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BE BOUNDLESS

Bangalore City University

Department of Physics

Central College Campus

Bengaluru – 560 001

Syllabus for

I & II Semester Physics Papers

Under Graduate(UG) Program

Framed according to the National Education Policy (NEP 2020)

September 27, 2021

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Introduction

The NEP-2020 offers an opportunity to effect a paradigm shift from a teacher-centric to a student-centric higher education system in India. It is based on Outcome Based Education, where the Graduate Attributes are first kept in mind to reverse-design the Programs, Courses and Supplementary activities to attain the graduate attributes and learning outcomes. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours) Physics is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills in Physics, as well develop scientific orientation, spirit of enquiry problem solving skills and human and professional will values which foster rational and critical thinking in the students.

Graduate attributes in Physics

Some of the characteristic attributes a graduate in Physics should possess are:

- Disciplinary knowledge and skills:
- Skilled communication:
- Critical thinking and problem solving capacity:
- Sense of inquiry:
- Team player/worker:
- Project Management Skills:
- Digital and ICT efficiency:
- Ethical awareness / reasoning:
- National and international perspective:
- Lifelong learning

Flexibility

- The programmes are flexible enough to allow liberty to students in designing them according to their requirements. Students may choose a single Major, one Major with a Minor, and one Major with two Minors. Teacher Education or Vocational courses may be chosen in place of Minor/s. Below listed are the various options students may choose from.
- One Major subject/discipline, Two Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities.
- One Major and one Minor subject/discipline along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities
- Two Major subject/disciplines along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses, including Extracurricular Activities (subject to fulfilling the requirements as stated in 3.i and 3.ii)
- One Major subject/discipline and one Vocational course along with Languages, Generic Electives, Ability Enhancement and Skill Development and courses including Extracurricular Activities.

- One Major Discipline and One Education Discipline along with Languages, Generic Electives, Ability Enhancement and Skill Development Courses including Extracurricular Activities.

Progressive Certificate, Diploma, Bachelor Degree or Bachelor Degree with Honours Provided at the End of Each Year of Exit of the Four-year Undergraduate Programme/ Five-year Integrated Master's Degree Programme

EXIT OPTIONS	Credits required
Certificate upon the Successful Completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	44 - 48
Diploma upon the Successful Completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	88 - 96
Basic Bachelor Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four- year Undergraduate Programme/Five-year Integrated Master's Degree Programme	132 - 144
Bachelor Degree with Honours in a Discipline at the Successful Completion of the Fourth Years (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	176 - 192
Master's Degree in a Discipline at the Successful Completion of the Fifth Year (Ten Semesters) of the Five- year Integrated Master's Degree Programme	224- 240

Aims of UG program in Physics

The aims and objectives of our UG educational programs in sciences in general and Physics in particular should be structured to

- Create the facilities and environment in all the educational institutions to consolidate the knowledge acquired at +2 level and to motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.
- Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
- Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
- Expose the student to the vast scope of Physics as a theoretical and experimental science with applications in solving most of the problems in nature spanning from 10^{-15} m to 10^{26}m in space and 10^{-10} eV to 10^{25}eV in energy dimensions.
- Emphasize the discipline of Physics to be the most important branch of science for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
- To emphasize the importance of Physics as the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities at all levels of employment.

The progressive curriculum shall position knowledge and skills required on the transformation of novice problem solvers (at entry level of the program) to expert problem solvers (by the time of graduation) as given below:

- At the end of first year – Ability to solve well defined problems
- At the end of second year – Ability to solve broadly defined problems
- At the end of third year – Ability to solve complex problems that are ill-structure that require multi-disciplinary skills to solve them
- During fourth year – Experience of workplace problem solving in the form of internship or Research Experience preparing for higher education or Entrepreneurship and employment.

Curriculum Framework for Multidisciplinary Four- year Undergraduate Programme/ Five-year Integrated Master's Degree Programme

Year	Objectives	Nature of Courses	Outcome	No. of courses
1st year – (1^{st} & 2^{nd} Semesters)	Understanding and Exploration	1. Major Core Courses 2. Minor/Related Discipline 3. Languages, 4. Ability Enhancement Compulsory Courses 5. Skill Enhancement/ Development Courses	Understanding of Disciplines Language Competency Gaining perspective of context/Generic skills Basic skills sets to pursue any vocation	1+1 1+1 2+2 1+1 1+1
Exit option with Certification				
2^{nd} Year - (3^{rd} & 4^{th} Semesters)	Focus and Immersion	1. Major Core Courses 2. Minor/ Related Discipline 3. Ability Enhancement 4. Skill based Vocational 5. Extra Curricular Activities	Understanding of disciplines Gaining perspective of context Skill sets to pursue vocation Development of various Domains of mind &Personality	2+2 1+1 1+1 1+1 1+1
Exit Option with Diploma				
3^{rd} Year - (5^{th} & 6^{th} Semesters)	Real time Learning	1. Major Discipline Core and Elective Courses 2. Minor Discipline/ Generic or Vocational Electives/Field based Learning/ Research Project	In depth learning of major and minor disciplines, Skill sets for employability. Exposure to discipline beyond the chosen Subject Experiential learning/ Research.	2+2 1+1 1+1
Exit option with Bachelor Degree				
4^{th} Year - (7^{th}&8^{th} Semesters)	Deeper Concentration	Major Discipline Core and Elective courses Research/ Project Work with Dissertation	Deeper and Advanced Learning of Major Discipline Foundation to pursue Doctoral Studies & Developing Research competencies	4+4
Bachelor Degree with Honours				
5th Year - (9th & 10th Semesters)	Master of the subject	Major Discipline Core and Elective courses/ Research/ Project Work with Dissertation	Deeper and Advanced Learning of the Major Discipline towards gaining proficiency over the subject	4+4/6+6
Master's Degree				

Course Structure
(Major Discipline: Physics)
Semester 1 - 10

SEMESTER	Discipline Core Theory (DSCT)	Core Papers
SEMESTER -1	Phy.DSCT1	Mechanics & Properties of Matter (Select one Open Elective from the Pool A)
SEMESTER -2	Phy.DSCT2	Electricity and Magnetism (Select one Open Elective from the Pool A)
SEMESTER -3	Phy.DSCT3	Wave motion and optics (Select one Open Elective from the Pool A)
SEMESTER -4	Phy.DSCT4	Thermal Physics & Electronics (Select one Open Elective from the Pool A)
SEMESTER -5	Phy.DSCT5 Phy.DSCT6	1. Classical Mechanics and Quantum Mechanics- I 2. Elements of Atomic, Molecular Physics
SEMESTER -6	Phy.DSCT7 Phy.DSCT8	1. Elements of Nuclear Physics and Nuclear Instruments 2. Elements of Condensed Matter Physics
SEMESTER -7	Phy.DSCT9 Phy.DSCT10 Phy.DSCT11	1. Mathematical Methods of Physics – I 2. Classical Electrodynamics. 3. Experimental methods of Physics 4. Research Methodology
SEMESTER -8	Phy.DSCT12 Phy.DSCT13 Phy.DSCT14	1. Classical Mechanics and Quantum Mechanics-II 2. Statistical Mechanics 3. Astrophysics & Astronomy 4. Research Project* (Select Two DSE subjects from the Pool B-II shown below) *In lieu of the research Project, two additional elective papers/ Internship may be offered.
SEMESTER -9	Phy.DSCT15	1. Mathematical Methods of Physics – II (Select One DSE subjects from the Pool B-III shown below) 2. Research Project
SEMESTER -10	Phy.DSCT17	1. Quantum Mechanics – III (Select One DSE subjects from the Pool B-IV shown below) 2. Research Project

Open Electives

Sl. No.	1 to 4 Semester Pool A
1.	Phy-OE1: Energy Sources
2.	Phy-OE2: Climate Science
3.	Phy-OE3: Astronomy
4.	Phy-OE4: Medical Physics
5.	Phy-OE5: Optical Instruments
6.	Phy-OE6: Sports Science
7.	Phy-OE7: Nanotechnology
8.	Phy-OE8: Electrical Instruments
9.	Phy-OE9: Physics for All.[@@@]

[@]Students who have chosen Phy-DST1 paper are not eligible to take Phy-OE9: paper

Discipline Specific Electives for 7 to 10 Semesters

7th Sem Electives		8th Sem Electives	
A.	Condensed Matter Physics-1	A.	Atomic & Molecular Physics-1
B.	Nuclear and Particle Physics	B.	Materials Physics & Nano materials
C.	Theoretical and Computational Physics-I	C.	Lasers and non-linear optics
D.	Biophysics	D.	Plasma Physics
E.	Astronomy and Astrophysics	E.	Physics of Semiconductor devices

9th Sem Electives (Specialization papers) Pool B-III		10th Sem Electives (Specialization papers) Pool B-IV	
A.	Condensed Matter Physics-2	A.	Condensed Matter Physics-3
B.	Nuclear and Particle Physics-2	B.	Nuclear and Particle Physics-3
C.	Atomic & Molecular spectroscopy-1	C.	Atomic & Molecular spectroscopy-2
D.	Materials Physics & Nanophysics –1	D.	Materials Physics & Nanophysics -2
E.	Theoretical and Computational Physics-I	E.	Theoretical and Computational Physics-2
F.	Astronomy and Astrophysics-1	F.	Astronomy and Astrophysics-2

Detailed Syllabus for Semester I & II

Semester – I

Phy-DSCT1: Mechanics and Properties of Matter	Course Credits (L+T+P) : 4+0+2=6
Total Contact Hours: 52	Duration of ESA: 3 hours

Course Outcomes (COs):

1. Fixing units, tabulation of observations, analysis of data (graphical/analytical).
2. Accuracy of measurement and sources of errors, importance of significant figures.
3. Knowledge of how g can be determined experimentally and derive satisfaction.
4. Understanding the difference between simple and torsional pendulum and their use in the determination of various physical parameters.
5. Knowledge of how various elastic moduli can be determined.
6. Measuring surface tension and viscosity and appreciate the methods adopted.
7. Hands on experience of different equipments.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
Fixing units, tabulation of observations, analysis of data (graphical/analytical)	x					
Accuracy of measurement and sources of errors, importance of significant figures		x				
Knowledge of how g can be determined experimentally and derive satisfaction.	x					
Understanding the difference between simple and torsional pendulum and their use in the determination of various physical parameters					x	
Knowledge of how various elastic moduli can be determined	x					
Measuring surface tension and viscosity and appreciate the methods adopted	x					
Hands on experience of different equipments.	x					

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'x' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content Phy.DSCT1: Mechanics & Properties of Matter		Hrs
Unit – 1 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 1	**Units and measurements:** System of units (CGS and SI), measurement of length, mass and time, dimensions of physical quantities, dimensional formulae, errors, Mean deviation.	4
Chapter No. 2	**Momentum and Energy**: Work and energy, Conservation of linear momentum, Conservation of energy with examples, Motion of rockets.	4
Chapter No. 3	**Special Theory of Relativity:** Constancy of speed of light, Postulates of the Special Theory of Relativity. Length contraction and Time dilation. Relativistic addition of velocities.	5
Topics for Self-study	Variable mass problem & Rocket motion Twin paradox	
	Suggested Activities	
Activity No. 1	i). Measure diameters of small balls of different size and estimate their volumes. ii). Measure lengths of nails of different size. iii). Measure volume of a liquid. iv). Measure distances and put the result both in CGS and SI units in 2, 3 and 4 significant figures. Mention the precession of the measurement. v). Estimate standard deviations wherever possible.	
Activity No. 2	Understand conservation of energy in every day examples like i) What happens in solar energy conversion panels ii) Pushing an object on the table it moves iii) Moving car hits a parked car causes parked car to move. In these cases, it is known that energy is conserved. How? Understand and verify if possible.	
Unit – 2 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 4.	**Laws of Motion:** Newton's Laws of motion, Dynamics of single particle and a system of particles, Centre of mass.	3

Chapter No. 5.	**Dynamics of Rigid bodies**: Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy, Moment of inertia (MI): Laws of MI, MI of a rectangular lamina and solid cylinder, Flywheel.	6
Chapter No. 6.	**Gravitation:** Law of Gravitation, Motion of a particle in a central force field (motion in a plane, conservation of angular momentum, constancy of areal velocity is constant). Kepler's laws (statements). Satellite in a circular orbit.	4
Topics for self study(If any)	Geosynchronous orbits Basic idea of global positioning system (GPS).	
	Suggested Activities	
Activity No. 3	Moment of inertia is an abstract concept. It simply gives a measure of rotational inertia of a rigid body and it is proportional to the product of the square of radius, r of the body and its mass, m. Refer to different websites to construct and perform simple experiments to verify MI of different objects.	
	Reference : www.khanacademy.org, www.pinterest.com, www.serc.cerleton.edu	
Activity No. 4	Prepare suitable charts and give seminar talks in the class.	
	Reference : Weblink/Youtube/Book	
Unit – 3 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 7	**Elasticity:** Hooke's law, Stress-strain diagram, elastic moduli, relation between elastic constants, Poisson's ratio, expression for Poisson's ratio in terms of elastic constants. Work done in stretching and work done in twisting a wire, twisting couple on a cylinder. Beams, bending of beams, expression for bending moment, theory of single cantilever. Torsional pendulum, expression for time-period of torsional oscillations, determination of rigidity modulus (static and dynamic methods) and moment of inertia, determination of q, η and σ by Searle's double bar with necessary theory.	13
Topics for self study	Time period of oscillations of a spring-mass system with non-negligible mass of the spring.	

