

**Learning Outcomes based Curriculum Framework
(LOCF)**

For

**B.Sc. Physics
(Four Year Degree Programme)**

w.e.f. Session 2021-22



**University School for Graduate Studies
Chaudhary Devi Lal University
Sirsa-125055, Haryana
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1. About University School for Graduate Studies (USGS)

National Education Policy (NEP) -2020 has provided an impetus to the changing horizons of Higher Education. Chaudhary Devi Lal University Sirsa has recently established University School for Graduate Studies (USGS) in Teaching Block-IV (Dr. APJ Abdul Kalam Bhawan) of the university in order to start new programmes and courses for tuning ourselves to the latest state-of-the-art in Higher Education. The University School for Graduate Studies (USGS) will focus on strengthening graduate studies especially in the wake of NEP-2020 and will focus on designing, developing and execution of market/industry demand-oriented Four Year Degree Programmes (FYDP). To benefit students, society and faculty, the USGS is destined to start graduate programmes based on Learning Outcomes Curriculum Framework and as per NEP-2020 such as: (i) B.Com. Banking & Insurance, (ii) B.Com. Fintech & Financial Markets, (iii) B.Com. Derivatives & Risk Management, (iv) B.Sc. Data Science, (v) B.Sc. Mathematics, (vi) B.Sc. Physics, (vii) B.A. Economics & Finance. In addition, there is a 1-year programme namely (viii) Bachelor of Library & Information Science. The holistic development of the students to compete the changing scenario of the world in the 21st century is of prime importance. The University School for Graduate Studies is committed to impart quality education comprising academic knowledge and technical skills to the students.

2. Learning Outcomes based Curriculum Framework

The Choice Based Credit Scheme (CBCS) evolved into learning outcome-based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the Programme

B.Sc. Physics – Four year undergraduate programme in Physics is structured:

1. to motivate/inspire the students to inculcate deep knowledge and understanding of physical concepts, principles and theories of Physics.
2. to learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories of Physics.
3. to develop the ability to apply the knowledge and critical thinking to specific problems in theoretical and experimental Physics.
4. to make strong foundation in basic and applied aspects of Physics, in order to develop skills to solve problems of Physics having applications in other disciplines and/or in the real world; and hence undergo research in interdisciplinary areas, jobs in scientific and industrial sectors and/or teaching career in Physics.

2.2 Programme Outcomes (POs)

After completing the programme, the students have:

PO1	Knowledge	capability of demonstrating comprehensive knowledge acquired during the course of study.
PO2	Communication	ability to communicate effectively on different aspects of Physics through examples with the scientific community as well as society at large.
PO3	Problem Solving	capability of applying knowledge to solve scientific and other problems using theoretical and experimental techniques/tools; and ability to use and learn scientific techniques, skill and tools for practices in Physics and the real world.
PO4	Investigation of Problems	ability of critical thinking, analytical reasoning and research based knowledge including design/performance of experiments, analysis and interpretation of data to provide conclusions.
PO5	Science and Society	ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PO6	Life-Long Learning	aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.
PO7	Ethics	Apply ethical principles and professional responsibilities in scientific practices.
PO8	Project Management	ability to demonstrate knowledge and understanding of the scientific principles and apply them to manage projects

2.3 Programme Specific Outcomes (PSOs)

After completing the programme, the students:

PSO1	acquire basic knowledge and understanding in different core areas of Physics such as mechanics, electricity and magnetism, thermal physics, waves and optics, statistical mechanics, modern physics quantum mechanics, electronics, electromagnetic theory, semiconductor physics, communication systems, mathematical physics, computational physics, digital and analog systems, nuclear and particle physics, solid state physics, nanomaterials and applications, and some other elective areas.
PSO2	learn how to design and perform experiments demonstrating their understanding of scientific concepts/phenomena/methods/techniques; and develop skills and aptitude to pursue higher studies and research in Physics.
PSO3	develop written and oral communications skills to communicate physics-related topics effectively through verbal, written, computational and graphical presentations.
PSO4	apply knowledge, understanding, critical thinking and skills of Physics to analyze interdisciplinary problems and solve them using theoretical and experimental techniques/tools and skills.

3. Programme Structure

B.Sc. Physics- Four year (Eight semesters) undergraduate programme is of 200 credits weightage consisting of Core Courses (CC), Discipline Specific Elective Courses (DSC), Skill Enhancement Courses (SEC), Generic Elective Courses (GEC) and Ability Enhancement Compulsory Courses (AECC).

Table 1: Courses and Credit Scheme

Semester	Core Courses (CC)		Discipline Specific Elective Courses (DSC)		Skill Enhancement Courses (SEC)		Ability Enhancement Compulsory Courses (AECC)		Generic Elective Courses (GEC)		Grand Total Credits
	1	2	3	4	5	6	7	8	9	10	
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	(2+4+6+8+10)
I	4	12	-	-	1	2	2	8	1	6	28
II	5	13	-	-	2	4	1	4	1	6	27
III	4	12	2	6	-	-	-	-	2	6	24
IV	5	13	2	6	-	-	-	-	2	6	25
V	6	17	2	6	1	2	-	-	-	-	25
VI	6	17	2	6	1	2	-	-	-	-	25
Total	Core Credits	84	Discipline Specific Elective Credits	24	Skill Enhancement Credits	10	Ability Enhancement Credits	12	Generic Elective Credits	24	154
Percentage (%)	Core Credits	54.54	Discipline Specific Elective Credits	15.58	Skill Enhancement Credits	6.49		7.79		15.58	100
VII	2	6	5	16	-	-	-	-	-	-	22
VIII	1	24	-	-	-	-	-	-	-	-	24
Total	Core Credits	114	Discipline Specific Elective Credits	40	Skill Enhancement Credits	10	Ability Enhancement Credits	12	Generic Elective Credits	24	200
Percentage (%)	Core Credits	60	Discipline Specific Elective Credits	20	Skill Enhancement Credits	5		6		12	100

