda for the meeting and Board transacted the following business:

Agenda Items:

1. To discuss and approve the modified list of core and elective courses for the undergraduate program in Physics.
2. To discuss and approve the syllabi of Semester III and Semester IV for the academic year 2016-17.
3. To discuss and approve the Question Paper Pattern for the Semester End Examination.
4. Any Other Business (A.O.B.)

PART A: Resolutions

1. The BoS passed the following resolutions with respect to titles of core and elective courses.
   i. The course entitled "Material Science" replaced by "Solid State Physics".
   ii. The course entitled "Introduction to Nanoscience" replaced by "Introduction to Material Science".
   iii. The course entitled "Statistical Physics" replaced by "Thermodynamics and Statistical Mechanics".

2. The Chairman explained the need to have flexibility in reshuffling/ replacing the elective courses between the semesters of the B.Sc. program. Having agreed with the Chairman, BoS passed the resolution to provide flexibility to the department of Physics in reshuffling/ replacing the elective courses between the semesters.

3. The list of core and elective courses for undergraduate program in Physics for the Semester III, IV, V and VI were discussed and modified. The revised list is presented in **Annexure I.**

4. The syllabi of undergraduate courses were presented and discussed at the meeting. After minor changes the BoS approved the syllabi of the courses for Semester III and IV. The redrafted syllabi of Semester III and Semester IV are presented in **Annexure II.**

5. The general guidelines for setting question papers for the Semester End Examination prepared by the Faculty of Science were read out by the Chairman at the meeting. The BoS passed the resolution to approve the pattern of the question paper that provided overall choice to students and accept all other conditions attached to that pattern of the question paper. The pattern of the Question paper is presented in **Annexure III.**

PART B: Resolutions/Recommendations of BoS that require consideration / approval of Academic Council:

1. The list of core and elective courses presented in Annexure I.
2. Flexibility to the Department of Physics in shuffling and replacing the elective courses between the semesters of the B.Sc. program in Physics.
3. The syllabi of Semester III and Semester IV presented in Annexure II.
4. The pattern of the Question paper presented in Annexure III.

The foregoing minutes of the meeting are circulated by the Chairman on 27th October, 2015.

The Chairman thanked the members of Board of Studies in Physics for their valuable contribution and active participation.

The meeting ended at 4:00 pm.

The following members of Board of Studies in Physics were present for the meeting:

1. Dr. Ananya Das (Chairman)
2. Mrs. Malati Dessai
3. Mr. Yatin Desai
4. Dr. Reshma Raut Dessai
5. Ms. Placida Pereira
6. Prof. Kaustubh Priolkar (Academic Council Nominee)
7. Prof. A.V. Kulkarni (Academic Council Nominee)
8. Mr. Pramod Maurya (Industry Representative)
9. Mr. Deepak Kumar (Postgraduate Alumni)
10. Dr. Ashish M. Desai (Member Secretary)

Due to prior commitments Dr. Preeti Bhobe (Vice-Chancellor Nominee) conveyed her inability to attend the meeting.

Dr. Ashish M. Desai
Member Secretary
BoS (Physics)

Ananya Das

Dr. Ananya Das
Chairman
BoS (Physics)

Date: 27th October, 2015

PART C: The remarks of the Dean of the Faculty:-

a. The minutes are in order
b. The minutes may be placed before the Academic Council with remark, if any.
c. Important points of the minutes which need clear policy decision of the Academic council to be recorded.

Date:

Signature of the Dean: Ananya Das
(Faculty of Science) (Dr.Ananya Das)

Annexure I

Core Papers for Major in Physics (CC)

Sr. No	Semester	Title of the Paper	Code
1	I	Introduction to Mathematical Physics	PHY-I.C-1
2	I	Mechanics-I	PHY-I.C-2
3	II	Heat and Thermodynamics	PHY-II.C-3
4	II	Electricity and Magnetism	PHY-II.C-4
5	III	Electromagnetic Theory-I	PHY-III.C-5
6	IV	Quantum Mechanics	PHY-IV.C-6
7	V	Electromagnetic Theory-II	PHY-V.C-7
8	VI	Atomic and Molecular Physics	PHY-VI.C-8

Elective Papers for Major in Physics (CE)

Sr. No	Semester	Title of the Paper	Code
1	III	*Optics	PHY-III.CE-1
2	III	Modern Physics	PHY-III.CE-2
3	III	Oscillations, Waves and Sound	PHY-III.CE-3
4	III	Properties of Matter and Acoustics	PHY-III.CE-4
5	IV	*Electronics-I	PHY-IV.CE-5
6	IV	Solid State Devices	PHY-IV.CE-6
7	IV	Computational Physics	PHY-IV.CE-7
8	IV	Astronomy and Astrophysics/ Instrumentation	PHY-IV.CE-8
9	V	*Solid State Physics	PHY-V.CE-9
10	V	Thermodynamics and Statistical Mechanics	PHY-V.CE-10
11	V	Electronics-II	PHY-V.CE-11
12	V	Introduction to Physical Oceanography	PHY-V.CE-12
13	VI	*Mechanics II	PHY-VI.CE-13
14	VI	Nuclear and Elementary Particle Physics	PHY-VI.CE-14
15	VI	Introduction to Special Theory of Relativity	PHY-VI.CE-15
16	VI	Introduction to Material Science	PHY-VI.CE-16

***** Electives are compulsory

Core Compulsory Papers for Minor in Physics (CM)

Sr. No.	Semester	Title of the Paper	Code
1	I	Mechanics, Properties of Matter and Sound	PHY-I.CM-1
2	II	Electricity, Magnetism and Electronics	PHY-II.CM-2
3	III	Elementary Modern Physics	PHY-III.CM-3
4	IV	Heat and Optics	PHY-IV.CM-4
5	V	Solid State Physics	PHY-V.CM-5
6	VI	Atomic and Nuclear Physics	PHY-VI.CM-6

Annexure II

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester III and Semester IV

for the undergraduate course

in

Physics

(2016-2017)

Core and Elective Courses for students taking Physics as their Major subject.

Semester III:

1. Electromagnetic Theory-I
2. Optics
3. Modern Physics
4. Oscillation, Waves and Sound
5. Properties of Matter and Acoustics

Semester IV:

1. Quantum Mechanics
2. Electronics-I
3. Solid State Devices
4. Computational Physics
5. Astronomy and Astrophysics
6. Instrumentation

Courses for students taking Physics as their Minor subject.

Semester III

1. Elementary Modern Physics

Semester IV

1. Heat and Optics

Paper Title	**:**	**Electromagnetic Theory – I**
Paper Code	**:**	**PHY-III.C-5**
Name of Faculty	**:**	**Yatin P. Desai**
Marks	**:**	**75 (Theory) + 25 (Practical)**
Credits	**:**	**3 (Theory) + 1 (Practical)**
Contact Hours	**:**	**45 (Theory) + 30 (Practical)**

**Course Objectives : **To acquaint students with fundamental principles of Electrostatics part of the Electromagnetic Theory.

**Learning Outcome : **At the end of this course students would understand interaction between charges, the concept of electric field, electric potential in vacuum as well as in matter. Students would also learn techniques to solve electrostatic problems.

Pre-requisite: Electricity and Magnetism (PHY-II.C-4) and Introduction to Mathematical Physics (PHY-I.C-1)

Theory:

1. **Vector Analysis** **[8L]**

1.1. Vector Algebra: Vector Operations, Vector Algebra: Component form, Triple Products, Position, Displacement and Separation Vectors
[Ref. No. 1 pp. 1 – 8]

1.2. Differential Calculus: Ordinary Derivatives**,** Gradient**,** The Operator ∇**,** The Divergence and Curl**,** Product Rules**,** Second Derivatives
[Ref. No. 1 pp. 13 – 22]

1.3 Integral Calculus: Line, Surface and Volume Integrals, The fundamental Theorem for Divergences**,** The fundamental Theorem for Curls.
[Ref. No. 1 pp. 28, Ref. No. 2 pp. 20, Ref. No. 2 pp. 26]

1.4 Different Co-ordinate Systems: Cartesian Co-ordinate System, Cylindrical Co-ordinate System, Spherical Co-ordinate System, Some Useful Vector Identities with Proofs
[Ref. No. 2 pp. 36, Ref. No. 2 pp. 30-31]

2. **Electrostatics** **[15L]**

2.1. The Electric Field: Coulomb’s Law, The Electric Field, Continuous Charge Distributions.

2.2. Divergence and Curl of Electrostatic Fields: Field Lines, Flux and Gauss's Law**,** The Divergence of E**,** Applications of Gauss's Law**,** The Curl of E.