	Suggested Activities	
Activity No. 5	Arrange a steel spring with its top fixed with a rigid support on a wall and a meter scale along side. Add 100 g load at a time on the bottom of the hanger in steps. This means that while putting each 100g load, we are increasing the stretching force by 1N. Measure the extension for loads up to 500g. Plot a graph of extension versus load. Shape of the graph should be a straight line indicating that the ratio of load to extension is constant. Go for higher loads and find out elastic limit of the material.	
	Reference : Weblink/Youtube/Book	
Activity No.6	Repeat the above experiment with rubber and other materials and find out what happens after exceeding elastic limit. Plot and interpret.	
	Reference : Weblink/Youtube/Book	
Unit – 4 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 8	**Surface tension:** Definition of surface , angle of contact, surface energy, relation between surface tension and surface energy, pressure difference across a curved surface (with example), excess pressure inside a spherical liquid drop.	7
	Text Book : Units/sections to be Referred:	
Chapter No. 9	Topics to be covered: **Viscosity:** Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poisulle's method, Stoke's method.	6
	Text Book : Units/sections to be Referred:	
Topics for self study(If any)	Capillarity determination of surface tension by drop weight method.	
	Suggested Activities	
Activity No.7	Measure surface tension of water and other common liquids and compare and learn i) Why water has high ST? think of reasons. ii) Check whether ST is a function of temperature? You can do it by heating the water to different temperatures and measure ST. iii) Plot ST versus T and learn how it behaves.	

	Mix some quantity of kerosene or any oil to water and measure ST. Check whether ST for the mixture is more or less than pure water. Think of reasons.	
	Reference : Weblink/Youtube/Book	
Activity No. 8	Collect a set of different liquids and measure their viscosity. i) Find out whether sticky or non sticky liquids are most viscous. Think of reasons. ii) Mix non sticky liquid to the sticky liquid in defined quantities and measure viscosity. Find out viscosity is increasing or decreasing with increase of non-sticky liquid concentration. iii) Do the above experiment by mixing sticky liquid to the non sticky liquid. Find out change in viscosity with increase of concentration of sticky liquid. Think why anyone should know viscosity of a liquid.	
	Reference : Weblink/Youtube/Book	

Text Books

Sl No	Title of the Book	Author(s)	Publisher	Year of Publication
1	Mechanics	D. S. Mathur	S.Chand &Co.	2000
2	Mechancis and Relativity (3rd Edition)	Vidwan Singh Soni,	PHI Learning Pvt. Ltd.	2013
3	Mechanics (In SI Units): Berkeley Physics Course Vol 1	Charles Kittel, Walter Knight, et al	Tata McGraw-Hill	2007
4	Properties of Matter	Brij Lal & Subrahmanyam	S.Chand &Co.	2002

References Books

Sl No	Title of the Book	Author(s)	Publisher	Year of Publication
1	Principles of Physics	David Halliday, Jearl Walker & Robert Resnick	Wiley India Pvt. Ltd	2010
2	Physics (8^{th} Edition)	David Halliday & Robert Resnick	Wiley India Pvt Ltd	2008

Paper Code: Phy-DSCP1 - Lab I
List of Experiments to be performed in Lab I

1.	Determination of g using bar pendulum (L versus T and L versus LT^2 graphs)
2.	Determination of moment of inertia of a Fly Wheel.
3.	Determination of rigidity modulus using torsional pendulum
4.	Verification of parallel and perpendicular axis theorems.
5.	Determine the Young's Modulus of a bar by uniform bending method
6.	Determination of elastic constants of a wire by Searle's double bar method
7.	Young's modulus by Koenig's method
8.	Modulus of rigidity of a rod –Static torsion method.
9.	Viscosity by Stoke's method
10	Verification of Hooke's law.
11.	Determination of surface tension of a liquid and the interfacial tension between two liquids using drop weight method.
12	Critical pressure for stream line flow
13	Determine the Young's Modulus a bar by single cantilever method.
14	Study of motion of a spring and to calculate spring constant, g and mass of the spring.

Note: A minimum of EIGHT experiments to be carried out

Reference Books for Laboratory Experiments

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Physics through experiments	B. Saraf	Vikas Publications	2013
2	A laboratory manual of Physics for undergraduate classes, 1st Edition,	D P Khandelwal	Vikas Publications.	1985
3	B.Sc. Practical Physics (Revised Edition)	C. L Arora	S.Chand & Co.	2007
4	An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.	2002

Course Content: Semester – II

Phy-DSCT2: Electricity and Magnetism	Course Credits (L+T+P) : 4+0+2=6
Total Contact Hours: 52	Duration of ESA: 3 hours

Course Outcomes (COs):

1. Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
2. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
3. Apply Gauss's law of electrostatics to solve a variety of problems.
4. Describe the magnetic field produced by magnetic dipoles and electric currents.
5. Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.
6. Describe how magnetism is produced and list examples where its effects are observed.
7. Apply Kirchhoff's rules to 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.
8. Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity,• Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point, line, surface, and volume distributions of charges.	x	x				
Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.	x					
Apply Gauss's law of electrostatics to solve a variety of problems.	x	x			x	
Describe the magnetic field produced by magnetic dipoles and electric currents.	x					
Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.	x					
Describe how magnetism is produced and list examples where its effects are observed.	x				x	x
Apply Kirchhoff's rules to 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.	x	x			x	x
Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity,• Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.	x	x			x	x

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark '**X**' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content **Phy-DSCT2:Electricity and Magnetism**		**Hrs**
Unit – 1 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 1	**Electric charge and field:** Coulomb's law, electric field strength, electric field lines, point charge in an electric field and electric dipole, work done by a charge (derivation of the expression for potential energy)	3
Chapter No. 2	**Gauss law:** Gauss's law and its applications - electric fields of a (i) spherical charge distribution, (ii) line charge and (iii) an infinite flat sheet of charge.	3
Chapter No. 3	**Electrostatic potential** Electric potential, line integral, gradient of a scalar function, relation between field and potential. Potential due to point charge and distribution of charges (Examples: potential associated with a spherical charge distribution, infinite line charge distribution, infinite plane sheet of charges). Constant potential surfaces, Potential due to a dipole and electric quadrupole.	7
Topics for self study	Concept of Voltage and Current Sources, Kirchhoff's Laws Power transform theorem.	
	Suggested Activities	
Activity No. 1	(i) Learn the difference between and DC and AC electricity and their characteristics. (ii) Voltage and line frequency standards in different countries. (iii) A small project report on production of electricity as a source of energy: Different methods	
	Reference : Weblink/Youtube/Book	
Activity No. 2	(i) Learn to use a multimeter (analog and digital) to measure voltage, current and resistance. Continuity testing of a wire. (ii) Learn about household electrical connection terminals:	

	Live, neutral and ground and voltage between the terminals. Role of earthing and safety measures	
	Reference : Weblink/Youtube/Book	
Unit – 2 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 4.	**Conductors in electrostatic field:** Conductors and insulators, conductors in electric field. Capacitance and capacitors, expression for capacitance in a parallel plate capacitor, parallel plate capacitor with dielectric, Dielectrics: an atomic view. Energy stored in a capacitor, Dielectric and Gauss's law.	6
Chapter No. 5.	**DC currents:** Electric currents and current density. Electrical conductivity and Ohm's law (Review). Network theorems (Thevenin's theorem, Superposition theorem and the maximum power transfer theorem), Transient currents in RC, LR and LCR circuits.	7
Topics for self study(If any)	AC Currents and voltages in pure R, L and C circuits	
	Suggested Activities	
Activity No. 3	(i) Learn about electrical appliances which work with AC and DC electricity. (ii) Learn about types of resistors and their colour codes and types of capacitors (electrolytic and non-electrolytic)	
	Reference : Weblink/Youtube/Book	
Activity No. 4	(i) Learn about power transmission: 3-phase electricity, voltage and phase (ii) Visit a nearby electrical power station. Interact with line men, Electrical engineers and managers. Discuss about power loss in transmission. How to reduce it? (iii) Prepare a small project report on street lighting and types of electrical bulbs.	
	Reference : Weblink/Youtube/Book	

Unit – 3 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No.6	**Magnetism:** Definition of magnetic field, Ampere's law and Biot-Savart law (magnetic force and magnetic flux), Magnetic force on a current carrying conductor, Lorentz force, Hall effect in a conductor. Electromagnetic induction, Faraday's laws of induction, Lenz's Law, expression for self-inductance and energy stored in a magnetic field. Mutual inductance. conducting rod moving in a magnetic field,	7
Chapter No. 7	**AC circuits:** RMS and average value of AC, Response of series RL, RC, LCR circuits using j-operator method, Quality factor, admittance and impedance, power and energy in AC circuits.	6
Topics for self study (If any)	Response of parallel RL, RC, LCR circuits using j-operator method	
	Suggested Activities	
Activity No. 5	(i) Prepare a small project report on street lighting and types of electrical bulbs. (ii) Learn the measurement of electric current using tangent galvanometer.	
	Reference : Weblink/Youtube/Book	
Activity No.6	Build a small coil with insulated copper wire. Connect an ammeter micro/milli ammeter. Verify magnetic induction using a powerful bar magnet.	
	Reference : Weblink/Youtube/Book	
Unit – 4		
Chapter No. 8	**Electromagnetic waves:** Equation of continuity, Maxwell's equations, displacement current, equation for propagation of electromagnetic wave, transverse nature of electromagnetic wave, energy transported by electromagnetic waves. Poynting vector, magnetic moment of a point charge moving in a circular loop, electric current in	8

	atoms, electron spin and magnetic moment,	
Chapter No. 9	**Magnetic materials:** Magnetic intensity and magnetic induction, Intensity of magnetization, Susceptibility, Permeability, Types of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials. Classical Langevin's theory of diamagnetism, B-H hysteresis curves, Hard and soft magnetic materials.	5
Topics for self study(If any)	1. Super conductivity 2. At least two Applications of magnetic materials	
	Suggested Activities	
Activity No.7	(i) Prepare a small project report on production of magnetic field: Permanent magnets, electromagnets and superconducting magnets. (ii) Learn the principle of working of a Gauss meter to measure magnetic field	
	Reference : Weblink/Youtube/Book	
Activity No. 8	(i) Model the earth's magnetic field with a diagram. (ii) Explain the effect of tilt of the earth's axis and reasons for the change in the tilt of the earth's axis over thousands of years.	
	Reference : Weblink/Youtube/Book	

Text Books

Sl No	**Title of the Book**	**Author(s)**	**Publisher**	**Year of Publication**
1	Physics-Part-II,	David Halliday and Robert Resnick	Wiley Eastern Limited	2001
2	Berkeley Physics Course, Vol-2, Electricity and Magnetism, Special Edition	Edward M Purcell	Tata Mc Graw-Hill Publishing Company Ltd, New Delhi	2008

Paper Code: Phy-DSCP1-Lab II

List of Experiments to be performed in Lab II

1.	Verification of Superposition theorem.
2.	Verification of Maximum power transfer theorem
3.	Verification of Thevenin's theorem
4.	Determination of L and C by equal voltage method
5.	Determination of high resistance by leakage method using BG
6.	Determination of mutual inductance using a Ballistic galvanometer.
7.	Charging and discharging of a capacitor (energy dissipated during charging and time constant measurement.).
8.	Frequency response of LCR Series resonance circuit
9.	Frequency response of LCR Parallel resonance circuit.
10.	Impedance of series RC circuits - determination of frequency of AC.
11.	Identification and measurement of L, C and R elements in a black box
12.	Determination of self-inductance of a coil using Anderson's bridge
13.	Verification of laws of combination of capacitances using de-Sauty's bridge
14.	Determination of inductance using Maxwell's impedance bridge
15.	Determination of B_H using Helmholtz double coil galvanometer .

Note: A minimum of EIGHT experiments to be performed.

Open Elective Papers
Phy-OE1: Energy Sources (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I: Non-Renewable energy sources	**Hrs.**
Introduction: Energy concept-sources in general, its significance & necessity, Classification of energy sources: Primary and Secondary energy, Commercial and Non-commercial energy, Renewable and Non-renewable energy, Conventional and Non-conventional energy, Based on Origin-Examples and limitations. Importance of Non-commercial energy resources (4 hours) **Conventional energy sources:** Fossil fuels & Nuclear energy- production & extraction, usage rate and limitations. Impact on environment and their issues & challenges. Overview of Indian & world energy scenario with latest statistics- consumption & necessity. Need of eco-friendly & green energy & their related technology. (8 hours)	**13**
Unit-II: Renewable energy sources	
Introduction: Need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. (05 hours) **Solar energy**: Solar Energy-Key features, its importance, Merits & demerits of solar energy, Applications of solar energy. Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell -brief discussion of each. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. (8 hours)	**13**
Unit-III	
Wind and Tidal Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies, Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy. (8 hours) **Geothermal and hydro energy:** Geothermal Resources, Geothermal Technologies (2 hours), Hydropower resources, hydropower technologies, environmental impact of hydro power sources (3 hours), Carbon captured technologies, cell, batteries, power consumption (1 hour)	**13**

Activity for tutorial classes 01 hour/week

1. Demonstration of on Solar energy, wind energy, etc, using training modules at Labs.
2. Conversion of vibration to voltage using piezoelectric materials.
3. Conversion of thermal energy into voltage using thermoelectric (using thermocouples or heat sensors) modules.
4. Project report on Solar energy scenario in India
5. Project report on Hydro energy scenario in India
6. Project report on wind energy scenario in India
7. Field trip to nearby Hydroelectric stations.
8. Field trip to wind energy stations like Chitradurga, Hospet, Gadag, etc.
9. Field trip to solar energy parks like Yeramaras near Raichur.
10. Videos on solar energy, hydro energy and wind energy.