Table 2: Detailed break-up of Credit Courses

Semester	Core Courses (CC)	Discipline Specific Elective Courses (DSC)	Skill Enhancement Courses (SEC)	Ability Enhancement Compulsory Courses (AECC)	Generic Elective Courses (GEC)	Total Courses (CC+DSC+SEC+AECC+GEC)
I	CC1 CC2 CC3 CC4	-	SEC1	AECC1 AECC2	GEC1	08
II	CC5 CC6 CC7 CC8 CC9	-	SEC2 SEC3	AECC3	GEC2	09
III	CC10 CC11 CC12 CC13	DSC1 DSC2	-	-	GEC3 GEC4	08
IV	CC14 CC15 CC16 CC17 CC18	DSC3 DSC4	-	-	GEC5 GEC6	09
V	CC19 CC20 CC21 CC22 CC23 CC24	DSC5 DSC6	SEC4	-	-	09
VI	CC25 CC26 CC27 CC28 CC29 CC30	DSC7 DSC8	SEC5	-	-	09
VII	CC31 CC32	DSC9 DSC10 DSC11 DSC12 DSC13	-	-	-	07
VIII	CC33 Research (Dissertation/ Project/Product development/ etc.)	-	-	-	-	01

Table 3: Course code and Title along with credits details

Sr. No.	Course Code	Course Title	Credits		
			Lecture+ Tutorial	Practical	Total
Semester I					
1.	ENG/1/AECC1	Functional English	4	-	4
2.	EVS/1/AECC2	Environmental Studies	4	-	4
3.	BSc/Phy/1/CC1	Mechanics	4	-	4
4.	BSc /Phy/1/CC2	Electricity & Magnetism	4	-	4
5.	BSc /Phy/1/CC3	Physics Lab.-I	-	2	2
6.	BSc /Phy/1/CC4	Physics Lab.-II	-	2	2
7.	BSc /Phy/1/SEC1	(i) Basic Instrumentation Skills OR (ii) Electrical Circuits & Networks	2	-	2
8.	...../1/GEC1	To be opted by student from Pool of Generic Elective Courses	-	-	6
Total					28
Semester II					
1.	HIN/2/AECC3	Prayojanmoolak Hindi	4	-	4
2.	BSc/Phy/2/CC5	Thermal Physics	4	-	4
3.	BSc/Phy/2/CC6	Waves & Optics	4	-	4
4.	BSc/Phy/2/CC7	Physics Lab.-III	-	2	2
5.	BSc/Phy/2/CC8	Physics Lab.-IV	-	2	2
6.	BSc/Phy/2/CC9	Seminar	-	-	1
7.	BSc/Phy/2/SEC2	(i) Basic Instrumentation Lab. OR (ii) Electrical Circuits & Networks Lab.	-	2	2
8.	COMP/2/SEC3	Computer Skills	-	2	2
9.	...../2/GEC2	To be opted by student from Pool of Generic Elective Courses	-	-	6
Total					27
Semester III					
1.	BSc/Phy/3/CC10		4	-	4
2.	BSc/Phy/3/CC11		4	-	4
3.	BSc/Phy/3/CC12		-	2	2
4.	BSc/Phy/3/CC13		-	2	2
5.	BSc/Phy/3/DSC1		4	-	4
6.	BSc/Phy/3/DSC2		-	2	2
7.	...../3/GEC3		4	-	4
8.	...../3/GEC4		-	2	2
Total					24
Semester IV					
1.	BSc/Phy/4/CC14		4	-	4
2.	BSc/Phy/4/CC15		4	-	4
3.	BSc/Phy/4/CC16		-	2	2
4.	BSc/Phy/4/CC17		-	2	2
5.	BSc/Phy/4/CC18		-	-	1
6.	BSc/Phy/4/DSC3		4	-	4

7.	BSc/Phy/4/DSC4		-	2	2
8.	...../4/GEC5		4	-	4
9.	...../4/GEC6		-	2	2
				Total	25
Semester V					
1.	BSc/Phy/5/CC19		4	-	4
2.	BSc/Phy/5/CC20		4	-	4
3.	BSc/Phy/5/CC21		4	-	4
4.	BSc/Phy/5/CC22		-	2	2
5.	BSc/Phy/5/CC23		-	2	2
6.	BSc/Phy/5/CC24		-	-	1
7.	BSc/Phy/5/DSC5		4	-	4
8.	BSc/Phy/5/DSC6		-	2	2
9.	BSc/Phy/5/SEC4		2	-	2
				Total	25
Semester VI					
1.	BSc/Phy/6/CC25		4	-	4
2.	BSc/Phy/6/CC26		4	-	4
3.	BSc/Phy/6/CC27		4	-	4
4.	BSc/Phy/6/CC28		-	2	2
5.	BSc/Phy/6/CC29		-	2	2
6.	BSc/Phy/6/CC30		-	-	1
7.	BSc/Phy/6/DSC7		4	-	4
8.	BSc/Phy/6/DSC8		-	2	2
9.	BSc/Phy/6/SEC5		-	2	2
				Total	25
Semester VII					
1.	BSc/Phy/7/CC31		4	-	4
2.	BSc/Phy/7/CC32		-	2	2
3.	BSc/Phy/7/DSC9		4	-	4
4.	BSc/Phy/7/DSC10		4	-	4
5.	BSc/Phy/7/DSC11		-	2	2
6.	BSc/Phy/7/DSC12		-	2	2
7.	BSc/Phy/7/DSC13		4	-	4
				Total	22
Semester VIII					
1.	BSc/Phy/8/CC33				24
				Grand Total (I+II+III+IV+V+VI+VII+VIII)	200

**Table 4: Generic Elective Courses offered by Department of Physics
for the Students of other departments**

Course Code	Course Title	Credits
Semester -I		
BSc/Phy/1/GEC1	Mechanics (Theory)	4
BSc/Phy/1/GEC2	Mechanics (Lab.)	2
Semester -II		
BSc/Phy/2/GEC3	Waves and Optics (Theory)	4
BSc/Phy/2/GEC4	Waves and Optics (Lab.)	2

Semester-I

ENG/1/AECC1 - FUNCTIONAL ENGLISH

Credits: 4 (Theory)
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Objective: The course aims to introduce students to the theory, fundamentals and tools of communication and to develop in them effective communication skills which should be integral to personal, social and professional interactions. In addition, to develop in them the understanding of the English language.

Learning Outcomes: After completion of the course, learners will:

CO1: have the knowledge of communication.

CO2: have speaking skills in social interactions and communication in professional situations such as interviews, group discussions and office environments.

CO3: have the knowledge and understanding of the language of communication.

CO4: have reading, listening and writing skills.