2.3. Electric Potential: Introduction to Potential**,** Poisson's Equation and Laplace's Equation**,** Potential of a Localised Charged Distribution**,** Summary: Electrostatic Boundary Condition.

2.4. Work and Energy in Electrostatics: Work Done to Move a Charge**,** The Energy of a Point Charge Distribution**,** The Energy of a Continuous Charge Distribution**,** Comments on Electrostatic Energy.

2.5. Conductors: Basic Properties of Conductor, Induced Charges, Surface Charge and the Force on a Conductor,Capacitors.

[Ref. No. 1, pp. 58 – 103]

3. Techniques to Solve Electrostatic Problems [8L]

3.1. Poisson's Equation

3.2. Laplace's Equation: Laplace's Equation in One Dimension, Laplace's Equation in Two Dimensions, Laplace's Equation in Rectangular Co-ordinates, Solution to Laplace's Equation in Spherical Co-ordinates (Zonal Harmonics).

3.3. Conducting Sphere ina Uniform Electric Field

3.4. Electrostatic Images: Point Charge and Conducting Sphere**,** Line Charge and Line Images.

[Ref. No. 3 pp. 51 – 67]

4. Electrostatic Field in Matter [8L]

Polarization, Gauss's Law in a Dielectric, Electric Displacement Vector, Electric Susceptibility and Dielectric Constant, Boundary Conditions on the Field Vectors, Boundary Value Problems Involving Dielectric, Dielectric Sphere in a Uniform Electric Field

[Ref. No. 3 pp. 75 – 93]

5. Microscopic Theory of Dielectrics [6L]

Molecular field in a dielectric: ClausiusMossotti Relation, Polar and Non-Polar Molecules, Induced Dipoles,Langevin's Debye Formula, Permanent Polarization, Ferroelectricity.

[Ref. No. 3 pp. 101 – 109]

Experiments: (Minimum Six)

1. Vandegraff Generator.
2. Measurement of dielectric constant and susceptibility of liquid using parallel metal plates.
3. Measurement and Study of variation of dielectric constant of $BaTiO_3$ ferroelectric and determination of its Curie temperature.
4. E and D measurement for a parallel plate capacitor and calculation of dielectric constant.
5. Law of Capacitance using Dielectric Constant Measurement Kit.
6. Absolute capacity by ballistic galvanometer.
7. C_1/C_2 by De-Sauty's method using ballistic galvanometer.
8. Dipole Moment and Polarizability of Benzene.

References:

1. Griffiths D. J., Introduction to Electrodynamics, Prentice Hall of India, 3rd Ed. (2011)
2. Harper Charlie, Introduction to Mathematical Physics, Prentice Hall of India, 5th reprint, (1993)
3. Reitz J. R., Milford F. J., Christy R. W., Foundations of Electromagnetic Theory, Addison-Wesley Publishing Company, 3rd Ed., (1979)

Additional Reference:

1. Mukherji U., Electromagnetic Field Theory and Wave Propagation, Narosa Publishing House, (2008)

Paper Title : **Optics**

Paper Code : **PHY-III.CE-1**

Name of Faculty : **Ananya Das**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The course aims to enable the students to develop understanding towards the different phenomena exhibited by light.

Learning Outcome: On completion of this course, the students will be able to:

- understand the image formation for various optical systems.
- differentiate between optical phenomena like Interference, Diffraction and Polarization.
- correlate the theoretical basis of various concepts of Geometrical Optics and Physical Optics while performing experiments.

Pre-requisite: Nil.

Theory:

Unit-I **[13 L]**

Geometrical Optics: (5 L)

Fundamentals of Reflection and Refraction: Refractive index and optical path, Fermat's Principle of least time, Derivation of the laws of reflection and refraction using Fermat's Principle.

Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).

[Ref.1: Chapter.1: 1.6, 1.7; Ref.2: Chapter.1: 1.2, 1.3, 1.4; Ref.1: Chapter.4: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 4.17; Chapter.5: 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 5.10, Chapter.6: 6.1, 6.2]

Lens Aberrations: (4 L)

Introduction, Types of aberrations: monochromatic and chromatic aberration, Monochromatic aberration and its reduction: Spherical aberration, Types of chromatic aberration: Achromatism (lenses in contact and separated by finite distance).

[Ref.1: Chapter.9: 9.1, 9.2, 9.5, 9.5.1, 9.10, 9.11, 9.12, 9.13]

Optical Instruments: (4 L)

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece, Telescopes, Refracting and Reflecting type of telescopes and Constant deviation Spectrometer.

[Ref.1: Chapter.10: 10.8, 10.10, 10.10.1, 10.11, 10.11.1,10.12, 10.15, 10.15.1, 10.16, 10.16.1, 10.17]

Unit-II **[10 L]**

Interference: (6L)

Introduction: Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Young's Double Slit Experiment, Phase Change on reflection: Stoke's law.

[Ref.1: Chapter.14: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Ref.2: Chapter6: 6.3]

Interference in Thin Films: Thin Film, Plane Parallel Film, Interference due to Transmitted light, Haidinger Fringes, Wedge-shaped Film, Newton's Rings.

[Ref.1: Chapter.15: 15.1, 15.2, 15.2.1 to 15.2.5, 15.3, 15.4, 15.5, 15.5.1 to 15.5.4, 15.6, 15.6.1 to 15.6.9]

Interferometry: (4L)

Michelson's Interferometer: Principle, Construction, Working, Circular Fringes, Localised Fringes, White Light Fringes, Application of Michelson's Interferometer: Measurement of Wavelength and Determination of the difference in the wavelength of two waves.

[Ref.1: Chapter.15: 15.7, 15.7.1 to 15.7.5, 15.8, 15.8.1, 15.8.2]

Unit-III **[12 L]**

Diffraction: (5L)

Difference between Interference and Diffraction, Types of diffraction: Fresenel Class and Fraunhoffer Class.

[Ref.1: Chapter.17: 17.6, 17.7 and Ref.2: Chapter7: 7.5, 7.6]

Diffraction of Light (Fresnel Class):

Division of cylindrical wave-front into Fresnel's half period strips, Diffraction at straight edge, Diffraction at a narrow wire.

[Ref.2: Chapter.7: 7.9, 7.10, 7.11]

Diffraction of Light (Fraunhoffer Class): (7L)

Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit, Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Diffraction at N slits(only conceptual), Determination of wavelength of a spectral line using Plane Transmission Grating.

Resolving Power, Rayleigh's criterion, Resolving power of telescope and Resolving Power of Prism.

[Ref.1: Chapter.18: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 18.7, 18.7.1, 18.7.2, 18.7.6 and Chapter.19: 19.1, 19.2, 19.6, 19.7, 19.11]

Unit-IV **[10 L]**

Polarization:

Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Effect of Polarizer on Natural Light, Effect of Analyser on Plane Polarized Light, Types of Polarized Light, Retardation plates - Quarter wave plate and Half wave plate, Production of Elliptically and Circularly Polarized Lights, Detection of plane, circularly, elliptically polarized lights, Analysis of polarized light, Optical activity, Specific rotation, Simple Polarimeter, Laurent's Half-Shade Polarimeter.

[Ref.1: Chapter.20: 20.3, 20.4, 20.5, 20.5.1 to 20.5.5, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.6.3, 20.15, 20.17.1, 20.17.2, 20.18, 20.18.1, 20.19, 20.19.1, 20.20, 20.24, 20.24.1, 20.25, 20.26]

Experiments:(Minimum six)

1) Cardinals points of Two lenses
2) Prism Spectrometer: Optical levelling, Angle of Prism
3) Dispersive power of prism
4) Newton's Rings
5) Single Slit Diffraction
6) Diffraction Gratings
7) Brewster's Law
8) Polarimeter
9) Lloyd's Mirror/Biprism (Demonstration)
10) Cylindrical Obstacle (Demonstration)

References:

1. Subhramanyam N., Lal Brij, Avadhanulu M. N., A Text book of Optics, S. Chand & Company Ltd., New Delhi, Firstmulticolour Edition (2006).
2. Singh S. P. and Agarwal J. P., Optics, PragatiPrakashan, 8th Edition (2001).