Reference Books

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

Phy-OE2: Climate Science (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	Hrs.
Atmosphere: Atmospheric Science (Meteorology) as a multidisciplinary science. Physical and dynamic meteorology, Some terminology, difference between weather and climate, weather and climate variables, composition of the present atmosphere: fixed and variable gases, volume mixing ratio (VMR), sources and sinks of gases in the atmosphere. Green house gases. Structure (layers) of the atmosphere. Temperature variation in the atmosphere, temperature lapse rate, mass, pressure and density variation in the atmosphere. Distribution of winds.	**13**
Unit-II	
Climate Science: Overview of meteorological observations, measurement of : temperature, humidity, wind speed and direction and pressure. Surface weather stations, upper air observational network, satellite observation. Overview of clouds and precipitation, aerosol size and concentration, nucleation, droplet growth and condensation (qualitative description). Cloud seeding, lightning and discharge. Formation of trade winds, cyclones. Modelling of the atmosphere: General principles, Overview of General Circulation Models(GCM) for weather forecasting and prediction. Limitations of the models. R and D institutions in India and abroad dedicated to climate Science, NARL, IITM, CSIR Centre for Mathematical Modeling and Computer Simulation, and many more.	**13**
Unit-III	

Global Climate Change: Green house effect and global warming, Enhancement in concentration of carbon dioxide and other green house gases in the atmosphere, Conventional and non-conventional energy sources and their usage. EL Nino/LA Nino Southern oscillations. Causes for global warming: Deforestation, fossil fuel burning, industrialization. Manifestations of global warming: Sea level rise, melting of glaciers, variation in monsoon patterns, increase in frequency and intensity of cyclones, hurricanes, tornadoes. Geo-engineering as a tool to mitigate global warming, Schemes of geo-engineering.	**13**

Activity for tutorial classes (01 hour/week)

1. Try to find answer to the following questions:
   (a) Imagine you are going in a aircraft at an altitude greater than 100 km. The air temperature at that altitude will be greater than 200^{o}C. If you put your hands out of the window of the aircraft, you will not feel hot.
   (b) What would have happened if ozone is not present in the stratosphere.
2. Visit a nearby weather Station and learn about their activities.
3. Design your own rain gauge for rainfall measurement at your place.
4. Learn to determine atmospheric humidity using wet bulb and dry bulb thermometers.
5. Visit the website of Indian Institute of Tropical Meteorology (IITM), and keep track of occurrence and land fall of cyclone prediction.
6. Learn about ozone layer and its depletion and ozone hole.
7. Keep track of melting of glaciers in the Arctic and Atlantic region through data base available over several decades.
8. Watch documentary films on global warming and related issues (produced by amateur film makers and promoted by British Council and BBC).

Reference Books

1. Basics of Atmospheric Science – A Chndrashekar, PHI Learning Private Ltd. New Delhi, 2010.
2. Fundamentals of Atmospheric Modelling- Mark Z Jacbson, Cambridge University Press, 2000.

Phy-OE3: Astronomy (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I : History and Introduction	**Hrs.**
Ancient Astronomy: Greek Observations, Sumerian Observations, Mayan Observations, Arabic Observations ,Chinese Observations (2 hours) **Indian Astronomy:** Vedic Astronomy, Ancient Astronomy – Aryabhata, Varahamihira, Bhaskara, Astronomy in Indian Scriptures, Precession of the Equinox, Celebrations of Equinox (2 hours) **Medieval & Modern Astronomy:** Invention of Telescopes, Models of the Solar System & Universe, Observations by Tycho Brahe, Kepler, Galileo, Herschel and Other, Modern Astronomy (3 hours) **Optical Tools for Astronomy:** Pin Hole, Binoculars, Telescopes & Imaging (1 hour) **Mathematical Methods of Observations:** Angular Measurement, Trigonometric functions, Stellar Parallax (2 hour) **Observational Terminologies:** Cardinal Directions, Azimuth, Altitude, Measurements using Compass and Hand. Equatorial Co-ordinates, Light years, Magnitude, Colors etc. (3 hours)	**13**
Unit-II: Observations of the Solar System	
The Sun: Ecliptic and the Orientation of the Earth, Seasons - Solstices and Equinox, Observations of the Sun from Earth during seasons. Eclipses, Zero-shadow day, Sunspots (3 hours) **The Moon:** Earth-Moon system – Phases, Lunar Eclipses, Ecliptic and Lunar Orbital Plane – Nodes, Lunar Month, Full Moon Names (3 hours) **Inner Planets: Mercury & Venus** - Observational History, Observational Windows, Appearance, Apparitions, Elongations, Superior Conjunctions, Inferior Conjunctions, Transits. (4 hours) **Outer Planets: Mars, Jupiter & Saturn** - Observational History. Observational Windows, Appearance, Frequency of Oppositions, Conjunctions, Moons Eclipses. Galilean Moons, Saturn's Rings (3 hours)	**13**

Unit-III: Major Astronomy Observations	
March to June: Prominent Stars and Constellations Visible during this period, Methods of Spotting. (4 hours) **June to September:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours) **September to December:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours) **December to March**: Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours)	**13**

Activity for tutorial classes (01 hour/week)

1. Measuring Seasons using Sun's Position.
2. Measuring Distance using Parallax
3. Estimation of the Stellar Diameter using Pin Hole
4. Measuring Height of an Object Using Clinometer.
5. Star spotting using constellation maps
6. Constellation spotting using Skymaps
7. Estimation of 'Suitable Periods' to observe deep sky objects using Planisphere.
8. Estimation of the Size of the Solar System in using Light Years.
9. Identification of Lunar Phases across a year.
10. Measuring Constellation of the Sun using Night Skymaps or Planispheres

Reference Books

1. The Stargazer's Guide - How to Read Our Night Sky by Emily Winterburn
2. A guide to the Night Sky – Beginner's handbook by P.N. Shankar
3. The Complete Idiot's guide to Astronomy by Christopher De Pree and Alan Axelrod

Phy-OE4: Medical Physics (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	Hrs.
Human Anatomy and Physiology: Overview of human anatomy - cells, cell structure, type of cells and their functions, tissues, organs, and their functions. Different systems in the human body, their structure and function, physiological properties of the circulatory system, digestive system, respiratory system, reproductive system, excretory system, endocrine system and nervous system.	**13**
Unit-II	
Physics of Medical Diagnostics: Principle of production of X-rays. Use of X-rays in medical diagnosis, X-ray imaging systems. Computed Tomography (CT): principle and generation of CT. Magnetic Resonance Imaging (MRI): basic principle and image characteristics. Ultrasound Imaging: Interaction of sound waves with body tissues, production of ultrasound, transducers, acoustic coupling, image formation, modes of image display and color Doppler.	**13**
Unit-III	
Physics of Radiotherapy: Clinical aspects of radiation therapy: Biological basis of radiotherapy, radiation sources, radiation dose, time dose fractionation. External beam radiation therapy, radiation therapy modalities, production of radioisotopes, use of radioisotopes in therapy, particle and ion beam radiotherapy. Brachytherapy - principle of brachytherapy and classification of brachytherapy techniques.	**13**

Activity for tutorial classes (01 hour/week)

1. Demonstrate the shape, size, positions and functions of different organs in the body with the help of models.
2. Visit any hospital/diagnostic centers to study the working of X-ray machines. Learn how X-rays are used in the diagnosis of the fractured bone
3. Prepare a short report on the principle and use of X-ray films in imaging.
4. Observe that as the density of materials between the gamma source and the detector changes the reading on the meter (or intensity of the beefing sound) changes.
5. Visit any ultrasound diagnostic center to study the principle and use of ultrasound in diagnosis.
6. Visit any radiotherapy center to study the modalities of radiotherapy.
7. List out different type of cancers and possible causative factors. List out the healthy practices to reduce the risk of cancers.
8. Group discussions on the medical physics programme in general.

Text and Reference Books

1. C. H. Best and N. B. Taylor. A Test in Applied Physiology. Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick. Anatomy and Physiology for Radiographers. Oxford University Press, 2001.
3. Jerrold T. Bushberg. The Essential Physics for Medical Imaging (2nd Edition). Lippincott Williams & Wilkins, 2002.
4. Jean A. Pope. Medical Physics: Imaging. Heinemann Publishers, 2012.
5. Faiz M. Khan and Roger A. Potish. Treatment Planning in Radiation Oncology. Williams and Wilkins, USA, 2003.
6. D. Baltas. The physics of modern brachytherapy for oncology. Taylor and Francis, 2007.
7. J. R. Brobek. Physiological Basis of Medical Practice. Williams and Wilkins, London, 1995.
8. Edward Alcamo, Barbara Krumhardt. Barron's Anatomy and Physiology the Easy Way. Barron's Educational Series, 2004.
9. W. E. Arnould Taylor. A textbook of anatomy and physiology, Nelson Thornes, 1998.
10. G. S. Pant. Advances in Diagnositc Medical Physics. Himalaya Publishing House, 2006.
11. Faiz M Khan. The Physics of Radiation Therapy (3rd edition). Lippincott Williams & Wilkins, USA, 2003.
12. Jatinder R. Palta and T. Rockwell Mackie. Intensity Modulation Radiation Therapy. Medical Physics publishing, Madison, Wisconsin, 2003.
13. Peter Hoskin, Catherine Coyle. Radiotherapy in Practice. Oxford University Press, 2011.
14. W. R. Handee. Medical Radiation Physics. Year Book Medical Publishers Inc., London, 2003.
15. Steve Webb. The Physics of Three–Dimensional Radiotherapy. Institute of Physics Publishing, Bristol and Philadelphia, 2002

Phy-OE5: Optical Instruments (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	**Hrs.**
Basics of Optics: Scope of optics, optical path, laws of reflection and refraction as per Fermat's principle, magnifying glass, Lenses (thick and thin), convex and concave lenses, Lens makers formulae for double concave and convex lenses, lens equation. Focal and nodal points, focal length, image formation, combination of lenses, dispersion of light: Newton's experiment, angular dispersion and dispersion power. Dispersion without deviation. (No derivations; concepts to be discussed qualitatively).	**13**
Unit-II	
Camera and microscopes: Human eye (constitution and working), Photographic camera (principle, construction and working), construction, working and utilities of (i) Simple microscopes (ii) Compound microscope (iii) Electron microscopes (iv) Binocular microscopes **Self study:** Experimental determination of magnifying power of a microscope.	**13**
Unit-III	
Telescopes and Spectrometer: Construction, working and utilities of (i) Astronomical telescopes (ii) Terrestrial telescopes (iii) Reflecting telescopes, Construction, working and utilities of Eyepieces or Oculars (Huygen, Ramsden's, Gauss) Spectrometer – Construction, working and utilities, measurement of refractive index. **Self study:** Telescopes used at different observatories in and outside India.	**13**

Activity for tutorial classes (01 hour/week)

1. Find position and size of the image in a magnifying glass and magnification.
2. Observe rain bows and understand optics. Create a rainbow.
3. Find out what makes a camera to be of good quality.
4. Observe the dispersion of light through prism.
5. Make a simple telescope using magnifying glass and lenses.
6. Learn principle of refraction using prisms.
7. Check bending of light in different substances and find out what matters here.
8. Learn about different telescopes used to see galaxies and their ranges.

Weblinks: **https://spark.iop.org, http://www.yenka.com, https://publiclab.org** etc.

Reference Books

1. Galen Duree. Optics for Dummies. Wiley. 2011.
2. Blaker J W. Optics: An Introduction for Students of Engineering. Pearson, 2015.
3. Hecht E. Optics. Pearson. 5th Edition, 2019.
4. Khurana A K. Theory And Practice Of Optics & Refraction. Elsevier India. 2016.
5. FlexBooks® 2.0 https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/19.9/primary/lesson/optical-instruments-ms-ps/

Phy-OE6: Sports Science (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	Hrs.
Measurement: Physical quantities, Standards and Units, International system of Units, Standards of time, length and mass, Precision and significant figures (4 hours) **Newton's laws of motion**: Newton's first law. Force, mass. Newton's second law. Newton's third law, Mass and weight. Applications of Newton's laws. (5 hours) **Projectile motion**: Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw. (4 hours) **Topics for self study:** https://www.real-world-physics-problems.com/physics-of_sports.html	**13**
Unit-II	
Conservation laws: Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carom, Billiards, Racing) (4 hours) **Centre of mass**: Physics behind Cycling, Rock climbing, Skating (5 hours) **Gravitation**: Origin, Newton's law of gravitation, Archimedes's principle, Buoyancy & Physics behind swimming (4 hours) **Topic for self-study:** Archimedes' Principle: Made EASY | Physics in You tube	**13**
Unit-III	
Food and Nutrition: Proteins, Vitamins, Fat, Blood pressure. Problems due to the deficiency of vitamins. (4 hours) **Energy:** Different forms of Energy, Conservation of mass-energy (3 hours) **Physical exercises:** Walking, Jogging and Running, Weight management. (3 hours) **Topic for self-study:** 10 Best Exercises for Everyone – Healthline	**13**

Activity for tutorial classes (01 hour/week)

1. Identify the methods of measurement of time, length and mass from ancient time and build models for them. **(**Reference : History of measurement - Wikipedia *https://en.wikipedia.org › wiki › History_of_measurement*)
2. Identify Physics principles behind various Sports activities. **https://www.real-world-physics-problems.com/physics-of-sports.html**
3. List the difficulties experienced in Gymnastics, Cycling and Weight lifting.
4. List the difficulties experienced in swimming.
5. Learn breathing exercises.
6. Write an essay on Physical health v/s Mental health or conduct a debate on Physical health v/s Mental health.