***Note for the Paper Setter:** The question paper will consist of five questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

Unit-I

Introduction: Definition and Theory of Communication, Types and modes of Communication. Language of Communication: Verbal and Non-verbal (Spoken and Written); Personal, Social and Business Barriers and Strategies; Intra-personal, Inter-personal and Group communication. Impact of communication on performance.

Unit-II

Speaking Skills: Monologue, Dialogue, Group Discussion, Effective Oral Communication, Miscommunication, Oral Presentation, Interview, Public Speech.

Unit-III

Remedial English: Parts of Speech, Sentences, Subject- Verb Agreement, Active and Passive Voice, Degrees of comparison, Direct and Indirect Speech, Question Tags.

Reading and Understanding: Close Reading, Comprehension, Summary, Paraphrasing, Analysis and Interpretation, Translation (from Indian language to English and vice-versa), Literary/Knowledge Texts.

Unit-IV

Writing Skills: Elements of writing, Documenting, Report Writing, Making notes, Letter writing, Business communications

Listening Skills: Listening and its types, Barriers of effective Listening, Barriers and Strategies for effective listening, Listening to complaints.

Suggested Readings:

1. B.K. Das and A. David, A Remedial Course in English, Book 2, C.I.E.F.L. (O.U.P.) 1980.
2. A.S. Hornby, Oxford Advanced Learner's Dictionary of Current English (O.U.P.) 3, A Textbook of English Phonetics for Indian Students by T. Balasubramanian.
3. Fluency in English - Part II, Oxford University Press, 2006.
4. Business English, Pearson, 2008.
5. Language, Literature and Creativity, Orient Blackswan, 2013.

EVS/1/AECC2 - ENVIRONMENTAL STUDIES

Credits: 4 (Theory)

Lectures: 60

Duration of Exam.: 3 Hrs.

Max. Marks: 100

Final Term Exam.: 70

Internal Assessment: 30

Course Objective: Students will understand how science and the scientific methods work to address environmental problems. The students will become familiar with the Earth's major systems, how they function and how they are affected by human?

Course Outcomes: After completing the course in Environmental Studies, students will be able to: Demonstrate an integrated approach to environmental issues with a focus on sustainability; Use critical thinking, and methodological approaches of the social sciences, natural sciences, and humanities in environmental problem solving.

Note for the Paper Setter: The question paper will consist of five questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

UNIT I

The multidisciplinary nature of environmental studies: Definition, Scope and importance need for public awareness. Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources; Growing energy needs, renewable and non-renewable energy sources, case studies. Land resources: Land as a resource, land degradation man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNIT II

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem. Producers, Consumers and decomposers. Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, Characteristic features, structure and function of the following of the ecosystem: Forest ecosystem, Grass land ecosystem, desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: Introduction-Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of diversity: consumptive use, productive use, social, ethical; aesthetic and option calls. Biodiversity at global, National and local levels. India as a mega- diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemics. Conservation of biodiversity: In-situ and Ex-situ, Conservation of biodiversity.

UNIT III

Environmental Pollution: Definition-Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: floods, earthquake, cyclone and landslides.

Social Issues and the environment: From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Air (prevention and Control of Pollution) Act. Water (prevention and control of pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

UNIT IV

Human Population and the Environment: Population growth, variation among nations. Population explosion- family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and child welfare, role of information technology in environment and human health, Case Studies.

Field work: Visit to a local area to document environmental assets: river/forest grass land/hill/mountain, Visit to a local polluted site-Urban/Rural/Industrial/ Agricultural, Study of common plants, insects, birds. Study of simple ecosystems pond, river, hill slopes, etc.

Suggested Readings:

1. Agarwal, K.C. 2001 *Environmental Biology*, Nidhi Publ. Ltd. Bikaner.
2. Bharucha Erach, *The Biodiversity of India*, Mapin Publishing Pvt. Ltd., Ahmedabad- 380013, India.
3. Clerk RS., *Marine Pollution*; Clarendon Press Oxford.
4. *Down to Earth*, Centre for Science and Environment.
5. Hawkins R.E., *Encyclopedia of Indian Natural History*, Bombay Natural History Society, Bombay.
6. Mhaskar A.K, *Matter Hazardous*, Techno-Science Publications.
7. Townsend C., Harper J, and Michael Begon, *Essentials of ecology*, Blackwell Science.
8. Trivedi R.K and P.K Goel, *Introduction to air pollution*, Techno-Science Publications.
9. Trivedi R.K, *Handbook of Environmental Laws, Rules, Guidelines Compliances and Standards, Vol I and II*, Envirol Media.
10. Wagner KD., 1998. *Environmental Management*. W.B. Saunders Co. Philadelphia, USA.

BSc/Phy/1/CC1–Mechanics

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Objective: The objective of this course is to teach the students fundamentals of Newtonian Mechanics, rigid body dynamic, concept of inverse square force and the special theory of relativity.

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Learn the concept of conservation of energy, momentum, angular momentum and apply them to understand the basic problems in physics.

CO2: Understand the application of rotational dynamics motions in analyzing rolling with slipping. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.

CO3: Understand the concept of central force problem, gravitational energy and GPS. Applications of inverse square law.

CO4: Describe special relativistic effects and their effects on the mass and energy of a moving object and appreciate the nuances and important outcomes of Special Theory of Relativity.

Note for the Paper Setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit-I

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, Fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass (discrete and continuous), Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.

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

Unit-II

Rotational Dynamics: Equation of motion of a rigid body, Rotational motion of a rigid body in general and that of plane lamina, Rotation of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia (discrete and continuous), Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation, elementary Gyroscope.

Unit-III

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self-

energy, two body problem and concept of reduced mass, Motion of a body under central force, Equation of orbit in inverse-square force field, satellite in Circular orbit & Geosynchronous orbits, Basic idea of GPS (Global Positioning System).

Unit-IV

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Galilean transformation (velocity, acceleration) and its inadequacy, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, 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 Doppler effect, Relativistic Kinematics (decay, inelastic collision, Compton effect), Transformation of Energy, Momentum and force, Four Vectors.

Text/Reference Books:

1. Classical Mechanics by H. Goldstein (2nd Edition)
2. Berkeley Physics Course. Vol. 1. Mechanics, E.M. Purcell
3. Concepts of Modern Physics, Arthur Beiser
4. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 2007, McGraw-Hill.
5. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2012.
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, F.W. Seers, M. W. Zemansky, H. D. Young, Addison-Wesley Pub. Co.
8. Fundamentals of Physics, Halliday, & Walker, Resnick John Wiley & Sons, Inc.