Additional References:

1. Mathur B. K., Principles of Optics, New Global Printing Press, Kanpur.
2. GhatakAjoy, Optics, Tata McGraw-Hill Publicashing Company Ltd. (1977)
3. Jenkins F. A. and White H. E., Fundamentals of Optics, Tata McGraw-Hill Publishing Company Ltd., (1981)

Paper Title : Modern Physics

Paper Code : PHY-III.CE-2

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objective: Modern Physics involves the study of radiation and matter at atomic levels and velocities close to the speed of light. This course will focus on the early development of the theory of atomic structure, wave particle duality, elementary nuclear physics and Lasers. Lectures will help you clarify concepts of modern physics through various conceptual questions and problems.

Learning Outcome: After completion of this course, students will develop a comprehension of broad knowledge in modern physics. Students will also acquire the necessary skills for critical thinking and problem solving.

Pre-requisite: Nil.

Theory:

1. **Electrons, Nucleus and Atoms: [5L]**
   Determination of e/m for cathode rays. Thomson's model of the atom and qualitative discussion of alpha scattering experiment. Rutherford's model of the atom. Determining upper limit to nuclear dimension. Electron orbits. Failure of Classical Physics.
   [Rajam: Pages 33-36, 44-50; Beiser: 5.1, 5.3, 5.5-5.7]

2. **Brief review of Atomic models: [6L]**
   Atomic Spectra. Frank-Hertz experiment. The Bohr Atom: Quantization of energy. Bohr-Sommerfeld model. Nuclear motion and reduced mass. Bohr's Correspondence Principle.
   [**Beiser: 6.1-6.8]**

3. **Particle Properties of waves: [4L]**
   Conepts of Blackbody radiation.The Photoelectric effect. Compton Effect. Experimental verification of the Photoelectric effect.
   [Beiser: 3.1,3.2, 3.5; Muregeshan: 8.5]

4. **Wave Properties of Particles:** **[6L]**
De Broglie's hypothesis. Electron Diffraction experiment of G. P. Thomson. Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons. The uncertainty principle and its application.
[Beiser 4.1-4.8; Feynman 1.1-1.8]

5. **Properties of the Nucleus:** **[3L]**
Nuclear sizes. Nuclear spin. Binding energy, B.E versus A plot. Saturation of nuclear forces.
[Beiser: 21.2, 21.4-21.6]

6. **Nuclear Forces and Models:** **[5L]**
Main characteristics of Nuclear Forces. Meson theory of Nuclear forces. Yukawa potential. Brief discussion of the Liquid drop Model and Shell Model.
[Beiser: 22.4-22.6]

7. **Radioactivity and Radioactive Decay:** **[8L]**
The law of Radioactivity Decay. Mean lifetime. Half life and Decay constant. Successive radioactive transformation (A-B-C) type, Ideal transient and secular equilibrium. Radioactive series. Carbon dating. Artificial radioactivity. Brief qualitative discussion on apha decay, beta decay and gamma decay.
[Patel: 2.3, 2.6-2.9, 2.11, 2.13; Beiser: 23.3, 23.6-23.10]

8. **Nuclear Fission and Nuclear Fusion:** **[4L]**
Nuclear fission. The chain reaction. Transuranic elements. Thermonuclear energy
[Beiser: 24.7-24.10]

9. **Lasers:** **[4L]**
Attenuation of light in an optical media. Thermal Equilibrium. Interaction of light with matter. Einstein's A and B coefficients and their relations. Population inversion. Principal pumping schemes. Ruby Laser and He-Ne Laser. Applications of Laser.
[Subrahmanyam: 22.1-22.8, 22.10, 22.14.1, 22.14.3, 22.19]

Experiments: (Minimum Six)

1. Determination of e/m of electrons using Thomson's method.
2. Measurement of k/e.
3. Measurement of diameter of Lycopodium powder.
4. To determine wavelength of Laser source by diffraction of single slit.
5. To determine wavelength of Laser source by diffraction of double slit.
6. Frank Hertz Experiment.
7. Photoelectric effect.
8. Geiger Muller Counter (Demonstration).

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.
2. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
3. Kakani, S. 2011, *Modern Physics*, Viva Books private limited, New Delhi.
4. Murugeshan, R 2009, *Modern Physics,* S. Chand and Company limited, New Delhi.
5. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd ed. New Age Inernational Limited, New Delhi.
6. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
7. Subrahmanyam, N., Lal, B. and Avadhanulu, M. 2004, *A Textbook of Optics*, S. Chand and Company limited, New Delhi.

Additional References:

1. Ghatak 2012, *Optics*,Mcgraw Hill Education, India.
2. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. McGraw-Hill Book Company, New Delhi.
3. Tipler, P. 2012, *Modern Physics*, WH Freeman, New York.

Paper Title : Oscillations, Waves and Sound

Paper Code : PHY-III.CE-3

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Prerequisite: Introduction to Mathematical Physics (PHY-I.C-1)

Course Objectives: Simple harmonic motion is one of the fundamental types of motion that exists in nature. The objective of this course is to cover the fundamental physical concepts of Simple harmonic motion, waves and sound.

Learning Outcome: After successful completion of this course, students will be able to

- Understand the behavior of oscillations and waves in nature
- Understand systems of single and multiple harmonic oscillators and appreciate the role of driving and damping harmonic systems.
- Demonstrate understanding of nature of sound waves and the Doppler Effect.

Theory:

1. **Undamped free oscillation** **[15L]**

   Different type of equilibria (Stable, unstable and neutral equilibrium). Periodic oscillations and potential well.
   [Mathur: 5.9]

   Differential equation for simple harmonic oscillator and its solutions. Energy of the harmonic oscillator.
   [Taylor: 5.1-5.2]

   Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, torsional pendulum, bifilar oscillations, Helmholtz resonator.

[Mathur: 7.7.1-7.7.5]

Superposition of two simple harmonic motions of the same frequency along the same line. Superposition of two mutually perpendicular simple harmonic vibrations of the same frequency. Superposition of two mutually perpendicular simple harmonic vibrations and having time periods in the ratio 1:2. Uses of Lissajous' figures.
[Subrahmanyam: 2.1, 2.2, 2.4, 2.6, 2.9]

2. **Damped Oscillations** **[8L]**
   Introduction. Differential equation of damped harmonic oscillator and its solution, discussion of different cases (Strong, weak and Critical damping). Logarithmic decrement. Energy equation of damped oscillations. Power dissipation.Quality factor.
   [Taylor: 5.4 and Mathur: 8.2-8.4]

3. **Driven Damped Oscillations** **[6L]**
   Introduction, Differential equation of forced oscillation and its solution (transient and steady state). Resonance.Width of the resonance; the Q factor. The phase at resonance. Velocity resonance.
   [Taylor: 5.5-5.6 and Mathur: 8.9]

4. **Waves and Sound** **[10L]**
   Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace's correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel.

   Production and detection of Ultrasonic waves and its applications
   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subrah.: 11.23 11.25,11.27]

5. **Doppler Effect:** **[6L]**
   Explanation of Doppler effect in sound. Observer in rest and source in motion. Source at rest and observer in motion. When both source and observer are in motion. Effect of wind velocity. Doppler effect in light. Applications of Doppler effect.
   [Subrahmanyam: 8.1-8.6]

Experiments: (Minimum Six)

1. To determine the equivalent length of the Kater's pendulum and the acceleration due to gravity using a resonance pendulum.
2. To determine the damping constant using Damped harmonic oscillator
3. To determine the velocity of Sound using Helmholtz resonator
4. To determine the value of acceleration due to gravity using a bar pendulum.
5. To determine the frequency of AC mains using Sonometer.

6. Bifilar suspension: Dependence of the time period on the geometry of non-parallel bifilar suspension.
7. Log Decrement.
8. Velocity of Sound using CRO.
9. Lissajous Figures (Demonstration).