Text Books

1. Yakov Perelman. Physics for Entertainment. Createspace Independent Pub, 2010.
2. Yakov Perelman. Physics Everywhere. Prodinnova Publishers, 2014.
3. Yakov Perelman. Mechanics for Entertainment. Prodinnova Publishers, 2014.
4. Vassilios McInnes Spathopoulos. An Introduction to the Physics of Sports. Createspace Independent Publishing Platform, 2013.
5. Walter Lewin. For the Love of Physics. Taxmann Publications Pvt. Ltd., 2012.
6. Swaminathan M. Handbook of Food and Nutrition. Bangalore Press. 2012.
7. Srilakshmi B. Food Science. New Age International Pub. 2015.

Internet Resources for Reference: Internet resources

https://www.topendsports.com/biomechanics/physics.htm
https://www.real-world-physics-problems.com/physics-of-sports.html
https://www.healthline.com/
https://www.mayoclinic.org/
https://www.who.int/news-room/

Phy-OE7: Nanotechnology (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	Hrs.
Introduction to nanomaterials: Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equationInfinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	**13**
Unit-II	
Synthesis and Characterization of nanostructure materials: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.	**13**
Unit-III	
Properties and applications of nanomaterials: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasiparticles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. (13 hours)	**13**

Activity for tutorial classes (01 hour/week)

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. XRD pattern of nanomaterials and estimation of particle size.
4. To study the effect of size on color of nanomaterials.
5. Growth of quantum dots by thermal evaporation.
6. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
7. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
8. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
9. Visit to nearby research labs to study the working of XRD, SEM, UV-Visible Spectrophotometer instruments
10. Visit to nearby research labs for project work and interaction with scientists at IISC, JNCSR, Universities etc.

References Books

1. C P Poole, Jr. Frank J. Owens. Introduction to Nanotechnology. Wiley-Interscience. 2002.
2. Kulkarni S K. Nanotechnology: Principles & Practices. Capital Publishing Company, 2011.
3. Chattopadhyay K K , Banerjee A N. Introduction to Nanoscience and Technology. PHI Learning Private Limited, 2009.
4. Richard Booker, Earl Boysen, Nanotechnology for Dummies. John Wiley and Sons, 2005.
5. Hosokawa M, Nogi,K, Naita M, Yokoyama T.Nanoparticle Technology Handbook Elsevier, 2007.
6. V.V. Mitin V V, Kochelap V A and Stroscio M A. Introduction to Nanoelectronics. Cambridge University Press, 2011.
7. Bharat Bhushan. Springer Handbook of Nanotechnology. Springer-Verlag, 2004.

Phy-OE8: Electrical Instruments (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	**Hrs.**
Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Ammeters, voltmeters: (DC/AC) (3 hours) Representation of sinusoidal waveforms, peak and rms values, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. Wattmeters: Induction type, single phase and three phase wattmeter, Energy meters: AC. Induction type single phase and three phase energy meter. (5 hours) Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications. (5 hours) **Topics for self study:** Types of switches and Circuits, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Fuses, MCB, ELCB and Relays, Filament lamp, Tube light, CFL and LED	**13**
Unit-II	
Galvanometers: General principle and performance equations of D'Arsonval Galvanometers, Vibration Galvanometer and Ballistic Galvanometer. (3 hours) Potentiometers: DC Potentiometer, Crompton potentiometer, construction, standardization, application. AC Potentiometer, Drysdale polar potentiometer; standardization, application. (3 hours) DC/AC Bridges :General equations for bridge balance, measurement of self inductance by Maxwell's bridge (with variable inductance & variable capacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device, Kelvin's double bridge. (7 hours) **Topics for self study:** Importance of grounding and Earthing, Methods for Earthing.	**13**
Unit-III	
Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer (6 hours) CRO: Block diagram, Sweep generation, vertical amplifiers, use of CRO in measurement of frequency, phase, Amplitude and rise time of a pulse. Digital Multi-meter: Block diagram, principle of operation (3 hours) Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. (4 hours) **Topics for self study:** Fuses, MCB, ELCB and Relays, Filament lamp, Tube light, CFL. and LED	**13**

Activity for tutorial classes (01 hour/week)

1. Identify variety of electrical switches and note down their applications/utility.
2. Identify the hazards involved in handling electrical circuits and instruments, make a list of safety precautions as well as first aid for electrical shocks.
3. Make a study of importance of grounding in electrical circuits.
4. Prepare a detailed account of various methods of earthing and their utility/ applications.
5. Prepare a document on evolution of incandescent bulbs to the present day LED lights.
6. Make a comparative study of Fuses, MCB, ELCB and Relays highlighting their use and applications.

References Books

1. Sawhney A K. A Course in Elec. & Electronics Measurements & Instrumentation. Dhanpatrai & Co, 1978.
2. Helfrick A D, Cooper W D. Modern Electronic Instrumentation and Measurement Techniques. PHI, 2016.
3. Kulshreshtha D C. Basic Electrical Engineering. Mc Graw Hill Publications, 2019.
4. David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems. Tata McGraw Hill Education Private Limited, 3rd Edition, 2015.
5. Vincent Del Toro. Electrical Engineering Fundamentals. Prentice Hall India, 2009.

Suggestions for (optional) experiments to be performed/demonstrated in the Laboratory

Sl No	Experiment
1	Introduction to Lab Equipment
2	Voltmeter Design
3	Ammeter Design
4	Ohmmeter Design
5	Multimeter Design
6	Measurement of Resistance using Wheatstone Bridge
7	Measurement of Capacitance using Schering Bridge
8	Measurement of Inductance using Maxwell Bridge
9	Measurement of Light Intensity
10	Measurement of Temperature

Phy-OE9: Physics for all (Credits:3)
3 hour teaching + 01 hour tutorial per week

Unit-I	Hrs.
Energy and Power: Explosions and energy; Energy, heat and its units; Energy table and discussions; Discussion of cost of energy; Measuring energy; Power; Different power sources; Kinetic energy.	**13**
Unit-II	
Gravity, Force and Space: The force of Gravity; Newton's third law; Weightlessness; Low earth orbit; Geosynchronous satellites; Spy satellites; Medium Earth Orbit satellite; Circular Acceleration; momentum; Rockets; Airplanes, helicopters and fans; Hot air and helium balloons; angular momentum and torque..	**13**
Unit-III	
Nuclei and radioactivity: Radioactivity; Elements and isotopes; Radiation and rays; Seeing radiation; The REM – The radiation poisoning; Radiation and cancer; The linear hypothesis; Different types of radiation; The half-life rule; Smoke detectors; measuring age from radioactivity; Environmental radioactivity; Glow of radioactivity; Nuclear fusion.	**13**

References Book

This course is extracted from the book titled "Physics and Technology for Future Presidents: An Introduction to the Essential Physics Every World Leader Needs to Know" by Richard A Muller, WW Norton and Company, 2007. (Unit-1 to 4 are from chapters 1, 3, 4 and 10, respectively).

COURSE PATTERN & SCHEME OF EXAMINATION for B.Sc. / B.Sc. (Hons.) as per NEP-2020

Sl. No	Semester	Title of the Paper	No of hrs	Hrs per week	Marks				Duration of Examination (hours)	Total Marks	Credits
					Theory/ Practicals		Internal Assessment (IA)				
					Max	Min	Max	Min			
1	I Semester	Phy-DSCT1: Mechanics and Properties of Matter	52	4	60	21	40	14	3	100	4
		Phy-DSCP1-Lab I	40	4	25	09	25	09	3	50	2
		Phy-OE1 to Phy-OE9 (See list below for titles of Pool A open elective papers)3072355930	39	3	60	21	40	14	3	100	3
2	II Semester	Phy-DSCT2: Electricity and Magnetism	52	4	60	21	40	14	3	100	4
		Phy-DSCP2-Lab II	40	4	25	09	25	09	3	50	2
		Phy-OE1 to Phy-OE9 (See list below for titles of Pool A open elective papers which were not chosen during I Semester)	39	3	60	21	40	14	3	100	3

Open Electives: Pool A

Phy-OE9: Energy Sources
Phy-OE2: Climate Science
Phy-OE3: Astronomy
Phy-OE4: Medical Physics
Phy-OE5:Optical Instruments
Phy-OE6: Sports Science
Phy-OE7: Nanotechnology
Phy-OE8:Electrical Instruments
Phy-OE9: Physics for All

Formative/Internal Assessment for Theory Papers	
Assessment Occasion	**Marks**
Test-1 (Activity related+ self study)	20
Test-2 (Theory based)	20
Total	40

Note: No questions to be set on topics of self-study

The mark distributions for the final practical examination is as follows:

1. Writing Principle / Statement / Formula with explanation of symbols and units	03 Marks
2. Diagram/ Circuit Diagram/ Expected Graph	03 Marks
3. Setting up of the experiment + Tabular Columns + taking reading	08 Marks
4. Calculations (explicitly shown) + Graph	04 Marks
5. Accuracy of results with units	02 Marks
6. Class Records (to be valued at the time of practical examinations)	05 Marks
Total for Practical Examinations	**25 Marks**
Note: Wherever explicit setting up of experiments does not exist like in the case of spectral charts or pre- acquired data is involved (Astrophysics or atmospheric experiments), the marks for setting up of experiment may be provided for Additional graphs and formulae	

QUESTION PAPER PATTERN FOR I BSc PHYSICS DEGREE EXAMINATION

BENGALURU CITY UNIVERSITY

I Semester B.Sc. Degree Examination

(2021-22)

Phy-DSCT1: Mechanics and Properties of Matter

Duration: 2 Hours] *[Max. Marks: 60*

PART	INSTRUCTIONS TO CANDIDATES	MARKS
Part- A	Answer **all** the questions. Each question carries 1 mark	5 x 1 = 5
Part- B	Answer any **THREE** questions out of **FIVE**. Each question carries **10** marks	3 ×10 =30
Part- C	Solve any **THREE** problems out of **FIVE**. Each problem carries 5 marks	3 ×5 = 15
Part- D	Answer any **FIVE** out of **EIGHT** questions. Each question carries 2 marks:	5 ×2 = 10
	TOTAL	60 MARKS

BENGALURU CITY UNIVERSITY

I Semester B.Sc. Degree Examination

Phy.DSCT1: Mechanics Properties of Matter

Time: 2 Hours] *[Max. Marks: 60*

Instructions to Candidates:

1. *Answer **all** the questions from PART- A*
2. *Answer **any three** questions from PART- B and PART -C*
3. *Answer **any five** questions from PART -D*
4. *Use of non-programmable scientific calculator is allowed.*

PART-A

Answer **all** the questions. Each question carries **1 mark**: **(5 x 1 = 5)**

1. The dimension of Gravitational constant is _____

   (a) $[M^{-1} L^{3} T^{-2}]$ (b) $[M^{-1} L^{2} T^{-2}]$

   (c) $[M^{-1} L^{3} T^{-5}]$ (d) $[M^{-2} L^{3} T^{-2}]$

2. In the case of uniform circular motion of a body, which one of the following physical quantities does not remain constant?

   (a) mass (b) speed

   (c) linear momentum (d) kinetic energy

3. The modulus of elasticity of a material does not depend upon

   (a) shape (b) temperature

(c) nature of material (d) impurities mixed

4. The fluid flow remains streamlined as long as it's velocity is _____

(a) below its critical velocity (b) equal to the square of its critical velocity

(c) equal to critical velocity (d) equal to the square root of its critical velocity

5. The cause of surface tension is

(a) intermolecular forces (b) viscous force

(c) gravitational force (d) nuclear force

PART B

Answer any **THREE** questions. Each question carries **10 marks**: (3 × 10 = 30)

6 a) Derive an expression for work done by a variable force.

b) Obtain an expression for length contraction of a moving rod on the basis of special theory of relativity. (5+5)

7 Derive an expression for the moment of inertia of a plane rectangular lamina about an axis passing through its centre and perpendicular to its (i) plane, (ii) length and (iii) breadth (10)

8 a) State Kepler's laws of planetary motion.

b) Derive an expression for orbital velocity of a satellite orbiting with a radius 'r' centered on the planet. (3+7)

9 a) What is surface tension? Write its SI unit.

b) Derive an expression for the difference of pressure between the two sides of a curved liquid surface. (2+8)

10 a) Obtain an expression for terminal velocity of a small solid sphere falling freely under gravity in a viscous liquid.

b) Describe with diagram an experiment to determine the coefficient of viscosity of a liquid by Poiseuille's method. (5+5)

PART C

Solve any **THREE** problems. Each problem carries **5 marks**: **(3** ×5 **= 15)**

11 A clock keeps correct time. With what speed should it be moved related to an observer so that it may seem to loose one minute in one- day.

12 A car of mass 1500 kg moves with a linear speed of 40 ms^{-1} on a circular race track of radius 50 m. What is the magnitude of its angular velocity and angular momentum relative to the centre of the track?