BSc/Phy/1/CC2– Electricity and Magnetism

Credits: 4

Lectures: 60

Duration of Exam.: 3 Hrs.

Max. Marks: 100

Final Term Exam.: 70

Internal Assessment: 30

Objective: The course on Electricity and Magnetism deals with Coulomb's law, Electric field, potential formulation of electrostatic, Capacitors, Magnetism and magnetic materials along with the applications of these concepts.

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Explain and differentiate the vector and scalar formalisms of electrostatics. Also be able to Apply Gauss's law of electrostatics to solve a variety of problems.

CO2: Describe the important properties of magnetic field. Understand the properties and theories of dia-, para- & ferromagnetic materials.

CO3: To understand the concept of dielectric behaviour of materials, Biot-Savart's law & its applications.

CO4: Analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor. Concept of network theorems.

***Note for the Paper Setter:** The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Electrostatics: Electric field, Electric field lines, Electric flux, Divergence of electrostatic field, Gauss' Law with applications, Conservative nature of Electrostatic Field, Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Electrostatic energy of system of charges, Energy per unit volume in electrostatic field, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor, Laplace's and Poisson equations, Laplace equation in three dimension, The Uniqueness Theorems.

Unit-II

The method of images : Point charge in the presence of grounded conducting sphere, Solution of Laplace equation by separation of variables for Cartesian and spherical coordinates, Multipole expansion of potential due to arbitrary charge distribution.

Dielectric Properties : Dielectric medium, Polarization, Bound charges in a polarized dielectric and their physical interpretation, Electric displacement, Gauss's theorem in dielectrics, Parallel plate capacitor completely filled with dielectric, dielectric constant.

Unit-III

Magnetism: Lorentz force law, Magnetic forces, Magnetostatics: Biot-Savart's law & its applications (i) circular coil (ii) solenoid carrying current, Divergence and curl of magnetic field, Ampere's circuital law and its applications for simple current configurations, Magnetic vector potential.

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

Unit-IV

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.

Network theorems: Ideal Constant-voltage and Constant-current Sources, Network theorems; Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem, Application to dc circuits.

Text/Reference Books:

1. D.J. Griffith, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
3. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
5. Electricity and Magnetism, Reitz and Milford (Prentice Hall of India)
6. Electricity and Magnetism, A.S. Mahajan and A.A. Rangwala (Tata McGraw Hill)
7. Electricity and Magnetism, Edward M Purcell, 1986, McGraw-Hill Education
8. Electricity and Magnetism, J.H. Fewkes & J. Yarwood, Vol. I, 1991, Oxford University Press.
9. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn 1998 Benjamin Cummings.
10. Electricity and Magnetism, R. Murugesan, S.Chand & Com. Pt. Ltd., New Delhi
11. Electromagnetic Fields and waves, K.D. Prasad, Satya Prakashan, New Delhi

BSc/Phy/1/CC3–Physics Lab-I

Credits: 2 (Practical)
Teaching per week: 4 Hrs.

Max. Marks: 50
Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands on experience with different instruments and measurements of different physical quantities and related concepts in Physics.

CO2: Verify some fundamental principles, effects and concepts of physics through experimentation.

CO3: Perform experiments related to mechanics (compound pendulum), rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity) and fluid dynamics (verification of Stokes law, Searle method) etc.

CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments:

1. Measurement of Length (or diameter) using Travelling Microscope.
2. Moment of Inertia of a Fly Wheel
3. Moment of Inertia of irregular body using a Torsion Pendulum.
4. Surface Tension by Jaeger's Method.
5. Young Modulus by Bending of Beam.
6. Modulus of rigidity of material of wire by Maxwell's Needle.
7. Elastic constant by Searle's method.
8. Viscosity of water by its flow through a uniform capillary tube.
9. Acceleration due to Gravity 'g' by Bar pendulum.
10. To study the Motion of spring and calculate Spring constant & value of Acceleration due to Gravity.
11. To compare Moment of Inertia of a solid Sphere, Hollow Sphere and solid Disc of same mass with the help of Torsion Pendulum.

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

BSc/Phy/1/CC4–Physics Lab-II

Credits: 2 (Practical)
Teaching per week: 4 Hrs.

Max. Marks: 50
Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.

CO2: Verify some fundamental principles, effects and concepts of physics through experiments. Gaining knowledge related to LCR circuits, Ballistic galvanometer, magnetic field and inductance of two coils.

CO3: Perform experiments related to A.C. mains, D.C. voltage and current. Learn experimentation with Thevenin, Norton and Superposition theorems.

CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. To use Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
2. Low resistance by Carey Foster's bridge with calibration.
3. Determination of Impedance of an A.C. circuit and its verification.
4. Frequency of A.C. mains using an electromagnet.
5. Frequency of A.C. mains Electrical vibrator.
6. High resistance by substitution method.
7. To study the characteristics of a series RC Circuit.
8. To determine an unknown Low Resistance using Potentiometer.
9. To determine an unknown Low Resistance using Carey Foster's Bridge
10. To compare capacitances using De'Sauty's bridge.
11. Measurement of field strength B and its variation in a solenoid (determine $\frac{dB}{dx}$).
12. To verify the Thevenin and Norton theorems.
13. To verify the Superposition, and Maximum power transfer theorems.
14. To determine self inductance of a coil by Anderson's bridge.
15. 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.
16. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
17. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
18. Determine a high resistance by leakage method using Ballistic Galvanometer.
19. To determine self-inductance of a coil by Rayleigh's method.
20. To determine the mutual inductance of two coils by Absolute method.

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.

BSc/Phy/1/SEC1 (i) Basic Instrumentation Skills

Credits: 02 (Theory)

Lectures: 30

Duration of Exam.: 2 Hrs.

Max.Marks: 50

Final Term Exam: 30

Internal Assessment: 20

Objective: The objective of this course is to impart knowledge of basic instruments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Exposure with various aspects of instruments and their usage through hands-on mode.

CO2: Experience of various Instrumentation Skills in the profession.

CO3: Basic understanding on instruments data observation, measurements, errors and analysis.

CO4: Training to use and learn techniques, skills and tools for professional practices.