References:

1. Khanna, D. and Bedi, R. 1992, *A Textbook of Sound*, Atma Ram and sons, Delhi.
2. Mathur, D. 2012, *Mechanics*, S. Chand, New Delhi.
3. Taylor, J. 2005, *Classical Mechanics*, University Science Books, USA
4. Subrahmanyam, N. and Lal, B. 1994, Waves and Oscillation, Vikas Publishing House, Noida

Additional References:

1. French, AP 2003, Vibration and Waves, CBS Publisher, India.
2. Halliday, D., Resnick, R. and Walker, J. 2003, Fundamentals of Physics, 6th edition, John Wiley and Sons, USA.
3. Pain, J. 2005, *The Physics of Vibration and Waves*, 6th Edition, Wiley.

Paper Title	**: Properties of Matter and Acoustics**
Paper Code	**: PHY-III.CE-4**
Name of Faculty	**: Malati Dessai**
Marks	**: 75 (Theory) + 25 (Practical)**
Credits	**: 3 (Theory) + 1 (Practical)**
Contact Hours	**: 45 (Theory) + 30 (Practical)**

Course Objectives: This course provides an introduction to dynamics of rigid bodies and calculation of moment of inertia, properties of matter and acoustics of rooms. An objective of this course is to build up an understanding of fundamental physical principles which are required for most of other physical sciences.

Learning Outcome: After successful completion of this course,

- Students will gain an introductory knowledge of dynamics of rigid bodies, and its applications to basic physical problems.
- They will have knowledge of acoustics of rooms and musical scales.
- Students will be able to comprehend the phenomenon of elasticity, surface tension, viscosity and their application.

Pre-requisite: Nil.

Dynamics of Rigid bodies: [11L]

Rigid bodies, Rotational Kinetic energy, Moment of inertia and its physical significance, Angular acceleration, angular moment, law of conservation of momentum, Analogy between translatory and rotatory motion, Theorem of perpendicular axis, Theorem of parallel axis, Moment of inertia of thin uniform bar, Moment of Inertia of a bar about an axis passing through one end and perpendicular to its length, Moment of Inertia of a bar about an axis perpendicular to its at a distance 'a' from one end, Moment of inertia of rectangular lamina, Moment of inertia of solid uniform bar of rectangular cross section, Moment of inertia of ring, Moment of inertia of disc, ,Moment of inertia of Annular disc, Moment of inertia of hollow cylinder, Moment of inertia of solid sphere, ,Moment of inertia of hollow sphere, Moment of inertia of spherical shell, ,Moment of inertia of a uniform elliptical lamina, Moment of inertia of a uniform triangular lamina, Moment of inertia of a solid cone.

[Reference#1 : Section 3.1-3.25]

Properties of Matter Elasticity: [12L]

Modulii of elasticity, Poisson's ratio and relationship between them.Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. A vibrating cantilever.Torsion in a string-couple per unit twist, Torsional Pendulum.

[Reference # 2, Section 8.8, 8.9, 8.12, 8.13, 8.14, 8.15, 8.16, 8.17, 8.18, 8.22, 8.26, 8.29, 8.30(a(i)), 8.32, 8.33(i)]

Surface Tension: [6L]

Brief review of molecular theory of surface tension.Relation between surface tension and surface energy. Excess pressure inside a spherical Liquid drop, difference of pressure across a curved surface,Angle of contact. Capillarity-rise of liquid in a capillary tube.

[Reference # 2, Section 14.1, 14.2, 14.3, 14.4 14.6, 14.8, 14.14, 14.15 and 14.17]
[Reference #1 section 8.7 -8.9]

Viscosity **[9L]**

Equation of continuity: Euler's equation for liquid flow, Bernoulli's theorem and its applications. Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube. Criticism of Poiseuille's equation

[Reference # 2, Section 12.1 - 12.12 (12.8 upto equation b)]

Acoustics of Rooms and Musical Scales **[7L]**

Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine's formula for reverberation time (discussions only) , Acoustic requirements of an auditorium. Musical interval, harmony, melody.Diatonic scale. Tempered scale. (only concepts)

[Reference # 3, Section: 23.1-23.17, Section:17.1-17.12]

Experiments: (Minimum Six)

1) Cantilever : Determination of Young's modulus by vertical vibrations of a cantilever.
2) Torsional Pendulum : Determination of Rigidity Modulus of the material of a wire.
3) Jagger's Method : Determination of Surface Tension
4) Viscosity of a liquid by Poiseuilles method
5) Bending of beams: determination of Young's modulus
6) Capillarity: determination of Surface tension
7) Flat Spiral Spring: determination of elastic constants by vertical and torsional oscillations of a loaded spring
8) Young's Modulus of Brass by Flexural Vibrations of Bar.
9) Rigidity Modulus of Brass.

References:

1) Properties of matter by Brij Lal N. Subrahmanyam, Eurasia Publishing House New Delhi (1999)
2) Elements of Properties of Matter, by D. S. Mathur, S. Chand and Company, New Delhi.
3) Text book of Sound. D. R. Khanna and R.S. Bedi, Atma Ram, New Delhi (1994).

Additional References:

1) Sound. F. G. Mee, Heinemann Ltd., London (1967)
2) Newman and Searle, General properties of Matter
3) C. J. Smith, Properties of Matter

Paper Title : **Quantum Mechanics**

Paper Code : **PHY-IV.C-6**

Name of Faculty : **Ashish Desai and Yatin Desai**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The objective of this course is to provide an introduction to quantum mechanics and its application.

Learning Outcome: On successful completion of this course, the students will be able to

1. develop a knowledge of the origin of Quantum Physics.
2. understand the wavelike properties of matter and interpret experiments displaying it.
3. understand the concepts and principles of quantum mechanics.
4. solve the Schrödinger equation to obtain wave functions for some important types of potential in one dimension.

Pre-requisite: Nil

Theory:

1. Review of Particle-like Properties of Radiation: **[3L]**

Black body radiation and Plank's constant. Einstein's quantum theory of the Photoelectric effect. Compton effect. The dual nature of electromagnetic radiation.

[Singh: 1.1-1.3], [Eisberg: 2.1-2.5]

2. De Broglie's Postulate - Wavelike properties of Particles: **[12L]**

- **2.1. Dual nature of matter:** Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons.
  [Feynman: 1.1-1.6]
- **2.2. Matter Waves**: De Broglie's postulate. Davisson and Germer experiment. Electron diffraction experiment of G. P. Thomson. Review of the Bohr's postulate about stationary states in the light of De Broglie's concepts.
  [Eisberg: 3.1], [Singh: 2.8]
- **2.3. Properties of Matter waves:** Wave and group velocities. Relation between the group velocity and phase velocity. Velocity of De Broglie wave. Wave packet and its motion in one dimension.
  [Singh: 2.3-2.5, 2.9]
- **2.4. The Philosophy of Quantum Theory**: Copenhagen interpretation of Bohr and Heisenberg; points of view of Einstein and De Broglie.
  [Eisberg: 3.6]

3. Heisenberg's Uncertainty Principle: **[5L]**

Uncertainty principle. Elementary proof of Heisenberg's uncertainty relation between position and momentum. Elementary proof of Heisenberg's uncertainty relation between energy and time. Illustration of Heisenberg's uncertainty principle with thought-experiments. Consequences of the uncertainty relation.