13 The force of attraction between two sphere of masses 40 kg and 10 kg equal to the weight of a body of mass 10.94×10^{-9} kg. If the distance between the centres of the spheres is 0.5 m, calculate the value G. Given g=9.8 ms^{-2}

14 Calculate the force required to stretch a steel wire $\mathbf{1}\times10^{-4}$ m^2 in cross section to increase its length by 0.1% of its original length. Given Young's modulus = $2 \times 10^{11} Nm^{-2}$.

15 Calculate the excess pressure inside a soap bubble of radius $\mathbf{3}\times10^{-3}$ m. Surface tension of soap solution =$\mathbf{20}\times10^{-3}$ Nm^{-1}. Also calculate the surface energy.

PART D

Answer any **FIVE** questions. Each question carries **2 marks**: **(2 ×5 = 10)**

16 a) How random errors and systematic errors be reduced?

b) Can a body have energy without momentum? Justify.

c) Why is most of the mass concentrated at the rim in a flywheel?

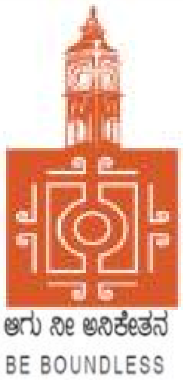
d) When an object falls to the earth, the earth also moves up to meet it. Why the earth's motion is not noticeable?

e) Can steel be preferred than copper for making springs? Explain.

f) Can Poisson's ratio of any material be less than –1? Explain.

g) Water sticks to a glass surface, while mercury does not. Explain.

h) Which type of flow is preferred for mixing of two fluids? Explain.



BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course- as per NEP 2020)

Syllabus for Physics
(III & IV Semester)

2022-23 onwards

Board of Studies in Physics (UG) Members

Professor. B Eraiah (Chairman)	Dept. Physics, Bangalore University, Bengaluru-56
Sri G Ramesha,	PES College, Hanumantha nagar, Bengaluru-50
Dr. R.S. Muralidhara	PES College, Hanumantha nagar, Bengaluru-50
Dr. Vasu	Vivekananda Degree College, Bengaluru-5
Dr. A S Govind,	Vijaya College, R.V. Road, Basavanagudi, Bengaluru -04
Dr. P Aswini	Vijaya College, R.V. Road, Basavanagudi, Bengaluru -04
Dr. K C Radha,	Vijaya College, R.V. Road, Basavanagudi, Bengaluru -04
Dr. K. S. Suresh	Vijaya College, R.V. Road, Basavanagudi, Bengaluru -04
Smt. Manjula S N	SJR College for Women, Rajajinagar, Bengaluru-03
Dr. V S Rohini	Nrupathunga University, Nrupathunga Road, Bengaluru-01

Date: 07.09.2022
Place: Bengaluru

Proceedings of the BOS (UG) Physics Meeting held on 07.09.2022 at 11 am in the Syndicate Hall. Administrative Office, Central College Campus, Bangalore City University, Bengaluru-560001

The following agenda was discussed (1) 3rd and 4th Semester BSc Syllabus of Physics papers (2) Panel of Examiners and BOE (proposed)for the academic year 2022-2023. After elaborate discussions and suitable modifications, the members of the BOS approved both the agenda.

Members of the BOS (UG) Physics

Sl. No	Names	Members	Signature
01	Dr. B. Eraiah, Professor PG Department of Physics, Bangalore University, Bengaluru-560056.	Chairman	
02	Dr. K.S.Suresh Associate Professor Department of Physics, Vijaya College, R.V.Road, Bengaluru-560004.	Member	
03	Dr. G.Ramesha, Associate Professor Department of Physics, PES College50 Feet Road, Mysore bank colony, Hanumantha nagar, Bengaluru-560050	Member	
04	Dr. R.S. Muralidhara, Associate Professor, Department of Physics, PES College50 Feet Road, Mysore bank colony, Hanumantha nagar, Bengaluru-560050	Member	
05	Dr. Vasu, Associate Professor Department of Physics, Vivekananda degree College, Dr. Rajkumar Road, Rajajinagar II stage, Bangalore-55	Member	
06	Dr. A.S. Govind, Associate Professor, Department of Physics, Vijaya College, R.V. Road, Basavanagudi, Bangalore-560 004	Member	
07	Dr. P. Ashwini Associate Professor, Department of Physics, Vijaya College, R.V. Road, Basavanagudi,Bangalore-560 004	Member	Absent
08	Dr. K.C. Radha, Associate Professor, Department of Physics, Vijaya College, R.V. Road, Basavanagudi,Bangalore-560 004.	Member	
09	Smt. Manjula S N Associate Professor, Department of Physics, SJR College For Women, Rajajinagar, Bengaluru-560003.	Member	
10	Dr. V S Rohini Associate Professor, Department of Physics, Nrupathunga University (Govt. Science College) Nrupathunga Road, Bengaluru-560 001 .	Member	

Dr. B. ERAIAH
M.Sc. M.Phil. Ph.D.,
Professor, Department of Physics
Bangalore University, Bangalore-560056

Course Structure
(Major Discipline: Physics)
Semester 1- 10

SEMESTER	Discipline Core Theory (DSCT)	Core Papers
SEMESTER -1	Phy.DSCT1	Mechanics & Properties of Matter
SEMESTER -2	Phy.DSCT2	Electricity and Magnetism
SEMESTER -3	**Phy.DSCT3**	**Wave motion and optics**
SEMESTER -4	**Phy.DSCT4**	**Thermal Physics &Electronics**
SEMESTER -5	Phy.DSCT5 Phy.DSCT6	1.Classical Mechanics and Quantum Mechanics-I 2. Elements of Atomic, Molecular Physics
SEMESTER -6	Phy.DSCT7 Phy.DSCT8	1.Elementsof Nuclear Physics and Nuclear Instruments 2.Elementsof Condensed Matter Physics
SEMESTER -7	Phy.DSCT9 Phy.DSCT10 Phy.DSCT11	1. Mathematical Methods of Physics – I 2. Classical Electrodynamics. 3. Experimental methods of Physics 4. Research Methodology
SEMESTER -8	Phy.DSCT12 Phy.DSCT13 Phy.DSCT14	1. Classical Mechanics and Quantum Mechanics-II 2. Statistical Mechanics 3. Astrophysics &Astronomy 4. Research Project* (Select Two DSE subjects from the Pool B-II shown below) *In lieu of the research Project, two additional elective papers/ Internship may be offered.
SEMESTER -9	Phy.DSCT15	1. Mathematical Methods of Physics – II (Select One DSE subjects from the Pool B-III shown below) 2. Research Project
SEMESTER -10	Phy.DSCT17	1. Quantum Mechanics – III (Select One DSE subjects from the Pool B-IV shown below) 2. Research Project

Open Electives

1st Semester	
1.	Phy-OE1: Energy Sources
2.	*Phy-OE2: Physics for All.
2nd Semester	
3.	Phy-OE3: Atmospheric Science
4.	Phy-OE4: Sports Science
3rd Semester	
5.	**Phy-OE5: Optical Instruments**
6.	**Phy-OE6: Elements of Astronomy and Astrophysics**
4th Semester	
7.	**Phy-OE7: Medical Physics**
8.	**Phy-OE9: ElectricalInstruments**

***Students who have chosen Phy-DST1 are not eligible to take Open Elective paper Phy-OE2.**

Discipline Specific Electives for 7 to 10 Semesters

7th Sem Electives Pool B-I (Select any two)		8th Sem Electives Pool B-II (Select any two)	
A.	Condensed Matter Physics-1	A.	Atomic &Molecular Physics-1
B.	Nuclear and Particle Physics	B.	Materials Physics &Nano materials
C.	Theoretical and Computational Physics-I	C.	Lasers and non-linear optics
D.	Biophysics	D.	Plasma Physics
E.	Astronomy and Astrophysics	E.	Physics of Semiconductor devices

9th Sem Electives (Specialization papers) Pool B-III		10th Sem Electives (Specialization papers) Pool B-IV	
A.	Condensed Matter Physics-2	A.	Condensed Matter Physics-3
B.	Nuclear and Particle Physics-2	B.	Nuclear and Particle Physics-3
C.	Atomic &Molecular spectroscopy-1	C.	Atomic &Molecular spectroscopy-2
D.	Materials Physics &Nanophysics–1	D.	MaterialsPhysics&Nanophysics-2
E.	Theoretical and Computational Physics-I	E.	TheoreticalandComputationalPhysics-2
F.	Astronomy and Astrophysics-1	F.	Astronomy and Astrophysics-2

Detailed Syllabus
for 3rd & 4th Semester Physics Papers
Under-Graduate(UG) B.Sc/B.Sc (Hon) Program
Framed according to the National Education Policy (NEP)

3rdSemester BSc

Phy-DSCT3: Wave Motion and Optics	**Course Credits (L+T+P) : 4+0+1**
Total Contact Hours: 52	**Duration of ESA: 4 hours**

Program Outcomes:	
1.	Disciplinary knowledge
2.	Communication Skills
3.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
4.	Problem-solving
5.	Research-related skills
6.	Cooperation/ Teamwork/ Leadership readiness/Qualities
7.	Information/ Digital literacy/Modern Tool Usage
8.	Environment and Sustainability
9.	Multicultural competence
10.	Multi-Disciplinary
11.	Moral and ethical awareness/Reasoning
12.	Lifelong learning / Self Directed Learning

Prerequisites	
i.	Fundamentals of waves

Course Learning Outcomes	
At the end of the course students it should be ensured that students understand the following	
i.	Identify different types of waves by looking into their characteristics.
ii.	Formulate a wave equation and obtain the expression for different parameters associated with waves.
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions, such as, when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.
vii.	Give the different models of light propagation and phenomenon associated and measure the parameters like the wavelength of light using experiments like Michelson interferometer, interference and thin films.

viii.	Explain diffraction due to different objects like singles slit, two slits, diffraction of grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through theoretical activity of a medium.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

Course Outcomes/Program Outcomes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
i.	Identify different types of waves by looking into their characteristics.	X	X	X	X	X	X					X	X
ii.	Formulate a wave equation and obtain the expression for different parameters associated with waves.	X	X	X	X	X	X					X	X
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions such as when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.	X	X	X	X	X	X					X	X
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.	X	X	X	X	X	X					X	X
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.	X	X	X	X	X	X					X	X
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.	X	X	X	X	X	X					X	X
vii.	Give the different models of light propagation and phenomenon associatedand measure the parameters like the wavelength of light using experiments like Michelson interferometer, interference and thin films.	X	X	X	X	X	X					X	X
viii.	Explain diffraction due to different objects like singles slit, two slits, diffraction grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.	X	X	X	X	X	X					X	X
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through the optical activity of a medium.	X	X	X	X	X	X					X	X

Course Content Phy.DSCT3: Wave Motion and Optics		Hrs
Unit – 1: Waves and Superposition of Harmonic Waves (11 hours of teaching plus 2 hours of activities)		
Chapter No. 1	**Waves:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation (derivation), Wave Equation – Differential form (derivation). Particle and Wave Velocities - Relation between them, Energy Transport – Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction (Derivation). Brief account of Ripple and Gravity Waves. **(Text Book : 1-4)**	**5 hours**
Chapter No. 2	**Superposition of Harmonic Waves**: Linearity and superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats) – Analytical treatment. Superposition of two perpendicular harmonic oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous' figures. **(Text Book: 1-4)**	**6 hours**
Topics for Self-study	Study of coupled pendulum. Explain the impact on the motion of one pendulum due to that of the other pendulum by varying the length, and mass of pendulum. Prepare a report.	
Suggested Activities (Any two activities to be conducted compulsorily)		
Activity No. 1	We know that sound is produced because of vibration. Look into at least 10 musical instruments and identify the regions of vibrations that produces the sound and those parts which enhances the sound because of reverberation. 1. Identify one common element in all of these. 2. Identify equipment's which creates beats and try to explain the underlying basic principles. Demonstrate the examples of beats using two tuning forks. 3. Identify what will happen when you drop a stone in a standing water, and when your drop two stones side by side. Make your observations sketch them and comment on it in a report.	
Activity No. 2	Draw two sine waves (Amplitude vs time) one shifted with other in phase. Identity where the resonation occurs for each phase shift. Plot phase vs time taken for resonance.	
Activity No. 3	Take smooth sand, place a pointed edged pen vertically on the sand. To the mid of the pen, connect two perpendicular threads. Pull these perpendicular threads by varying the forces and timings. Note down the different shapes produced on the sand. Try to interpret the shapes. Make a report of it	
Activity No. 4	Hang a pot with sand, which has a hole in the bottom. Gently pull the pot on one side and observe the pattern formed by the sand on the floor. Report the observations.	
Activity No. 5	Take a stretched spring. Stretch it across two edges. Put a weight on the string, pluck it and measure the amplitude of the vibration. Students should measure the total damping time of oscillating spring. (Using mobile or scale) And plot graphs by 1.Varying load on the spring and amplitude at the centre.	