***Note for the Paper Setter:** The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Unit-II

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.

Unit-III

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 (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

Unit-IV

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. Digital **Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer .
Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

BSc/Phy/1/SEC1 (ii) Electrical Circuits & Networks

Credits: 02 (Theory)

Lectures :30

Duration of Exam.: 2 Hrs.

Max. Marks: 50

Final Term Exam: 30

Internal Assessment: 20

Objective: The objective of this course is to impart knowledge of electrical circuits and networks.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode. Understanding electrical circuits.

CO2: Enhancing knowledge of electrical drawing, symbols, generators and transformers.

CO3: Learning technical skills of electric motors, rectifiers, capacitors, phase reversal electrical protection, and overload devices.

CO4: Learning basics for professional skills of electrical wiring, splices, shunting, inductors, Inductance and impedance.

***Note for the Paper Setter:** The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

Unit-II

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

Unit-III

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers.

Unit-IV

Overload devices: Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device). Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand & Co.
2. A text book of Electrical Technology - A K Theraja.
3. Performance and design of AC machines - M G Say ELBS Edn.

Semester-II

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vf/kdre vad%

vfire i fj {kk vad% 70

vkrfjd em; kdu% 30

UkV% प्र" न पत्र में कुल 9 प्र" न हैं प्रथम प्र" न अनिवार्य है, जिसमें समस्त पाठ्यक्रम से 2 अंक वाले 5 सक्षिप्त प्र" न हैं प्र" न पत्र में 4 ईकाई है, जिसमें प्रत्येक ईकाई में 15 अंको वाले 2 प्र" न हैं विद्यार्थी को प्रत्येक ईकाई में से 1 प्र" न करना अनिवार्य है

bdkb&I

पत्र-लेखन-सहकारी पत्र, परिपत्र, कार्यालय आदे" I, I" Iकायत पत्र, आवेदन पत्र, मूलपत्र, पत्रोत्तर, पावती, अनुस्मारक, सरकारी पत्र, ईमेल-लेखन, भासकीय आदे" I, अधिसूचना, पृष्ठाकन, प्रेस विज्ञप्ति, संक्षेपण लेखन- अर्थ परिभाषा प्रक्रिया, नियम (लेखन विधि)

bdkb&II

अभिनव काव्य गरिमा (काव्य पुस्तक) संप्रसंग व्याख्या व प्र" नोत्तर

bdkb&III

कम्प्यूटर- परिभाषा स्वरूप, महत्व

पारिभाषिक भाषावली - बैंकिंग, वाणिज्य, मंत्रालय, उपक्रमो, निगमों, ओद्योगिक क्षेत्रों व मीडिया क्षेत्र

अनुवाद लेखन - अर्थ परिभाषा, स्वरूप, महत्व, प्रक्रिया, प्रकार

टिप्पण लेखन - अर्थ परिभाषा, नियम, लेखन विधि, उदाहरण

bdkb&IV

प्रयोजनमूलक हिन्दी - अर्थ, संरचनात्मक स्वरूप महत्व, हिन्दी भाषा की प्रयोजनीयता

प्रयोजनमूलक हिन्दी के विविध रूप

भाषा को" I का अर्थ, परिभाषा, उद्दे" य प्रकार क्षेत्र व उपयोगिता

I UnHkZ i q_rda%

1 प्रयोजनमूलक हिन्दी: डॉ नरे" I मिश्रा (2017) राजपाल एण्ड सन्ज, क" मीरी गेट, दिल्ली

2 हिंदी साहित्य का इतिहास: डॉ रामसजन पाण्डेय (2012) संजय प्रका" I न, दिल्ली

3 अभिनव काव्य गरिमा: डॉ नरे" I मिश्रा (2012) राजकमल प्रका" I न, दिल्ली

4 प्रयोजनमूलक हिन्दी: सिद्धांत और प्रयोग दंगल झाल्टे, वाणी प्रका" I न, दिल्ली

5 राजभाषा हिंदी: विवेचना और प्रयुक्ति: डा कि" I गोर वासवानी, वाणी प्रका" I न, दिल्ली

6 राजभाषा हिंदी और उसका विकास: हीरालाल बाछोटिया, किताब घर प्रका" I न, दिल्ली

7 अनुवाद विज्ञान: सिद्धांत एवं प्रविधि, भोलानाथ तिवारी, किताब घर प्रका" I न, दिल्ली

BSc/Phy/2/CC5– Thermal Physics

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Objective: The course on thermal physics is framed with the objective that students are able to understand basic concepts of thermodynamical systems. Students will be able to understand heat, work, temperature, entropy and the laws of thermodynamics. Behaviour of real gases as thermodynamical systems has also been included.

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Learn about Kinetic interpretation of Temperature, the real gas equations, Van der Waal equation of state and Brownian motion.

CO2: Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion.

CO3: Understand the basic concepts of thermodynamics, the first and the second law of thermodynamics, Joule Thomson effect, Joule-Thomson (Porous plug) experiment, the concept of entropy and the associated theorems, calculations of entropy for reversible & irreversible process, T - S diagram and Nernst's law (third law of thermodynamics).

CO4: Derive the Clausius-Clapeyron and Clausius latent heat equations and understand their significance. The students will also be able to learn about Maxwell's thermodynamic relations and their physical interpretations.

Note for the Paper Setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit-I

Zeroth and First Law of Thermodynamics: Extensive and intensive thermodynamic variables, Thermodynamic equilibrium, zeroth law and Concept of Temperature, Work and heat, State functions, First law of thermodynamics, Internal energy, Applications of first law, General relation between C_p and C_v , Work done during isothermal and adiabatic processes.

Unit-II

Entropy and Third law of Thermodynamics: Concept of entropy, Clausius theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a Perfect Gas and Universe, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of Thermodynamics, Unattainability of absolute zero, T - S Diagrams, Phase Change, Classification of Phase Changes.

Unit-III

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables; Internal Energy; Definition, importance, properties and applications of Chemical Potential, Enthalpy, Gibbs function and Helmholtz function. **Maxwell's Thermodynamic Relations:** Derivations of Maxwell's Relations and their applications: (1) Clausius- Clapeyron equation (2) $C_p - C_v$ value, (3) Energy equations (4) Change of temperature during adiabatic process.