[Singh: 3.1-3.5]

4. Schrödinger's Theory of Quantum Mechanics: **[10L]**

4.1 Max Born's Interpretation of the wave function: Wavefunction. Complex character of the wave function. Wave function as computational devices. Probability density. Acceptable wave function. Normalisation of wave function.
[Beiser: 4.2], [Eisberg: 5.3]

4.2 Schrödinger's Wave Equation: One dimensional time-dependent Schrödinger's wave equation. One Dimensional Time-Independent Schrödinger's Wave Equation. Operators in quantum mechanics: position, momentum, kinetic energy, Hamiltonian, total energy, angular momentum. Eigen function, eigen value and eigen value equation. Expectation values. Postulates of quantum mechanics.
[Singh: 4.1 – 4.6]

5. **Applications of Schrödinger's Steady state equation:** **[15L]**

5.1 Free particle.
5.2 One dimensional infinite rectangular potential well (Particle in a one dimensional box). Concept of parity, parity operator and its eigen values.
5.3 Particle in a three dimensional rigid box. Degree of degeneracy.
5.4 One dimensional step potential of finite height (Energy less than step height and energy greater than step height)
5.5 One dimensional potential barrier. Tunnel effect. Tunnel diode. Qualitative discussion of alpha decay,
5.6 One dimensional finite rectangular potential well (placed symmetric to origin). Parity and parity operators,
5.7 One dimensional harmonic oscillator (Algebraic method using raising and lowering operators and analytical method.)
[Singh: 5.2], [Eisberg: 6.2 – 6.9], [Griffiths: 2.3]

Experiments:

1. Stefan's law
2. Photo-electric effect
3. Tunnel Diode I-V Characteristics: Tunnel Effect
4. Tutorial based on De Broglie's hypothesis and Dual nature of radiation/ matter
5. Tutorial based on Concepts of Wave Packets: Group Velocity and Phase Velocity
6. Tutorial based on Concepts of Uncertainty Principle
7. Tutorial based on Concepts of Wave function: Normalisation, Probability distribution and Expectation Values
8. Tutorial based on Quantum mechanical Operators
9. Tutorial-I based on Application of One dimensional Time-Independent Schrodinger's Wave Equation
10. Tutorial-II based on Application of One dimensional Time-Independent Schrodinger's Wave Equation

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
4. Griffiths, D. 2015, *Introduction to Quantum Mechanics*, Pearson Education, India.
5. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics*, S. Chand, New Delhi.

Additional References:

1. Flugge, S. 2008, *Practical Quantum Mechanics*, Springer (SIE).
2. Rajasekar, S. and Veluswamy, R. 2014, *Quantum Mechanics I: The Fundamentals*, CRC Press, New York.
3. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.
4. Verma, H. 2012, *Quantum Physics*, TBS, Calicut.
5. Wichmann, E. 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, Tata McGraw-Hill Book Company, New Delhi.

Paper Title : **Electronics-I**

Paper Code : **PHY-IV.CE-5**

Name of Faculty : **Malati Dessai**

Marks : **75 (Theory) + 25 (Practical)**

Credits :**3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The general goal of this course is to allow the students to understand the fundamentals of semiconductor behavior and the operation of basic semiconductor devices. This course lays the foundations for the understanding of more advanced semiconductor devices such as those covered in more advanced courses.

Learning Outcome: In this course, students will study basic circuit laws; semiconductor based analog circuits from a fundamental point of view. It extends this knowledge to descriptions of bipolar transistors and its applications. A discussion of feedback leads to the study of operational amplifier and sinusoidal oscillators.

Pre-requisite: Nil

Theory:

1. Basic concepts and resistor circuits [8L]
   Basics of current and voltages in a circuit, Constant voltage and Constant current source, Conversion of voltage source into current source, Maximum power transfer theorem, Kirchoff's Current and voltage Law, Thevenin's theorem and Norton's theorem,Techniques for solving circuit problems.
   [Reference #1 section1.1, 1.2.1.3, 1.2.3, Reference #2 section 1.8-1.16]

2. Semiconductor Diodes [10L]
   Semiconductor materials- intrinsic and extrinsic types, Ideal Diode, Terminal characteristics of diodes: p-n junction under open circuit condition, p-n junction under forward bias and reverse bias conditions, Diode I-V characteristic and load line for a simple diode circuit,Diodeapplications:Voltage dropper, Diode limiter, Variable diode clipper, Diode clamp, Rectification-working of Half wave and Full wave – calculation of efficiency, nature of rectifier output, comparison of rectifiers, Power supply filters (capacitor filter)
   [Reference #1 section 3.1.3, 3.1.4, 3.2.1-3.2.4, Reference #2 section 5.8-5.18,6.7-6.21]

3. Bipolar Junction Transistors (BJTs) [10L]
   Physical structure and operation modes, Transistor action, Transistor as an amplifier, Basic BJT amplifier configuration: common emitter, common base and common collector connections and their characteristics, comparison of transistor connections, Transistor as an amplifier in C-E mode, Active region operation of transistor, D.C. analysis of transistor circuits, performance of transistor amplifier, cut off and saturation points, power rating of

transistor.Biasing the BJT: fixed bias, emitter feedback bias, collector feedback bias and voltage divider bias.
[Reference #2 section 8.1- 8.23, 9.1-9.12, Reference #1 section 4.1-4.4]

4. **Sinusoidal oscillators** **[8L]**
   Positive and negative feedback,Voltage and current feedback, series and shunt feedback, Effect of negative feedback on gain, frequency response, input and output resistance and distortion, Positive feedback, Barkhausen criterion for oscillations, Phase shift oscillator, Wein bridge oscillator, Hartley oscillator and Colpitts oscillator.
   [Reference #2 section13.1-13.13 ,14.1-14.14, Reference #1 section 7.3-7.3.4.1]

5. Operation Amplifier (Op-amps) [9L]
   Ideal Op-amp, operation of differential amplifier, differential and common mode signals, common mode rejection ratio (CMRR), d.c. analysis of differential amplifier , parameters of differential amplifier due to mismatch of transistors,bandwidth of an Op-amp, Slew rate limiting, Frequency response, Practical op-amp circuits: inverting amplifier, non –inverting amplifier, integrator, differentiator.
   [Reference #2 section 25.1-25.5,25.9,25.11,25.15,25.19,25.21,25.23,25.35,25.37, Reference #1 section 6.1,6.3,6.4]

Experiments: (Minimum Six)

1. Half wave rectifier using Junction Diode
2. Full wave rectifier using Junction Diode
3. Bridge rectifier with capacitor filter- Ripple factor using CRO.
4. C.E. Amplifier: Gain v/s Load
5. C.E. Amplifier :Input and Output Impedance
6. C.E. Amplifier. Fequency response. Calculation of Gain Bandwidth product
7. OP-Amp: Characteristics Input and Output impedance
8. OP-Amp: Inverting and Non-inverting amplifier
9. Colpitts Oscillator
10. Wein's Bridge Oscillator

References:

1) Dennis L. Eggleston, Basic Electronics for Scientists and Engineers, CAMBRIDGE UNIVERSITY PRESS, First edition, 2011
2) V.K.Mehta,Rohit Mehta, Principles of Electronics,S. Chand and co. Ltd.

Additional References:

1) KalSaantiram, Basic Electronics: Devices, Circuits and IT fundamentals
2) Malvino, Electronic Principles, the McGraw- Hill companies
3) Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000)

Paper Title : Solid State Devices

Paper Code : PHY-IV.CE-6

Name of Faculty : Ananya Das

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1(Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The objectives are to provide a clear explanation of the operation of most commonly used solid state devices.

Learning Outcome: On successful completion of this course, the students will be able to understand the performance and usages of most of the solid statedevices.

Pre-requisite: Nil

Theory:

1. Basic Semiconductor and pn-Junction Theory: [10 L]

The Atom, Electron Orbit and Energy Levels, Energy Bands, Conduction in Solids, Conventional Current and Electron Flow, Bonding Forces between Atoms, Classification of Solids, Intrinsic Semiconductor, Conduction of Electrons and Holes, *p*-Type and *n*-Type Semiconductors, Effect of Heat and Light, Drift Current and Diffusion Current, The *pn*-Junction, Reverse-biased Junction, Forward-biased Junction, Temperature Effect, Mobility and Conductivity, Hall Effect and Hall Coefficient.

[Ref.1: Chapter 1 and Ref.2: Chapter 1: 1.8 and1.9]

2. Special Diodes: [6 L]

Zener Diode, Use of Zener Diode as voltage regulator and as Peak Clipper, Meter Protection, Tunneling Effect, Tunnel Diode, Tunnel Diode as Oscillator, Varactor, PIN Diode, Schottky Diode, Step Recovery Diode.

[Ref.3: Chapter 15]

3. Optoelectronic Devices: [8 L]

Light Units, Photomultiplier tube, Photoconductive Cell, Photovoltaic Cell, Photodiode, Solar Cell, Phototransistor, PhotoFET, Spectral response of Human eye, Light Emitting Diode(LED), Liquid Crystal Display(LCD), Optoelectronic Couplers, Laser Diode, Light Dependent Resistor (LDR).