	2. Take another weight and put that in another place and measure the amplitude of vibration at the centre. 3. Vary the load in the centre of the spring and measure the amplitude at the centre. **Note for the teachers for the activity:** Make 3 groups among students and assign each group the activity of drawing one of the 3 graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes:At the end of the topic, students should be able to understand the following

SL No	TLO's	BL	CO	PO
i.	Explain the difference between plane and spherical waves, longitudinal and transverse waves and give their characteristics.	**L2**	**1**	**1-6, 11-12**
ii.	Write down an equation for the progressive wave in its differential form.	**L2**	**1**	**1-6, 11-12**
iii.	Obtain the relation between particle and wave velocity.	**L2**	**1**	**1-6, 11-12**
iv.	Obtain an expression for intensity of progressive waves.	**L2**	**1**	**1-6, 11-12**
v.	Obtain Newton's formula for the velocity of sound and discuss the factors for which sound velocity is dependent.	**L2**	**2**	**1-6, 11-12**
vi.	Apply the Laplace's correction to the equation of motion of a progressive wave.	**L2**	**2**	**1-6, 11-12**
vii.	With examples explain ripple and gravity waves.	**L1**	**2**	**1-6, 11-12**
viii.	Give the theory of superposition of two linear waves having equal frequencies and different frequencies.	**L2**	**3**	**1-6, 11-12**
ix.	Discuss the formation of different Lissajous figures under different conditions of amplitude and frequency when they superimpose perpendicularly.	**L2**	**3**	**1-6, 11-12**
x.	Give some applications of an Lissajous figures.	**L1**	**3**	**1-6, 11-12**
xi.	Higher order problems.	**L3**	**1,2,3**	**1-6, 11-12**

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Unit – 2 - Standing Waves and Acoustics (11 hours of teaching plus 2 hours of activities)		
Chapter No. 3	**Standing Waves:** Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a transverse wave along a stretched string. Vibrations in rods – longitudinal and transverse modes (qualitative). Velocity of Longitudinal Waves in gases (derivation). Normal Modes of vibrations in Open and Closed Pipes – Analytical treatment. Concept of Resonance, Theory of Helmholtz resonator. **(Text Book : 1-4)**	**8 hours**
Chapter No. 4	**Acoustics**: Absorption coefficient, Reverberation time - Sabine's Reverberation formula (derivation), Factors affecting acoustics in buildings, Requisites for good acoustics. Acoustic measurements – intensity and pressure levels. **(Text Book : 1-4)**	**3 hours**
Topics for Self-study	List different phenomenon where standing waves are found in nature. Identify the phenomena and reason for standing waves. Also identify the standing waves in musical instruments. Make a report of it**.**	
Suggested Activities (Any two activities to be conducted compulsorily)		
Activity No. 6	1. Go to 5 different newly constructed houses when they are not occupied and when they are occupied. Make your observations on sound profile on each room. Give the reasons. Make a report of it**.** 2. Visit three very good auditoriums, list out different ways in which the acoustic arrangements have been done (as decoration and Civil works). Look for the reasons in Google and identify which is acoustically the best auditorium among the three you visited. Make a report of it**.**	
Activity No. 7	Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate ($KMNO_4$) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop a marble on the liquid at the centre of the bowl. Repeat the experiment by dropping the marble from the different heights. Plot a graph of- 1. Height v/s time of oscillation 2. Weight of the marble v/s time of oscillation **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.	
Activity No. 8	Take two marbles of same weight. Drop both the marbles on the surface of the liquid from some height. With the help of the mobile take the picture and measure the position of interface of two wave fronts formed in the liquid. Plot graphs for different activities by doing the following activities. 1. By dropping two marbles of same weight from different heights. 2. By dropping two marbles of different weight from the same height	

	Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes: At the end of the topic, students should be able to understand the following				
SL No	**TLO's**	**BL**	**CO**	**PO**
i.	Discuss the Transverse waves produced in stretched string and obtain the expression for the same.	**L2**	**3**	**1-6, 11-12**
ii.	Give a qualitative treatment of vibration of a string when it's both ends are fixed and free.	**L2**	**3**	**1-6, 11-12**
iii.	Explain normal modes of a stretched string. Obtain an expression for the energy density and discuss how this energy is transported along a stretched string.	**L2**	**3**	**1-6, 11-12**
iv.	Quantitatively bring about the mode of vibrations created in a rod.	**L2**	**4**	**1-6, 11-12**
v.	Explain types of waves that are produced in gas. Obtain an expression for the same.	**L2**	**4**	**1-6, 11-12**
vi.	With an analytical treatment explain the concept of resonance using the normal modes of vibrations of open and closed pipes.	**L2**	**5**	**1-6, 11-12**
vii.	Give the theory of Helmholtz resonator and explain how it is used to calculate some parameters of the way the standing waves are set in there.	**L2**	**5**	**1-6, 11-12**
viii.	Define Reverberation, Reverberation time and absorption coefficient of a material.	**L1**	**5**	**1-6, 11-12**
ix.	Obtain Sabine's Reverberation formula and discuss what are the factors on which the Reverberation time depends on.	**L2**	**5**	**1-6, 11-12**
x.	List out which are different parameters within a building which effects the acoustics.	**L1**	**6**	**1-6, 11-12**
xi.	Explain what are good acoustics of a building and how acoustics is measured in terms of intensity and pressure inside a building.	**L2**	**6**	**1-6, 11-12**

Teaching and Learning Methodology
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc
Formative Assessment Techniques
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Unit – 3: Nature of light and Interference (11 hours of teaching plus 2 hours of activities)		
Chapter No. 5	**Nature of light**: Corpuscular theory, The Wave model, Huygens' wave theory, , Maxwell's electromagnetic waves, Dual nature of light, concept of wave packet. Group velocity and wave velocity-relation between them. **(Text Book No 5)**	**2 hours**
Chapter No. 6	**Interference of light by division of wave front**: Coherent source-Interference of light waves by division of wave-front, Young's double slit interference- theory and experiment, Fresnel Biprism- theory and experiment (determination of wavelength) (**Text Book No 5)**	**4 hours**
Chapter No. 7	**Interference of light by division of amplitude:** at thin films - reflected and transmitted light, Colours of thin films; Theory of air wedge; Theory of Newton's rings (Reflection) - Determination of Refractive index of a liquid. Michelson Interferometer (qualitative) **(Text Book No 5)**	**5 hours**
Topics for Self-study	Why colour strips are seen in paddles on roads in rainy seasons? Give reasons. Make a report of it**.**	
Suggested Activities (Any two activities need to be conducted compulsorily)		
Activity No. 9	In the table given below explore which phenomenon can be explained by what and prepare report explaining it**.**	

Sl No	Phenomenon	Corpuscular Nature	Wave Nature
1.	Formation of images on lenses		
2.	Formation of images on mirror		
3.	Interference		
4.	Polarization		
5.	Diffraction due to single slit		

Activity No. 10	Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution). Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop two marbles of same weight (mass) from the same height on to the surface of the water but at the different time intervals. Analyze the wavefronts and draw pictures of different observations. **Note to the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment.

	2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.
Activity No. 11	Teachers should demonstrate the formation of Lissajous Figure using a CRO. Give different shapes of Lissajous Figure with varying frequency and amplitude. Then ask the students to comment on the observations and prepare a report.

Topic Learning Outcomes
At the end of the topic, students should be able to understand the following

SL No	TLO's	BL	CO	PO
i.	Discuss the wave model and the Corpuscular model of light.	**L2**	**7**	**1-6, 11-12**
ii.	Give the Huygen theory of wave-front.	**L1**	**7**	**1-6, 11-12**
iii.	Define Interference. Give some examples of Interference.	**L1**	**7**	**1-6, 11-12**
iv.	Give the theory of interference due to two coherent sources of light and obtain an expression for the wavelength of monochromatic source of light (Young's double slit experiment)	**L2**	**7**	**1-6, 11-12**
v.	Explain how using personal biprism, a monochromatic coherent source of light are obtained. Using this experimental setup explain how the wavelength of monochromatic sources of light is determined.	**L2**	**7**	**1-6, 11-12**
vi.	Give the theory of interference due to division of amplitude by parallel and non-parallel plates.	**L1**	**7**	**1-6, 11-12**
vii.	Explain how Newton's rings are obtained and discuss how the wavelength of light is determined using this experiment.	**L2**	**7**	**1-6, 11-12**

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Unit – 4 - Diffraction and Polarisation
(11 hours of teaching plus 2 hours of activities)

Chapter No. 8	**Fraunhofer diffraction**: Introduction- Fraunhofer diffraction- Theory of single slit diffraction, Two slit diffraction pattern (qualitative), Theory of diffraction Grating - oblique incidence – experimental determination of wavelength. Resolving power – Rayleigh criterion, Expression for resolving power of grating and telescope. (Text Book No 5)	**4 hours**
Chapter No. 9	**Fresnel Diffraction**- Concept of Fresnel half period zones (mention of equations), Qualitative discussion on diffraction by a circular aperture and diffraction by an opaque disc, Zone plate (mention of equation for focal length) Comparison of Zone plate with lens, Theory of diffraction at a straight edge. (Text Book No 5)	**3 hours**
Chapter No. 10	**Polarisation:** Production of polarized light, Malus' law, Phenomenon of double refraction in crystals, Huygen's theory of double refraction (qualitative), Quarter	**4 hours**

	wave plate and half wave plate, Optical activity**,** Laurent's half shade polarimeter. (Text Book No 5**)**	
Topics for Self-study	Using CDs and DVDs as diffraction Grating Ref:https://www.nnin.org/sites/default/files/files/Karen_Rama_USING_CDs_AND_DVDs_AS_DIFFRACTION_GRATINGS_0.pdf Obtain the diffraction pattern using a CD and design an experiment to find the distance between the tracks on it.(Ref: https://www.brighthubeducation.com/science-lessons-grades-9-12/39347-diffraction-experiment-measuring-groove-spacing-on-cds/, https://silo.tips/download/diffraction-from-a-compact-disk)	

Suggested Activities(Any two activities to be conducted compulsorily)

Activity No. 11	Explain polarization of light with the help of a chart. List out the surfaces that reflect polarized light. Learn how polarization of light can be learnt by both transmission and reflection.
Activity No. 12	What is the physics behind making 3D movies? Group Discussion (https://www.slideserve.com/rae/physics-behind-3d-movies-powerpoint-ppt-presentation)
Activity No. 13	List out different types of zone plates and look for their applications in day-to-day life. Prepare a report.
Activity No. 14	Collect information and study how optically polarizing lenses are made. Visit a nearby lens making facility. Learn the principle behind sunglasses. Prepare a report.

Topic Learning Outcomes
At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
	Define Fraunhofer diffraction.	**L2**	**8**	**1-6, 11-12**
	Give a qualitative treatment of single slit/diffraction double slit diffraction.	**L2**	**8**	**1-6, 11-12**
	Explain the theory of diffraction due to grating and the normal and oblique incidence.	**L2**	**8**	**1-6, 11-12**
	Explain how the resolving power of a grating depends of the number of slits used.	**L2**	**8**	**1-6, 11-12**
	Give the theory of Fersnel half period zones.	**L2**	**8**	**1-6, 11-12**
	Discuss zone plates with respect to convex lenses.	**L2**	**8**	**1-6, 11-12**
	Explain optical polarization and polaroids.	**L2**	**9**	**1-6, 11-12**
	Give different types of polaroids.	**L2**	**9**	**1-6, 11-12**
	Give the theory of phenomenon of double refraction and explain what are ordinary and extraordinary rays.	**L2**	**9**	**1-6, 11-12**
	Give the theory of quarter wave plates and half wave plates.	**L2**	**9**	**1-6, 11-12**
	Explain optical activity with theory. Give an experimental method to measure the optical activity of a material.	**L2**	**9**	**1-6, 11-12**
	Higher order problems.	**L3**	**8,9**	**1-6, 11-12**

Teaching and Learning Methodology
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.
Assessment Techniques
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Textbooks				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1	The Physics of Waves and Oscillations,	N K Bajaj	Tata McGraw-Hill Publishing Company Ltd., Second Edition,	1984
2	Waves and Oscillations	N Subramanyam and Brij Lal	Vikas Publishing House Pvt. Ltd., Second Revised Edition	2010
3	A Text Book of Sound	D R Khanna and R S Bedi	Atma Ram & Sons, Third Edition	1952
4	Oscillations and Waves	Satya Prakash	PragathiPrakashan, Meerut, Second Edition	2003
5	A Text Book of Optics	Brij Lal, M N Avadhanulu& N Subrahmanyam	S. Chand Publishing	2012

References Books				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1	Optics	AjoyGhatak	McGraw Hill Education (India) Pvt Ltd	2017
2	Berkeley Physics Course – Waves,	Frank S Crawford Jr.	Tata Mc Graw-Hill Publishing Company Ltd., Special Indian Edition,.	2011
3	Optics	E. Hecht	Pearson Paperback	2019
4	Introduction To Optics	F. L.Pedrotti, L.M.Pedrotti& L.S. Pedrotti	Pearson India	2008
5	Fundamentals of Optics	F. Jenkins &H. White	McGraw Hill Education	2017

Paper Code: Phy-DSCP3 - Lab III

List of Experiments to be performed in Lab III	
1.	Velocity of sound through a wire using Sonometer.
2.	Frequency of AC using Sonometer.
3.	Verification of Sabine's formula
4.	To verify the laws of transverse vibration using Melde's apparatus.
5.	Helmholtz resonator using tuning fork.
6.	Helmholtz resonator using electrical signal generator.
7.	Study of Lissajous figures using CRO
8.	To determine refractive index of the material of a prism using sodium source.
9.	To determine refractive index of a liquid by parallax method.
10.	To determine the dispersive power and Cauchy constants of the material of a prism using Hg source.
11.	To determine wavelength of sodium light using Fresnel Biprism.
12.	Determination of radius of curvature of a lens using Newton's rings.
13.	To determine the thickness of a paper using air-wedge.
14.	Determination of wavelength of laser using diffraction
15.	Study of Diffraction at a wire using laser
16.	To determine wavelength of spectral lines of Hg source using plane diffraction grating.
17.	To determine dispersive power and resolving power of a plane diffraction grating.
18.	To verify Brewster's law.
19.	To determine specific rotation of a solution using Polarimeter.