Unit-IV

Real gases: Behavior of Real Gases, Deviations from the Ideal Gas Equation. The Virial Equation, Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van -der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves, P-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas.

Thermo-electricity: Seebeck effect, Paltier effect, Thomson effect and their explanations.

Text/Reference Books:

1. A Treatise on Heat: Meghnad Saha and B.N. Srivastava, Indian Press
2. Thermal Physics: S. Garg, R. Bansal and Ghosh, Tata McGraw-Hill
3. Concepts in Thermal Physics: S.J. Blundell and K.M. Blundell, Oxford University Press
4. Heat and Thermodynamics: An Intermediate Textbook by M. W. Zemansky and R. Dittman, McGraw-Hill.
5. Thermal Physics and Statistical Mechanics, S.K. Roy, New Age International Publishers, New Delhi
6. Thermodynamics and Statistical Physics, J.K. Sharma and K.K. Sarkar, Himalaya Publishing House, Bombay
7. Introduction to Thermodynamics and its Applications, Stowe Keith, University Press (India) Pvt. Ltd, Hyderabad
8. Introductory Thermodynamics, PierreInfelta, Brown Walker Press, Boca Ratan, Florida
9. Fundamentals of Thermodynamics, J. K. Johnson, University of Pittsburgh 2009
10. Thermodynamics and Its Applications, Jefferson Tester, Michael Modell, 3rd Edition
11. Thermodynamics, Statistical Thermodynamics & Kinetics, Thomas Engel, Philip Reid, 2nd Edition

BSc/Phy/2/CC6– Waves & Optics

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Objective: The objective of this course is to introduce the basics of Waves & Optics and their applications.

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Have understanding of Interference - by Division of Wave front, by Division of Amplitude and Interference due to transmitted light & reflected light.

CO2: Learn about Huygens-Fresnel's theory, diffraction at a straight edge and at a circular aperture, diffraction due to a narrow slit and due to a narrow wire.

CO3: Understand and explain the Fraunhofer diffraction, dispersive power of grating, Rayleigh's criterion and resolving power of telescope & a grating.

CO4: Understand the theories and laws of polarization along with understanding of the production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light.

***Note for the Paper Setter:** The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT-I

Interference: Interference by Division of Wave front: Young's double slit experiment, Coherence, Conditions of interference, Fresnel's biprism and its applications to determine the wavelength of sodium light and thickness of a mica sheet, phase change on reflection. Interference by Division of Amplitude: Plane parallel thin film, production of colors in thin films, classification of fringes in films, Interference due to transmitted light and reflected light, wedge shaped film, Newton's rings.

UNIT-II

Diffraction-I : Huygens-Fresnel's theory, Fresnel's assumptions, rectilinear propagation of light, Fresnel's half period zones, zone plate, diffraction at a straight edge, rectangular slit and diffraction at a circular aperture. Diffraction due to a narrow slit, diffraction due to a narrow wire.

UNIT-III

Diffraction- II: Fraunhofer diffraction: one slit diffraction, two slit diffraction, N-slit diffraction, plane transmission grating spectrum, dispersive power of grating, limit of resolution, Rayleigh's criterion, resolving power of telescope and a grating.

UNIT-IV

Polarization : Polarization: Polarisation by reflection, refraction and scattering, Malus Law, Phenomenon of double refraction, Huygens's wave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light. Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz).

Text/Reference Books:

1. Principles of Optics, M. Born and E. Wolf, Pergamaman Press.
2. Fundamentals of Optics, Jenkins and White, McGraw Hill Book Co. Ltd., New Delhi.
3. Optics, K.D. Muller, University Science Books, Mill ally California.
4. An Introduction to Interferometry, Tolansky, John Wiley & Sons, New Delhi.
5. Polarized Light Production and Use, Shurcliff, Harward University Press, Cambridge, M A (USA)
6. Refresher Course in Physics Vol. II, C.L. Arora, S Chand and Co, New Delhi.

BSc/Phy/2/CC7–Physics Lab-III

Credits: 2 (Practical)

Teaching per week: 4 Hrs.

Max. Marks: 50

Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands on experience with different instruments and measurements of related physical quantities.

CO2: Verify some fundamental principles, effects and concepts of physics through experimentation.

CO3: Perform basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistance, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.

CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Measurement of Planck constant using black body radiation.
2. To determine Stefan's Constant.
3. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
4. To determine the thermal conductivity of bad conductor by Lee and Charlton's disc method.
5. To determine the temperature co-efficient of resistance by platinum resistance thermometer.
6. To study the variation of thermo e.m.f. across two junctions of a thermocouple with temperature.
7. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.
8. To determine Mechanical Equivalent of Heat by Callender and Barne's constant flow method.
9. To draw a calibration curve for a thermocouple.
10. To find the specific heat of a solid by a method of mixture
11. To find the specific heat of a liquid (Turpentine oil) by law of cooling.
12. To find coefficient of apparent expansion of glycerine

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

BSc/Phy/2/CC8–Physics Lab-IV

Credits: 2 (Practical)

Teaching per week: 4 Hrs.

Max. Marks: 50

Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. and resolving power of optical equipment.

CO2: Understand various optical phenomena, principles, workings and applications of optical instruments through experiments.

CO3: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

- 1 To measure the (a) area of a window (b) height of an inaccessible object using a sextant.
- 2 To determine Refractive index of the material of a prism using sodium source.
- 3 To determine the dispersive power and Cauchy constants of the material of a prism using Mercury discharge source.
- 4 To draw a graph between wavelength and minimum deviation for various lines from a Mercury discharge source.
- 5 Determination of wave length of sodium light and the number of lines per centimetre using a diffraction grating.
- 6 Determination of wave length of sodium light using Newton's Rings.
- 7 Resolving power of a telescope.
- 8 Comparison of Illuminating Powers by a Photometer.
- 9 Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
- 10 Ordinary and extra ordinary refractive indices for calcite or quartz.
- 11 To find the equivalent focal length of a lens system by nodal slide assembly.

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

BSc/Phy/2/CC9- Seminar

BSc/Phy/2/SEC2 – (i) Basic Instrumentation Lab

Credits: 2 (Practical)

Teaching per week: 4 Hrs.

Max. Marks: 50

Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through hands on training of basic instruments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Exposure with various aspects of instruments and their usage through hands-on mode.

CO2: Real work experience of various lab skills on related instruments in the profession.