[Ref.1: Chapter 19: 19-1 to 19-7, 19-9, 19-11, 19-12 and Ref.3: 16.1 to 16.3]

4. Breakdown Devices: **[12 L]**

Silicon Controlled Rectifier(SCR), SCR Characteristic and Parameters, Simple applications of SCR: HWR, Battery-charging regulator and Temperature Controller, Silicon Controlled Switch (SCS), Gate Turn Off switch (GTO), Light Activated SCR (LASCR), Shockley Diode, The TRIAC and DIAC, Typical Diac-Triac Phase control circuit, The Unijunction Transistor(UJT), UJT Characteristics, UJT Parameter and Specification, UJT Relaxation Oscillator, UJT Control of SCR, Programmable Unijunction Transistor.

[Ref.1: Chapter 18: 18-1, 18-2, 18-4, 18-6 to 18-11; Ref.4: Chapter 21: 21.6 to 21.10 and Ref.5: Chapter 28: 28-4]

5. Field Effect Transistors: **[9 L]**

Advantage and Disadvantage of The FET, Basic Construction of JFET, Characteristics curves of The JFET, Principle of operation of The JFET, Effect of V_{DS} on Channel Conductivity, Channel Ohmic Region and Pinch-Off Rergion, Characteristic Parameters of The FET, Effect of Temperature on FET Parameters, The MOSFET, The Depletion MOSFET, The Enhancement MOSFET, The difference between JFETs and MOSFETs, Dual Gate MOSFET, FET used in Phase-Shift Oscillator Circuit, Applications of FET in its Channel Ohmic Region, FET as a VVR in Voltage controlled Attenuator and in an Automatic Gain Controlled Circuit, Field-Effect Diode and its use as CRD, Power MOSFETs.

[Ref.5: Chapter 21: 21-1 to 21-8, Chapter 22: 22-1 to 22-5, 22-9, 22-10;
Ref.1: Chapter 8: 8-9]

Experiments: **(Minimum six)**

1. Energy Gap of a Semiconductor
2. Energy Gap of a LED.
3. Zener Diode Characteristics and Voltage regulation
4. LDR Characteristics
5. LED VI Characteristics
6. Phototransistor
7. SCR characteristics and gate controlled ac half wave rectifier
8. UJT Characteristics and its use in relaxation oscillator
9. FET Characteristics
10. Solar Cell.
11. SCR, DiacTriac Characteristics.

References:

1. Bell David A., Electronics Devices and Circuits, Prentice-Hall of India Pvt. Ltd., New Delhi, 3rd Edition (2000).
2. Singh Kamal and Singh S. P., Solid State Devices and Electronics, S. Chand & Company Ltd., New Delhi, 1st Edition (2007).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1st Multicolour Edition (2005).

4. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).
5. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).

Paper Title : Computational Physics
Paper Code : PHY-IV.CE-7
Name of Faculty : Ananya Das
Marks : 75 (Theory) + 25 (Practical)
Credits : 3 (Theory) + 1 (Practical)
Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The course aims to enable the students to solve problems in Physicswhich involves numerical methods by using FORTRAN as aprogramming language.

Learning Outcome: On completion of this course, the students will be able to:

- Understand various numerical methods
- Use FORTRAN language for numerical calculations
- Understand various concepts of Physics using numerical methods using FORTRAN as a programming language.

Pre-requisite: Nil

Theory:

1. Concepts of programming: [5L]
Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts.

2. FORTRAN Programming [20L]
Evolution of Fortran.
Simple Fortran Programs:
Writing a Program, Input statements, Some Fortran program examples.
Numerical Constants and Variables:
Constants, Scalar Variables, Declaring Variable Names, Implicit Declaration, Named Constants.
Arithmetic Expressions:
Arithmetic Operators and Modes of Expression, Integer Expressions, Real Expressions, Precedence of Operations in Expressions, Assignment Statements, Defining Variables, Some problems due to rounding of real numbers, mixed mode expressions, Intrinsic functions, Examples of Use of Functions.
Input-Output Statements:
List-directed input statements, List-directed output statements.
Conditional Statements:
Relational Operators, The block IF construct, Example programs Using IF structure.
Implementing Loops in Program:
The block DO loop, count control DO loop, Rules to be followed in writing DO loops.
Logical expressions and More Control statements:

Introduction, Logical constants, variables and expressions, precedence rules for logical operators, Some examples of use of Logical expressions, The case statements.

Functions and subroutines:

Introduction, function subprogram, syntax rules for function subprograms, Generic functions, Subroutines, Internal Procedures.

Defining and Manipulating Arrays:

Arrays Variables, Use of multiple subscripts, Do type notation for Input/Output Statements, Initializing arrays, Terminology used for multidimensional arrays, use of arrays in DO loops, whole array operations.

[Ref.1: Chapter-1 to Chapter-10]

3. Computational Physics: **[20L]**

Errors in Computation:

Inherent errors in storing, Numbers due to finite bit representation to use in Computer, Truncation error, round off errors (Explain with the help of examples)

Iterative methods:

Discussion of algorithm and flowcharts and writing FORTRAN programs for finding single root of equation using bi-section method, Newton-Raphson method.

Least Square Curve fitting:

Discussion of algorithm and flowcharts and writing FORTRAN program for straight line fit with example in physics.

Numerical Integration:

Discussion of algorithm and flowcharts and writing FORTRAN program for trapezoidal rule and Simpson's 1/3rd rule.

Solution of Differential equations:

Discussion of algorithm and flowcharts and writing FORTRAN program for Euler's method for finding solution of differential equation.

(*Derivation of formula is not expected for all the above numerical methods*)

[Ref.2: Chapters - 2, 3, 6, 8 and 9]

Experiments:

Following programs may be discussed thoroughly in theory lectures and implemented in the practicals.

1. Sum of digits of an integer
2. To find factorial of a number
3. Checking and printing of prime numbers
4. Generation of Fibonacci numbers

5. To find sin(X), cos(X) using series method
6. Sorting of Numerical data - ascending, descending.
7. Matrix operations – addition, subtraction, multiplication
8. Graphics- line, circle, arc, bar, ellipse.
9. Root of equation-Bisection method, Newton Raphson method
10. Numerical integration- Trapezoidal, Simpson's 1/3rd rule.
11. Least square curve fitting- data for ohm's law.
12. Freely falling body and motion of falling body including air drag. (using Euler's method)
13. Electric field due to a point charge
14. Charging and Discharging of Capacitor in RC circuit/Growth and Decay of current in RL Circuit.

References:

1. Rajaraman V., Computer Programming in Fortran 90 and 95, Prentice-Hall of India, New Delhi, 2nd Edition (1987).
2. Rajaraman V., Computer Oriented Numerical Methods, Prentice-Hall of India, New Delhi, 2nd Printing (1999).

Additional References:

Verma P. K. and Ahluwalia and Sharma K. C., Computational Physics, New Age International Publishers, India, (1999).

Paper Title : Astronomy and Astrophysics

Paper Code : PHY-IV.CE-8

Name of Faculty : Reshma Raut Dessai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1(Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course objectives: The objective of this course is to develop an understanding of the scale, constituents, and physics of stellar astronomy. A descriptive course includes the methods of astronomy and astrophysics, the motions of celestial objects and the evolution of galaxies.

Learning outcome: On completion of this course, the students will get necessary foundation in astronomy and astrophysics that will prepare them for the advanced study in Astronomy.

Pre-requisite: .