Note: A minimum of EIGHT experiments must be performed

* **One hour of Laboratory time every week has to be dedicated for suggested activities in the theory paper DSCT3: Wave Motion and Optics. Note that this is in addition to a total of 8 hour during theory teaching during the entire semester (2 hours each for every Unit of the theory paper).**

Reference Book for Laboratory Experiments

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Advanced Practical Physics for students	B.L. Flint and H.T. Worsnop	Asia Publishing House.	1971
2	A Text Book of Practical Physics	I. Prakash & Ramakrishna	Kitab Mahal, 11th Edition	2011
3	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn	Heinemann Educational Publishers, 4th Edition	1985
4	A Laboratory Manual of Physics for undergraduate classes	D.P.Khandelwal	Vani Publications.	1985

4th Semester BSc

Phy-DSCT4: Thermal Physics & Electronics	**Course Credits (L+T+P) :4+0+0**
Total Contact Hours: 52	**Duration of ESA: 4 hours**

Program Outcomes:	
1.	Disciplinary knowledge
2.	Communication Skills
3.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
4.	Problem-solving
5.	Research-related skills
6.	Cooperation/ Teamwork/ Leadership readiness/Qualities
7.	Information/ Digital literacy/Modern Tool Usage
8.	Environment and Sustainability
9.	Multicultural competence
10.	Multi-Disciplinary
11.	Moral and ethical awareness/Reasoning
12.	Lifelong learning / Self Directed Learning

Prerequisites	
ii.	Exposure of the topic in Pre-University

Course Learning Outcomes	
At the end of the course students will be able to:	
i.	Apply the laws of thermodynamics and analyze the thermal system.
ii.	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.
iii.	Use the concepts of semiconductors to describe different Semiconductor devices such as diode transistors, BJT, FET etc and explain their functioning.
iv.	Explain the functioning of OP-AMPS and use them as the building blocks of logic gates.
v.	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

Course Outcomes/Program Outcomes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
i	Apply the laws of thermodynamics and analyze the thermal system.	X	X	X	X	X	X					X	X
ii	Apply the laws of kinetic theory and radiation laws to the ideal and practical	X	X	X	X	X	X					X	X

	thermodynamics systems through derived thermodynamic relations.												
iii	Use the concepts of semiconductors to describe different Semiconductor devices like diode transistors, BJT, FET etc and explain their functioning.	X	X	X	X	X	X					X	X
iv	Explain the functioning of OP-AMPS and them as the building blocks of logic gates.	X	X	X	X	X	X					X	X
v	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.	X	X	X	X	X	X					X	X

Course Content **Phy.DSCT4: Thermal Physics & Electronics**		**Hrs**
Unit – 1: Thermodynamics **(11 hours of teaching plus 2 hours of activities)**		
Chapter No. 1	**Laws of Thermodynamics**: Review of the concepts of Heat and Temperature – the zeroth law of thermodynamics, Thermodynamic variables - extensive and intensive, Equations of state, PV diagrams.	**2 hours**
Chapter No. 2	**First Law of Thermodynamics:** Differential form of the First Law of Thermodynamics, Application of the first law for (i) Cyclic Process (ii) Adiabatic Process (iii) Isochoric Process (iv) Isobaric Process and (v) Isothermal Process. Equation of state for an adiabatic process (derivation) Work done in an isothermal and adiabatic process for an ideal gas, Internal Energy as a state function,	**3 hours**
Chapter No. 3	**Second Law of Thermodynamics:** Second law of thermodynamics (Kelvin's & Clausius' statements and their equivalence); Reversible and irreversible processes with examples; Heat engines: Carnot Engine; Carnot Cycle and its efficiency(derivation), Practical internal combustion engines - Otto and Diesel Cycles Carnot theorem, (qualitative treatment); Refrigerator- Coefficient of performance. Concept of Entropy, Second Law of Thermodynamics in terms of Entropy, Entropy in reversible process, Entropy in irreversible process, Principle of increase of entropy, Entropy change in (i) adiabatic process (ii) free expansion (iii) cyclic process (iv) isobaric process **Third Law of Thermodynamics(Nernst Heat theorem):** Statement, Significance and Unattainability of Absolute Zero	**6 hours**
Topics for Self-study	(1) Discuss when the temperature of the body is locked until what time you hold the thermometer in contact with a body. Discuss it in contact with laws of thermodynamics. (2) Discuss why when a person works or does exercise, he sweats. Reason it with the laws of thermodynamics.	

Suggested Activities (Any two activities to be conducted compulsorily)	
Activity No. 1	We feel cold because coldness enters our body. Discuss the statement in day-to-day life. Approximately give examples of a) open system b) closed system and c) isolated system
Activity No. 2	Take four different sizes of same metal, preferable of same shape and give one piece to each group. Heat it uniformly on a hot plate. Keep a beaker of water with a thermometer immersed in it. Drop one hot metal into the water and record the temperature with time. Repeat the experiment for the other heated metal pieces of different sizes. 1. Plot a graph for the volume of the metal piece used v/s respective temperature change observed. 2. Determine the heat capacity and specific heat of the metal used. All groups shall also do the following activity: **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.
Activity No. 3	Take ice cubes of different size and immerse in water and measure the temperature change with time and repeat the experiment. Graph the observations. **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes: At the end of the topic, students should be able to understand the following

SL No	TLO's	BL	CO	PO
i.	Explain the first law of thermodynamics.	**L1**	**1**	**1-6, 11-12**
ii.	Give the differential form of the first law of thermodynamics and define what is the internal energy.	**L2**	**1**	**1-6, 11-12**
iii.	Obtain an expression for work done in isothermal and adiabatic processes.	**L2**	**1**	**1-6, 11-12**
iv.	Give two systems of units of temperature measurement and give their equivalence.	**L2**	**1**	**1-6, 11-12**
v.	Describe and Discuss heat engine based on Carnot cycle.	**L2**	**1**	**1-6, 11-12**
vi.	Explain how the efficiency of refrigeration is measured?	**L2**	**1**	**1-6, 11-12**
vii.	Detail out the application of the Carnot engine to a locomotion system.	**L1**	**1**	**1-6, 11-12**
viii.	State the third law of thermodynamics and give its significance using the third law of thermodynamics describing why absolute zero temperature is not unattainable.	**L2**	**1**	**1-6,11-12**

Teaching and Learning Methodology
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.
Assessment Techniques
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Unit – 2 **(11 hours of teaching plus 2 hours of activities)**		
Chapter No. 4	**Thermodynamic Potentials**: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, properties and significance. **Maxwell's Thermodynamic Relations**: Maxwell's thermodynamic relations (using Thermodynamic potentials), Applications of Maxwell's Relations (1) Gibbs potential, First order Phase Transitions with examples, (2) Clausius - Clapeyron Equation. Joule-Thomson effect, Liquefaction of gases, Linde's air liquefier	**5 hours**
Chapter No. 5	**Kinetic Theory of Gases**: Maxwell's law of distribution of velocity (without derivation), Deduction of most probable velocity, mean velocity and root mean square velocity, Degrees of Freedom, Law of Equipartition of Energy. Derivation of Specific heats of ideal gas.	**3 hours**
Chapter No. 6	**Black body radiation** and its spectral energy distribution; Kirchhoff's law, Stefan's law and Stefan-Boltzmann's law, Wien's displacement law, Rayleigh-Jeans law (Statements), Planck's law (derivation)– deduction of Wien's Law & Rayleigh – Jeans Law.	**3 hours**
Topics for Self-study	(1) Equilibrium between phases -triple point of water. (2) Methods of producing low temperatures: (i) Joule Thomson (Joule Kelvin / Throttling / Porous plug) experiment.	
Suggested Activities (Any two activities to be conducted compulsorily)		
Activity No. 4	1. Watch the you tube video: https://www.youtube.com/watch?v=bODiX2PjCPE and write a report on the difference between heat and temperature. 2. Watch the you tube video https://www.youtube.com/watch?v=v5zAiWSi7rs "A simple animation showing the thermoelectric effect"(Seebeck effect) and explain it in your own words.	
Activity No. 5	Take two containers (cylindrical jars) A and B ofidentical size (volume 500 ml). Connect them to a reservoir (huge bottle containing water) thoughpipes of equal length, but of different radii of cross-section. Let container A be connected using a pipe of inner radius of 5 mm and container B be connected using a pipe of inner radius 1.5 mm. Sketch the graphs for the rise of water levels in containers A and B as a function of time when water was allowed to flow from the reservoir to the containers. Explain the results. What	

	happens if the diameter of the containers A is larger than that of B, but pipes of equal length connecting the containers with the reservoir have same inner radii.
Activity No. 6	A hot object at a temperature T_1 is placed in an environment at a temperature T_0. The temperature of the object will be some function oftime, T(t). This function will satisfy the equation: $\frac{dT}{dt} = -A(T - T_0)$ (a) Explain "what this equation explains" in your own words. (b) Show that the function $T(t) = T_0 + ce^{-At}$ satisfies the above equation. (c) Plot T(t) as a function of time t.
Activity No. 7	Take two dissimilar metal wires. Spot weld them forming two junctions. Dip one junction in ice and heat the other junction with a burner. Plot a graph of time of heating v/s Thermo EFM generated in the voltmeter. **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes: At the end of the topic, students should be able to understand the following				
SL No	**TLO's**	**BL**	**CO**	**PO**
i.	State Maxwell relations.	**L1**	**2**	**1-6, 11-12**
ii.	Give examples where Maxwell's relations are used.	**L1**	**2**	**1-6, 11-12**
iii.	Explain the phase transition. Which is called as first order phase transition? Give Examples	**L2**	**2**	**1-6, 11-12**
iv.	State Clausius - Clapeyron Equation.	**L1**	**2**	**1-6, 11-12**
v.	Obtain an equation for difference in C_P - C_V.	**L2**	**2**	**1-6, 11-12**
vi.	State Joule-Thomson effect and Joule-Thomson coefficient.	**L1**	**2**	**1-6, 11-12**
vii.	Obtain an expression, giving the relation between pressure, volume and temperature for a real gas (Vander Waals gas).	**L2**	**2**	**1-6, 11-12**
viii.	Explain how low temperature is achieved by the liquefaction of gases?	**L2**	**2**	**1-6, 11-12**
ix.	State Maxwell-Boltzmann Law of Distribution of velocities in Ideal gases.	**L1**	**2**	**1-6, 11-12**
x.	Explain the mean RMS and most probable speeds in ideal gases.	**L1**	**2**	**1-6, 11-12**
xi.	Explain degrees of freedom associated with particles in an ideal gas.	**L2**	**2**	**1-6, 11-12**

xii.	Define the specific heat of a gas.	**L1**	**2**	**1-6, 11-12**
xiii.	Explain black body radiation and its spectral distribution.	**L1**	**2**	**1-6, 11-12**
xiv.	Explain the different laws used to describe different parts of the curves of a spectral distribution of black body radiation.	**L2**	**2**	**1-6, 11-12**
xv.	Define ultraviolet radiation catastrophe? Discuss its importance in the explanation of black body radiation.	**L2**	**2**	**1-6, 11-12**
xvi.	Define Planck's law of radiation and discuss how it could describe the whole black body radiation curve.	**L2**	**2**	**1-6, 11-12**

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Unit – 3: Semiconductor devices
(11 hours of teaching plus 2 hours of activities)

Chapter No. 7	**Semiconductor devices**: Intrinsic semiconductors - concept of holes – effective mass - expression for carrier concentration of holes and electrons - electrical conductivity. Extrinsic semiconductors and electrical conductivity (qualitative), p-n junction and its characteristics, Zener diode as voltage regulator- load and line regulation.	**5 hours**
Chapter No. 8	**Junction Transistors**: Basics of Bipolar Junction Transistors (BJT), BJT operation, Common Base, Common Emitter and Common Collector Characteristics. Field Effect Transistor (FET) and its characteristics. Transistor as a CE-Amplifier (qualitative) and Oscillator (Phase shift)	**6 hours**
Topic for Self-study	Diode approximations	

Suggested Activities (Any two activities need to be conducted compulsorily)

Activity No. 8	a. Learn to identify the terminals of different types (packages) of BJTs. b. In the case of power transistors, learn how to fix a heat sink for the transistor. c. Learn the difference between BJT and FET from operational characteristics.
Activity No. 9	Take any 3 diodes and assign one each to three groups of students. Ask them to measure diode resistance when dipped in ice and while heating the ice till it boils. Using this data, plot calibration curve of temperature v/s resistance and also the cooling curve of temperature v/s time for the diode by each group. **Note for the teachers for the activity:** Form 3 groups. Assign each group the activity of drawing one of the graphs. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. Select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement.

	3. In the third slide, they will list three observations from that study.
Activity No. 10	Prepare a table consisting of (i) name of the semiconductor diode (Zener diode, Light Emitting Diode, Rectifier Diode, Schottky diode) (ii) its application/s (3) attach a sample photo for each type of semiconductor diode (4) give a link for the website where you got the sample photo of the diode.