CO3: Basic understanding on instruments data observation, measurements, errors and analysis.

CO4: Practical's training to use and learn techniques, skills and tools for professional practices.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope. 2. CRO as a versatile measuring device. 3. Circuit tracing of Laboratory electronic equipment, 4. Use of Digital multimeter/VTVM for measuring voltages 5. Circuit tracing of Laboratory electronic equipment, 6. Winding a coil/transformer. 7. Study the layout of receiver circuit. 8. Trouble shooting a circuit 9. Balancing of bridges.

Laboratory Exercises: 1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance. 2. To observe the limitations of a multimeter for measuring high frequency voltage and currents. 3. To measure Q of a coil and its dependence on frequency, using a Q- meter. 4. Measurement of voltage, frequency, time period and phase angle using CRO. 5. Measurement of time period, frequency, average period using universal counter/frequency counter. 6. Measurement of rise, fall and delay times using a CRO. 7. Measurement of distortion of a RF signal generator using distortion factor meter. 8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments: (i). Using a Dual Trace Oscilloscope, ii). Converting the range of a given measuring instrument (voltmeter, ammeter).

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata McGraw Hill.
7. Electronic circuits: Handbook of design and applications, U. Tietze, Ch. Schenk, 2008, Springer.
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

BSc/Phy/2/SEC2 – (ii) Electrical Circuits & Networks Lab

Credits: 2 (Practical)

Teaching per week: 4 Hrs.

Max. Marks: 50

Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through hands on training of electrical circuits and networks.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode. Understanding electrical circuits.

CO2: Enhancing knowledge of electrical drawing, symbols, generators and transformers.

CO3: Learning technical skills of electric motors, rectifiers, capacitors, phase reversal electrical protection, and overload devices.

CO4: Learning basics for professional skills of electrical wiring, splices, shunting, inductors, Inductance and impedance.

Laboratory Exercises:

Performance and design of Electrical Circuits & Networks in the Lab. as per syllabi of theory course namely Electrical Circuits & Networks.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata McGraw Hill.
7. Electronic circuits: Handbook of design and applications, U. Tietze, Ch. Schenk, 2008, Springer .
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

COMP/2/SEC3 - COMPUTER SKILLS

Credits: 2 (Practical)

Duration of Exam.: 3 Hrs.

Max. Marks: 50

Final Term Exam.: 50

Objective: The course aims to provide practical computer knowledge and skills to students and to enhance the usefulness of information technology tools in various activities.

Learning Outcomes: After completion of the course, learners will be able to:

CO1: Know about Operating System, Overview of various Computer & Mobile Operating systems and Applications.

CO2: Perform various features of Word processing such that Table, Mail merge, Hyperlink, etc.

CO3: Prepare a business presentation on MS PowerPoint.

CO4: Perform various mathematical, logical, and other functions on a large set of data using MS Excel.

Unit-I

Windows: Installation of Windows, Windows Desktop, My computer, My documents, Network neighbourhood, Recycle Bin, Quick launch tool bar, System tray, Start menu, Task bar - System Tray - Quick launch tool bar - Start button - Parts of Windows, Keyboard Accelerators: Key board short keys or hotkeys, Working with Notepad & WordPad, Creating & Editing Images with Microsoft paint, using the Calculator, Personalising Windows.

MS-Word: Working with Documents, Formatting page & setting Margins, Converting files to different formats, Importing & Exporting documents, Formatting Documents - Setting Font styles, Font selection- style, Setting Paragraph style, Alignments, Indents, Line Space, Margins, Bullets & Numbering. Setting Page style - Formatting Page, Page tab, Margins, Layout settings, Border & Shading, Columns, Header & footer, Setting Footnotes & end notes, page break, Setting Document styles, Table of Contents, Index, Page Numbering, date & Time, Creating Tables- Table settings, Borders, Alignments, Insertion, deletion, Merging, Splitting, Sorting, Drawing - Inserting Clip Arts, Pictures/Files, Tools –Spell Checks, Mail merge, Templates, Printing Documents.

Unit-II

MS-Excel: Spread Sheet & its Applications, Opening Spreadsheet, Menus , Working with Spreadsheets- opening, Saving files, setting Margins, Spread sheet addressing - Rows, Columns & Cells, Referring Cells & Selecting Cells – Shortcut Keys. Entering & Deleting Data, Inserting Data, Insert Cells, Column, rows & sheets, Inserting Functions, Formula - finding total in a column or row, Mathematical operations (Addition, Subtraction, Multiplication, Division, Exponentiation), Formatting Spreadsheets- Labelling columns & rows, Formatting- Cell, row, column & Sheet, Category - Alignment, Font, Border & Shading, Hiding/ Locking Cells, Working with sheets – Sorting, Filtering, Creating Charts , Tools – Error checking, Spell Checks.

MS-Power-Point: Introduction to presentation – Opening new presentation, Different presentation templates, setting backgrounds, selecting presentation layouts. Creating a presentation-Setting Presentation style, Adding text to the Presentation. Formatting a Presentation-Adding style, Colour, Arranging objects, Adding Header & Footer, Slide Background, Slide layout. Adding Graphics to the Presentation- Inserting pictures, tables into presentation, Adding Effects to the Presentation-Setting Animation & transition effect. Practical Exercises:

Suggested Readings:

1. Bharihoka, D. (2012). Fundamentals of Information Technology. New Delhi: Excel Book.
2. Boockholdt, J. L. (1999). Accounting Information System: Transaction Processing and Control. Boston: Irwin McGraw Hill.
3. Gelinas, U. J., & Steve, G. S. (2002). Sutton, Accounting Information System. Mason: South Western Thomson Learning.
4. Hall, J. A. (2006). Accounting Information System. Nashville: South Western College Publishing. Rajaraman, V. (2018). Introduction to Information Technology. New Delhi: PHI Learning Pvt. Ltd.

Note: Open-Source Software or MS Excel, MS Access, and Tally may be used at appropriate places.

Generic Elective Courses

BSc/Phy/1/GEC1–Mechanics (Theory)

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Objective: The objective of this course is to teach the students fundamentals of Newtonian Mechanics, rigid body dynamic, concept of inverse square force and the special theory of relativity.

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Learn the concept of conservation of energy, momentum, angular momentum and apply them to understand the basic problems in physics.

CO2: Understand the application of rotational dynamics motions in analyzing rolling with slipping. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.