Theory:

1. **Introduction to Astronomy** **[3L]**
   Introduction of astronomy and astrophysics. Importance and scope of astronomy. Methods of astronomy and astrophysics.The scientific method.
   [Abhyankar 1.1 - 1.5]

2. **Celestial coordinates** **[7L]**
   Spherical coordinates. Celestial sphere. Altazimuth system. Finding right ascension and declination of a star. Equatorial, ecliptic and galactic system of co-ordinates. Conversion of coordinates. Sky charts and their importance.
   [Abhyankar 2.1 – 2.8]

3. **Astronomical Scales and measurements** **[8L]**
   Units of measurement in astronomy. Measuring distances within solar system. Measuring distances in Universe: Parallax method. Standard Candle method**.** Cepheid variable method**.** RedShift.
   [Abhyankar 4.1 – 4.3]

4. **Stellar structure , Birth and Death of stars** **[8L]**
   Basic Properties of a Star: Star brightness, colour, magnitude. Effective temp of a star. Size, mass, and luminosity. Internal Structure of a star: The Hydrostatic Equilibrium. star formation and Proto stars. The Main Sequence (HR Diagrams). White Dwarf.Supernova.Neutron Stars and Black Holes.
   [Abhyankar 3.2, 9.1,9.2] [Maoz 4.1-4.5] [Choudhuri 3.2.1, 3.2.4, 3.6, 4.7]

5. **Galaxies** **[6L]**

   Galaxy formation and Evolution.Radio galaxies.Seyfert galaxies.Types of galaxies.Hubble tunning fork model for galaxy classification.Elliptical galaxies.Spiral galaxy.Lenticular galaxies.Irregular galaxies.Distance, luminosity, size and mass of galaxies.

   [Schneider 3.1, 3.2, 3.3] [Abhyankar 17.1,17.2]

6. **Milky way** **[5L]**

   Mass and size of the Milkyway Galaxy. Interstellar Medium and its composition. Structure of Milkway Galaxy from optical and radio observations. Star count. Distribution of stars in the solar neighbourhood. Motion of Stars within the Galaxy.

   [Choudhuri 6.1] [Abhyankar 14.1, 14.2,14.6,15.1]

7. **Telescopes and astronomy in different bands of electromagnetic radiation** **[8L]**

   Types of telescopes. Optical telescopes.Radio telescopes. Infrared and Ultraviolet telescopes. X-ray telescopes. Design and construction of an optical telescope. Schmidt telescopes. Optical astronomy.Infrared astronomy.Ultraviolet astronomy.Radio astronomy.X-ray astronomy and gamma ray astronomy.

   [Abhyankar 19.1 - 19.5] [Choudhuri 1.7]

Experiments: (Minimum Six)

1. Measurement of the solar constant.
2. Resolving power of telescope.
3. Study of scattering of light (Diameter of Lycopodium powder).
4. To obtain proper motion of Barnard’s star using Aladin.
5. Draw constellation map of a) Orion b) Auriga c)Taurus d)Ursa Major (Big Dipper) marking of pole star.
6. To determine the elements in sun using Fraunhofer spectra.
7. To estimate Astronomical Unit using venus transit data by parallax method.
8. Data analysis technique using virtual observatory.
9. Determine the period of revolution of sun using virtual laboratory.

References:

1. K.D. Abhyankar, *Astrophysics: Stars and Galaxies* (University Press, 2001).
2. D. Maoz, *Astrophysics in a Nutshell AKA basic astrophysics* (Princeton University Press 2007).
3. Peter Schneider, *Extragalactic Astronomy and Cosmology an introduction* (Springer 2006).
4. A. R. Choudhuri, *Astrophysics for Physicists* (Cambridge University Press 2010).

Additional References:

1. Seed Backman, *Foundations in Astronomy and Astrophysics* (Cengage Learning 2013)
2. M.Sandage and J.Kristian, *Galaxies and the Universe* (University of Chicago Press).
3. Gordon Walker, *Astronomical Observations - an Optical Perspective* (Cambridge University press).

Paper Title : Instrumentation

Paper Code : PHY-IV.CE-8

Name of Faculty: Ananya Das and Yatin P. Desai

Marks: 75 (Theory) + 25 (Practical)

Credit: 3 (Theory) + 1(Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The objective of this course is to understand basic concepts related to the various types of measuring instruments and measuring techniques.

Learning Outcome: On completion of this course, the students will get necessary knowledge of errors associated with instruments and basic principles involved in measuring instruments like Ammeter, Voltmeter, Ohmmeter and Multimeters. Students get familiar with working and use of CROs and Signal Generators. Students understand working and usage of the various types of transducers.

Pre-requisite: Nil

Theory:

1. Fundamentals of Measurement: [6 L]

Introduction, Performance Characteristics, Static Characteristics, Errors in Measurements, Types of Static Error, Sources of Error, Dynamic Characteristics, Standard, Electrical Standards.

[Ref.1: Chapter 1.2 to 1.7, 1.9, 1.10]

2. Indicators and Display Devices: [5 L]

Types of Instrument, Basic Meter Movement: PMMC Movement and Practical PMMC Movement, Classification of Displays, Use of LED and LCD as Display Devices, Segmental Displays using LEDs.

[Ref.1: Chapter 2.1, 2.2, 2.8, 2.10, 2.11, 2.12.3]

3. Measuring Instruments: [12 L]

DC Ammeter, Multirange Ammeter, Universal Shunt, Requirements of a Shunt, Extending of Ammeter Ranges. Basic Meter as a DC Voltmeter, DC Voltmeter, MultirangeVoltmeter, Extending Voltmeter Ranges, Loading, Transistor Voltmeter(TVM), FET DC Voltmeter. AC Voltmeter using Rectifiers, Multirange AC Voltmeter, AC current measurements using AC Voltmeter and a series Resistor. Ohmmeter: Series type and Shunt type, Multimeter.

Digital voltmeter: Ramp Technique, Digital Multimeters and Frequency meter (with help of Block Diagrams), Q meter.

[Ref.1: Chapter 3.1 to 3.5, 4.2 to 4.7,4.12 to 4.15, 4.21, 4.22, 4.25, 5.2, 6.2,6.3,10.7 and Ref.2: Chapter 22: 22-9]

4. Oscilloscope: [6 L]

Basic Principle, Block Diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, sweep generator, Delay line.

[Ref.1: Chapter 7.2.1, 7.4, 7.5, 7.5.1, 7.6, 7.7.1, 7.10]

5. Signal Generator: [4L]

Standard Signal Generator, AF Sine and Square Wave Generator, Function Generator.

[Ref.1: Chapter 8.4, 8.5, 8.7, 8.8]

6. Transducers: [12 L]

Introduction, Electrical Transducer, Selecting a Transducer, Strain Gauges, Resistance Wire Gauge, Types of Strain Gauges(Wire), Foil Strain Gauge, Semiconductor Strain Gauge, Inductive Transducer, Differential Output Transducers, Linear Variable Differential Transducers (LVDT), Capacitive Transducer, Piezo-Electric Transducer, Semiconductor Diode Temperature Sensor, Temperature Transducers: Resistance Temperature Detectors, Thermistors, Thermocouples.

[Ref.3: Chapter 36.1 to 36.3, 36.12 to 36.15] [Ref.1: Chapter 13.1 to 13.3, 13.6, 13.6.1 to 13.6.4, 13.9, 13.9.1, 13.9.2, 13.10, 13.11, 13.13, 13.15, 13.20.7]

Experiments: **(Minimum six)**

1. Use of CRO and Function Generator (AC/DC voltage measurement,frequency measurement).
2. To measure displacement (linear and angular) using potentiometer/variable inductor/variable capacitor.
3. Construction and design of analog two ranges Voltmeter.
4. Construction and design of analog two ranges Ohmmeter.
5. Crystal Oscillator: Determination of velocity of ultrasonic waves in a liquidmedium.
6. Study of strain Gauges
7. Study of LVDT (including calibration) and its use in any one application.
8. Calibration of Thermocouple
9. Thermistor as a temperature sensor.

References:

1. Kalsi H S, Electronics Instrumentation, Tata McGraw Hill Education Pvt. Ltd. New Delhi, 3rd Edition (2010).
2. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1stMulticolour Edition (2005).

Additional References:

1. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).

Paper Title : Elementary Modern Physics

Paper Code : PHY-III.CM-3

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objective: The course will focus on the two major theories, which were developed in the beginning of the 20th century, the special theory of relativity and the quantum mechanics. Lectures will help the students in clarifying the concepts of modern physics through various conceptual questions and problems.

Learning Outcome: Upon completion of this course students will develop a better understanding of fundamental concepts and theories of modern physics required for advanced courses in physics and other physical sciences. Students will also be able to analyze and solve basic problems in modern physics.

Theory:

1. **Special Theory of Relativity: [8L]**
   Postulates of special theory of relativity. The Michelson-Morley experiment. The Galilean transformation. The Lorentz transformation. The Lorentz-Fitzgerald contraction. Time dilation. Simultaneity.
   [Beiser 1.2-1.8]

2. **Relativistic Mechanics: [6L]**
   Velocity addition. The relativity of mass. Mass and energy
   [Beiser 2.1-2.5]

3. **Particle Properties of waves: [5L]**
   Concepts of Black Body Radiation. The Photoelectric effect. Compton effect, Experimental verification of the Photoelectric effect.
   [Beiser 3.1-3.2, 3.5]

4. **Wave Properties of Particles: [9L]**
   De Broglie's hypothesis. Wave function. Wave and group velocities. Davisson-Germer Experiment. Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons. The uncertainty principle and its application.
   [Beiser 4.1-4.8, Feynman 1.1-1.8]

5. **Schrodinger's Wave Equation**: **[8L]**
Derivation of the wave equation on a stretched string. Schrodinger's Equation: Time-dependent form. Probability current. Expectation values and operators. Schrodinger's equation: Steady state form. Eigenvalues and Eigenfunctions.
[Beiser 7.1-7.9]

6. Application of Quantum Mechanics **[9L]**
6.1 Free particle.
6.2 Particle in a one-dimensional infinite square well potential.
6.3 One dimensional step potential of finite height (Energy less than step height and energy greater than step height)
6.4 One dimensional potential barrier. Qualitative discussion of alpha decay.
[Eisberg: 6.2-6.6, 6.8]

Experiments: (Minimum Six)

1. Measurement of diameter of Lycopodium powder
2. Fraunhoffer diffraction over double slit
3. Frank Hertz Experiment
4. Photoelectric effect.
5. Determination of Boltzmann's constant using transistor.
6. Determination of e/m of electrons using Thomson's method.
7. Michelson Interferometer.

References:

1. Beiser, A 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Feynman, RP 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.

Additional References:

1. Griffiths, D 2015, *Introduction to Quantum Mechanics*, Pearson Education, India.
2. Singh, K. 2013, *Elements of Quantum Mechanics*, S. Chand and Company, New Delhi.
3. Resnick, R. 2010, *Introduction to Special Relativity*, Wiley India Pvt Ltd, India.
4. Verma, HC 2012, *Quantum Physics*, TBS, Calicut.
5. Wichmann E 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, Mcgraw Hill Education, India.

Paper Title : Heat and Optics

Paper Code : PHY-IV.CM-4

Name of Faculty: Yatin P. Desai and Ananya Das

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours: 45 (Theory) + 30 (Practical)

Course Objectives: The objective of this course is to understand basics of Heat and Optics.

Learning Outcome: On completion of this course, the students will get necessary foundation in Heat and Optics that will prepare them for the advanced study in Thermodynamics and Optics.

Theory:

Section-I : Heat

Unit 1: Equations of State **[5L]**

Equation of state, Andrew's experiment, Amagat's experiment, Van der Waal's equation of State, Critical constants, Reduced equation of state, Boyle temperature.

[Saha& Srivastava: 10.1 -10.6, Brij.&Subr.: 2.6, 2.14]

Unit 2: Laws of Thermodynamics **[12L]**

Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics, Concept of work and internal energy, First law of thermodynamics, Isothermal and adiabatic changes, Work done in isothermal and adiabatic changes, Relation between pressure, volume and temperature in adiabatic process, Reversible and irreversible processes, Carnot Heat engine, Carnot cycle for perfect gas, efficiency, Second law of thermodynamics (Kelvin – Planck Statement, Clausius Statement).

[Brij.&Subr.: 4.1, 4.4 – 4.7, 4.10.4, 4.11 - 4.13, 4.20 – 4.24, 4.28]

Unit 3: Principle of Thermometry **[5L]**

Review of concept of heat and temperature, Thermometry, Types of thermometers, Centrigrade, Fahrenheit, Rankine Scales and relations between them, Platinum resistance thermometer, Thermocouple (thermoelectric) thermometers.

[Saha& Srivastava: 13.1 – 13.5, 13.15, 13.23]

Section-II: Optics

Unit-1 **[6L]**

Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).

[Ref.1: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 4.17, 5.10, 6.1, 6.2]

Lens Aberrations: Introduction, Types of Aberrations: Monochromatic and Chromatic aberration, Methods to minimize Spherical and Chromatic Aberrations (only concept, without derivation)

[Ref.1: 9.1, 9.2, 9.5, 9.5.1, 9.10 , 9.11, 9.12, 9.13]

Optical Instruments:

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece and Constant deviation Spectrometer.

[Ref.1: 10.8, 10.10, 10.10.1, 10.11, 10.11.1, 10.12, 10.17]

Unit-2 **[6L]**

Interference:

Introduction: Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Phase Change on reflection: Stoke's law.

[Ref.1: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Ref.2: 6.3]

Interference in Thin Films: Thin Film, Plane Parallel Film, Interference due to Transmitted light, Haidinger Fringes, Wedge-shaped Film, Newton's Rings.

[Ref.1: 15.1, 15.2, 15.2.1 to 15.2.5, 15.3, 15.4, 15.5, 15.5.1 to 15.5.4, 15.6, 15.6.1 to 15.6.9]

Unit-3 **[6L]**

Diffraction:

Difference between Interference and Diffraction, Types of diffraction: Fresenel Class and Fraunhoffer Class.

[Ref.1: 17.6, 17.7 and Ref.2: 7.5, 7.6]

Diffraction of Light (Fresnel Class):

Division of cylindrical wave-front into Fresnel's half period strips(concept), Diffraction at Straight edge.

[Ref.2: 7.9, 7.10]

Diffraction of Light (Fraunhoffer Class):

Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit(Concept, no derivation), Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Resolving Power, Rayleigh's criterion, Resolving power of telescope.

[Ref.1: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 19.1, 19.2, 19.6, 19.7]

Unit-4 **[5L]**

Polarization:

Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Optical activity, Specific rotation, Simple Polarimeter.

[Ref.1: 20.3, 20.4, 20.5, 20.5.1, 20.5.2, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.24, 20.25, 20.26]

Experiments: (Minimum six)

I. Heat: (Minimum Three)

1. Calibration of Si diode as a Thermometer
2. Constant Volume Air Thermometer
3. Thermal conductivity by Lee's method
4. Temperature coefficient of resistance of Copper

II. Optics: (Minimum Three)

1. Newton's Rings
2. Brewster's Law
3. Cardinal points
4. Spectrometer: Dispersive Power of prism

References:

I. Heat:

1. Saha M.N., Shrivastava B.N., *Treatise on Heat*, The Indian Press 5th Ed. (1965).
2. Brijlal, Subramanyam N., Hemne P.S., *Heat Thermodynamics and Statistical Physics*, S. Chand (2007).

II. Optics:

3. Subhramanyam N., Lal Brij, Avadhanulu M. N., A Text book of Optics, S. Chand & Company Ltd., New Delhi, First multicolour Edition (2006).
4. Singh S. P. and Agarwal J. P., Optics, PragatiPrakashan, 8^{th} Edition (2001).

Additional References:

1. Roberts J. K., Miller A.R., *Thermodynamics*, E.L.B.S. (1960).
2. Zemansky M.W., Ditman R.H., *Heat and Thermodynamics*, McGraw Hill, 8^{th} Ed. (5^{th} reprint), 2013
3. GhatakAjoy, Optics, Tata McGraw-Hill Publicashing Company Ltd. (1977)
4. Jenkins F. A. and White H. E., Fundamentals of Optics, Tata McGraw-Hill Publishing Company Ltd., (1981)

Annexure III

Pattern of Question paper for Semester End Examination

Q1 12 Marks	Q2 18 Marks	Q3 18 Marks	Q4 24 Marks	Max marks	Total marks
Any 3 OF 4 3×3= 9 Marks	**Any 2 OF 3 2×6=12 Marks**	**Any 2 OF 3 2×6=12 Marks**	**Any 1 OF 2 12 Marks**	**45**	**72**

Note: The Question no. 4of the approved Question Paper pattern may be divided into sub questions with combinations of **6+6** or **6+3+3** or**5+4+3** or**4+4+4** or **3+3+3+3** marks.