CO3: Understand the concept of central force problem, gravitational energy and GPS. Applications of inverse square law.

CO4: Describe special relativistic effects and their effects on the mass and energy of a moving object and appreciate the nuances and important outcomes of Special Theory of Relativity.

Note for the Paper Setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit-I

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, Fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass (discrete and continuous), Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.

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

Unit-II

Rotational Dynamics: Equation of motion of a rigid body, Rotational motion of a rigid body in general and that of plane lamina, Rotation of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia (discrete and continuous), Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation, elementary Gyroscope.

Unit-III

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self-

energy, two body problem and concept of reduced mass, Motion of a body under central force, Equation of orbit in inverse-square force field, satellite in Circular orbit & Geosynchronous orbits, Basic idea of GPS (Global Positioning System).

Unit-IV

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Galilean transformation (velocity, acceleration) and its inadequacy, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, 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 Doppler effect, Relativistic Kinematics (decay, inelastic collision, Compton effect), Transformation of Energy, Momentum and force, Four Vectors.

Text/Reference Books:

1. Classical Mechanics by H. Goldstein (2nd Edition)
2. Berkeley Physics Course. Vol. 1. Mechanics, E.M. Purcell
3. Concepts of Modern Physics, Arthur Beiser
4. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 2007, McGraw-Hill.
5. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2012.
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, F.W. Seers, M. W. Zemansky, H. D. Young, Addison-Wesley Pub. Co.
8. Fundamentals of Physics, Halliday, & Walker, Resnick John Wiley & Sons, Inc.

BSc/Phy/1/GEC2– Mechanics (Lab.)

Credits: 2 (Practical)

Teaching per week: 4 Hrs.

Max. Marks: 50

Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands on experience with different instruments and measurements of different physical quantities and related concepts in Physics.

CO2: Verify some fundamental principles, effects and concepts of physics through experimentation.

CO3: Perform experiments related to mechanics (compound pendulum), rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity) and fluid dynamics (verification of Stokes law, Searle method) etc.

CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments:

1. Measurement of Length (or diameter) using Travelling Microscope.
2. Moment of Inertia of a Fly Wheel
3. Moment of Inertia of irregular body using a Torsion Pendulum.
4. Surface Tension by Jaeger's Method.
5. Young Modulus by Bending of Beam.
6. Modulus of rigidity of material of wire by Maxwell's Needle.
7. Elastic constant by Searle's method.
8. Viscosity of water by its flow through a uniform capillary tube.
9. Acceleration due to Gravity 'g' by Bar pendulum.
10. To study the Motion of spring and calculate Spring constant & value of Acceleration due to Gravity.
11. To compare Moment of Inertia of a solid Sphere, Hollow Sphere and solid Disc of same mass with the help of Torsion Pendulum.

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

BSc/Phy/2/GEC3– Waves & Optics (Theory)

Credits: 4

Lectures: 60

Duration of Exam.: 3 Hrs.

Max. Marks: 100

Final Term Exam.: 70

Internal Assessment: 30

Objective: The objective of this course is to introduce the basics of Waves & Optics and their applications.

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Have understanding of Interference - by Division of Wave front, by Division of Amplitude and Interference due to transmitted light & reflected light.

CO2: Learn about Huygens-Fresnel's theory, diffraction at a straight edge and at a circular aperture, diffraction due to a narrow slit and due to a narrow wire.

CO3: Understand and explain the Fraunhofer diffraction, dispersive power of grating, Rayleigh's criterion and resolving power of telescope & a grating.

CO4: Understand the theories and laws of polarization along with understanding of the production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light.

***Note for the Paper Setter:** The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT-I

Interference: Interference by Division of Wave front: Young's double slit experiment, Coherence, Conditions of interference, Fresnel's biprism and its applications to determine the wavelength of sodium light and thickness of a mica sheet, phase change on reflection. Interference by Division of Amplitude: Plane parallel thin film, production of colors in thin films, classification of fringes in films, Interference due to transmitted light and reflected light, wedge shaped film, Newton's rings.

UNIT-II

Diffraction-I : Huygens-Fresnel's theory, Fresnel's assumptions, rectilinear propagation of light, Fresnel's half period zones, zone plate, diffraction at a straight edge, rectangular slit and diffraction at a circular aperture. Diffraction due to a narrow slit, diffraction due to a narrow wire.

UNIT-III

Diffraction- II: Fraunhofer diffraction: one slit diffraction, two slit diffraction, N-slit diffraction, plane transmission grating spectrum, dispersive power of grating, limit of resolution, Rayleigh's criterion, resolving power of telescope and a grating.

UNIT-IV

Polarization: Polarisation by reflection, refraction and scattering, Malus Law, Phenomenon of double refraction, Huygens's wave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light. Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz).

Text/Reference Books:

1. Principles of Optics, M. Born and E. Wolf, Pergamaman Press.
2. Fundamentals of Optics, Jenkins and White, McGraw Hill Book Co. Ltd., New Delhi.
3. Optics, K.D. Muller, University Science Books, Mill ally California.
4. An Introduction to Interferometry, Tolansky, John Wiley & Sons, New Delhi.
5. Polarized Light Production and Use, Shurcliff, Harward University Press, Cambridge, M A (USA)
6. Refresher Course in Physics Vol. II, C.L. Arora, S Chand and Co, New Delhi.

BSc/Phy/2/GEC4–Waves & Optics (Lab.)

Credits: 2 (Practical)

Teaching per week: 4 Hrs.

Max. Marks: 50

Duration of Exam: 3 Hrs.

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. and resolving power of optical equipment.

CO2: Understand various optical phenomena, principles, workings and applications of optical instruments through experiments.

CO3: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. To measure the (a) area of a window (b) height of an inaccessible object using a sextant.
2. To determine Refractive index of the material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using Mercury discharge source.
4. To draw a graph between wavelength and minimum deviation for various lines from a Mercury discharge source.
5. Determination of wave length of sodium light and the number of lines per centimetre using a diffraction grating.
6. Determination of wave length of sodium light using Newton's Rings.
7. Resolving power of a telescope.
8. Comparison of Illuminating Powers by a Photometer.
9. Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
10. Ordinary and extra ordinary refractive indices for calcite or quartz.
11. To find the equivalent focal length of a lens system by nodal slide assembly.

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House