Topic Learning Outcomes: At the end of the topic, students should be able to understand the following				
SL No	**TLO's**	**BL**	**CO**	**PO**
i.	Define Semiconductors and Band Gap. Explain on what basis they are classified as intrinsic and extrinsic.	**L2**	**3**	**1-6, 11-12**
ii.	Define PN junction. Explain its functioning in forward and reverse bias.	**L1**	**3**	**1-6, 11-12**
iii.	Explain the approximation used in a real diode with respect to an ideal PN Junction?	**L2**	**3**	**1-6, 11-12**
iv.	With a schematic diagram, explain half wave and full wave rectifiers.	**L1**	**3**	**1-6, 11-12**
v.	Define a Zener diode and explain how it is different from an ordinary diode using V-I curves?	**L2**	**3**	**1-6, 11-12**
vi.	With the schematic diagram, explain the working of voltage regulators of different types using a Zener diode.	**L1**	**3**	**1-6, 11-12**
vii.	Give the basic concepts used in the instruction of bipolar junction transistor and its operation.	**L1**	**3**	**1-6, 11-12**
viii.	Compare the V-I curve of common base common emitter and common collector BJT curves while explaining their working principles.	**L2**	**3**	**1-6, 11-12**
ix.	Define FET. Give its characteristics.	**L1**	**3**	**1-6, 11-12**
x.	Explain how a transistor can be used as an amplifier and an oscillator using a circuit diagram.	**L2**	**3**	**1-6, 11-12**
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.				

Assessment Techniques		
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc		
Unit – 4: Electronics		
Chapter No. 9	**Electronics**: Integrated Circuits, Operational Amplifier, Ideal characteristics of Op-Amp, Basic concepts of feedback and virtual ground, Inverting and Non-Inverting Configurations. Applications- Voltage Follower, Addition and Subtraction.	**4 hours**
Chapter No. 10	**Digital Electronics:** Analog and Digital circuits, Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary. **Digital Circuits**: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, XOR Gate, Algebraic Simplification, De Morgan's theorem, Realisation of NAND and NOR functions using TTL.	**7 hours**
Topics for Self-study	(i)Understand the concept of virtual ground of an OP-AMP. (ii)Learn the different types of op-amps used for different applications. (iii)What is a buffer? Prepare a report on buffers and its application in instrumentation electronics.	
Suggested Activities (Any two activities need to be conducted compulsorily)		
Activity No. 12	Learn how to implement logic functions (AND, OR, NOT) using just diodes and resistors. With a circuit diagram show how different types of gates can be built by NAND Or NOR gates.	
Activity No. 13	A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by one of the switches irrespective of the state of the other switch. Explain switching of the bulb in terms of logic gate operation.	
Activity No. 14	A man has to take a wolf, a goat, and some cabbage across a river. His rowboat has enough room for the man plus either the wolf or the goat or the cabbage. If he takes the cabbage with him, the wolf will eat the goat. If he takes the wolf, the goat will eat the cabbage. Only when the man is present are the goat and the cabbage safe from their enemies. All the same, the man carries wolf, goat, and cabbage across the river. How? Write the truth table for the above story and implement using digital gates.	
Activity No. 15	A locker has been rented in the bank. Express the process of opening the locker in terms of digital operation.	

Topic Learning Outcomes: At the end of the topic, students should be able to understand the following

SL No	TLO's	BL	CO	PO
i.	Define op-amps and give the characteristics of an ideal op-amp.	**L1**	**4**	**1-6, 11-12**
ii.	Explains an inverting and non-inverting configuration of typical op-amps, with a schematic diagram.	**L2**	**4**	**1-6, 11-12**
iii.	Explain how op-amps can be used as a voltage follower, with a schematic diagram and with relevant expressions.	**L2**	**4**	**1-6, 11-12**

iv.	Explain how op-amps can be used as a voltage follower, adder and subtractor, with a schematic diagram and with relevant expressions.	**L2**	**4**	**1-6, 11-12**
v.	Give different digital wave forms and explain how one can visualize the switching and logic levels.	**L1**	**5**	**1-6, 11-12**
vi.	Write any four-digit numbers other than zero in the decimal number system and convert that into binary and hexadecimal.	**L2**	**5**	**1-6, 11-12**
vii.	Write any number in a Binary System of 8 digits other than zero and convert it into decimal and hexadecimal.	**L2**	**5**	**1-6, 11-12**
viii.	Write any number in the hexadecimal system of 4 digits other than zero and converted it into a binary and decimal number.	**L2**	**5**	**1-6, 11-12**
ix.	Give simplified diagram for a given Boolean circuit diagram of logic gates, and verify using the De-Morgan's theorem.	**L2**	**5**	**1-6, 11-12**
x.	Why are NAND and NOR gates called Universal Gates?	**L2**	**5**	**1-6, 11-12**

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Textbooks

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1.	Heat and Thermodynamics	Brij lal, N. Subrahmanyam and P.S.Hemne	S. Chand Publishing	2001
2.	Heat and Thermodynamics	D. S. Mathur	S. Chand Publishing	2008
3.	Heat and Thermodynamics	M.W. Zemansky and Richard Dittman	McGraw-Hill Education	2017
4.	Thermal Physics	S C Garg, R M Bansal & C K Ghosh	McGrawHill Education (India)	2013
5.	Fundamentals of Classical Thermodynamics	G. J. V. Wylen, R. E. Sonntag, C. Borgnakke	John Wiley	1994
6.	Integrated Electronics	J. Millman, C. Halkias& C. Parikh	McGraw Hill Education	2017
7.	Digital Fundamentals	T. L. Floyd	Pearson Education	2005
8.	Principals of Electronics	V.K Mehta and Rohit Mehta	S. Chand Publishing	2020

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication

1	A Treatise on Heat	M. Saha&B.N.Srivastava	Hafner Publishing Company, Indian Press	1958
2	Thermodynamics, Kinetic theory & Statistical Thermodynamics	F. W. Sears & G. L. Sailinger	Pearson Education	1975
3	Electronic Principles	A Malvino and D J Bates	McGraw Hill Education	2017
4	Electronic Devices and Circuits	David A. Bell	PHI, New Delhi	2004
5	Basic Electronics	B L Theraja	S Chand and Co	2006

Paper Code: Phy-DSCP4 - Lab IV

List of Experiments to be performed in Lab IV	
1.	Specific heat by Newton's law of cooling
2.	Verification of Newton's law of cooling
3.	Calibration of thermocouple for Temperature measurement
4.	Thermal conductivity of a bad conductor by Lee's and Charlton's method
5.	Thermal conductivity of rubber
6.	Mechanical Equivalent of Heat by Callender and Barne's method
7.	Coefficient of thermal conductivity of Copper by Searle's method
8.	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
9.	Determination of Stefan's constant/ Verification of Stefan's law
10.	Variation of thermo-emf across two junctions of a thermocouple with temperature
11.	Verification of Clausius-Clapeyron equation
12	Study of Gaussian distribution using Monte Carlo method.
13	Determination of Planck's constant.
Any FOUR of the above listed experiments 1-13 must be conducted in Lab IV	
14.	V-I Characteristics of Silicon & Germanium PN Junction diodes (FB)
15.	(i) V-I Characteristics of Zener Diode (ii) Regulated power supply (using Zener diode).
16.	Characteristics of BJT in Common Emitter Configuration
17.	Half Wave rectifier with and without Filter
18.	Full Wave Rectifier with and without Filter
19.	Determination of transistor h-parameter
20.	Frequency response of a CE amplifier.
21.	Frequency response of CC Amplifier (Emitter Follower).
22.	Applications of Operational Amplifier: (i) Non-inverting and Inverting op-amp circuits OR (ii) Voltage follower, Adder and Subtractor circuits
23.	Truth table verification of logic gates using TTL 74 series ICs.
24.	Logic Gates; Combinational Circuits (Half adder and Full adder);
25.	Experiments with CRO.
Any FOUR of the above listed experiments 14-24must be conducted in Lab IV	

* **One hour of Laboratory time every week has to be dedicated for suggested activities in the theory**

Reference Books for Laboratory Experiments				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1	Advanced Practical Physics for students	B.L. Flint and H.T. Worsnop	Asia Publishing House.	1971
2	Basic Electronics Lab Manual 2015-16,	National Institute of Science Education and Research, Bhubaneswar, 2015.	NISER, Bhubaneswar	**2015**
3	Engineering Practical Physics	S. Panigrahi, B. Mallick	Cengage Learning India Pvt. Ltd	**2015**

paper DSCT3: Thermal Physics & Electronics. Note that this is in addition to a total of 8 hour during theory teaching during the entire semester (2 hours each for every Unit of the theory paper).

OPEN ELECTIVE PAPERS

Phy-OE5: Optical Instruments (Credits:3)
3 hours of teaching per week

Unit-I		**Hrs.**
Basics of Optics: Scope of optics, optical path, laws of reflection and refraction as per Fermat's principle, magnifying glass, Lenses (thick and thin), convex and concave lenses, Lens makers formulae for double concave and convex lenses, lens equation. Focal and nodal points, focal length, image formation, combination of lenses, dispersion of light: Newton's experiment, angular dispersion and dispersion power. Dispersion without deviation. (No derivations; concepts to be discussed qualitatively).		**13**
Unit-II		
Camera and microscopes: Human eye (constitution and working), Photographic camera (principle, construction and working), construction, working and utilities of (i) Simple microscopes (ii) Compound microscope (iii) Electron microscopes (iv) Binocular microscopes **Self study:** Experimental determination of magnifying power of a microscope.		**13**
Unit-III		
Telescopes and Spectrometer: Construction, working and utilities of (i) Astronomical telescopes (ii) Terrestrial telescopes (iii) Reflecting telescopes, Construction, working and utilities of Eyepieces or Oculars (Huygen, Ramsden's, Gauss) Spectrometer – Construction, working and utilities, measurement of refractive index.		**13**
Self study	Telescopes used at different observatories in and outside India.	

Suggested Activities

1. Find position and size of the image in a magnifying glass and magnification.
2. Observe rain bows and understand optics. Create a rainbow.
3. Find out what makes a camera to be of good quality.
4. Observe the dispersion of light through prism.
5. Make a simple telescope using magnifying glass and lenses.
6. Learn principle of refraction using prisms.
7. Check bending of light in different substances and find out what matters here.
8. Learn about different telescopes used to see galaxies and their ranges.

Weblinks: **https://spark.iop.org, http://www.yenka.com, https://publiclab.org** etc

Reference Books

1. Galen Duree. Optics for Dummies. Wiley. 2011.
2. Blaker J W. Optics: An Introduction for Students of Engineering. Pearson, 2015.
3. Hecht E. Optics. Pearson. 5th Edition, 2019.
4. Khurana A K. Theory And Practice Of Optics & Refraction. Elsevier India. 2016.
5. FlexBooks® 2.0 https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/19.9/primary/lesson/optical-instruments-ms-ps/

Phy-OE6: Elements of Astronomy& Astrophysics (Credits:3)
3 hours of teaching per week

Unit-I : History and Introduction	**Hrs.**
Ancient Astronomy: Greek Observations, Sumerian Observations, Mayan Observations, Arabic Observations ,Chinese Observations (2 hours) **Indian Astronomy:** Vedic Astronomy, Ancient Astronomy – Aryabhata, Varahamihira, Bhaskara, Astronomy in Indian Scriptures, Precession of the Equinox, Celebrations of Equinox (2 hours) **Medieval & Modern Astronomy:** Invention of Telescopes, Models of the Solar System & Universe, Observations by Tycho Brahe, Kepler, Galileo, Herschel and Other, Modern Astronomy (3 hours) **Optical Tools for Astronomy:** Pin Hole, Binoculars, Telescopes & Imaging (1 hour) **Mathematical Methods of Observations:** Angular Measurement, Trigonometric functions, Stellar Parallax (2 hour) **Observational Terminologies:** Cardinal Directions, Azimuth, Altitude, Measurements using Compass and Hand. Equatorial Co-ordinates, Light years, Magnitude, Colors etc. (3 hours)	**13**
Unit-II: Observations of the Solar System	
The Sun: Ecliptic and the Orientation of the Earth, Seasons - Solstices and Equinox, Observations of the Sun from Earth during seasons. Eclipses, Zero-shadow day, Sunspots (3 hours) **The Moon:** Earth-Moon system – Phases, Lunar Eclipses, Ecliptic and Lunar Orbital Plane – Nodes, Lunar Month, Full Moon Names (3 hours) **Inner Planets: Mercury &Venus** -Observational History, Observational Windows, Appearance, Apparitions, Elongations, Superior Conjunctions, Inferior Conjunctions, Transits. (4 hours) **Outer Planets: Mars, Jupiter & Saturn** - Observational History. Observational Windows, Appearance, Frequency of Oppositions, Conjunctions, Moons Eclipses. Galilean Moons, Saturn's Rings (3 hours)	**13**
Unit-III: Major Astronomy Observations	

March to June: Prominent Stars and Constellations Visible during this period, Methods of Spotting. (4 hours) **June to September:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours) **September to December:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours) **December to March**:Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours)	**13**

Suggested Activities

1. Measuring Seasons using Sun's Position.
2. Measuring Distance using Parallax
3. Estimation of the Stellar Diameter using Pin Hole
4. Measuring Height of an Object Using Clinometer.
5. Star spotting using constellation maps
6. Constellation spotting using Skymaps
7. Estimation of 'Suitable Periods' to observe deep sky objects using Planisphere.
8. Estimation of the Size of the Solar System in using Light Years.
9. Identification of Lunar Phases across a year.
10. Measuring Constellation of the Sun using Night Skymaps or Planispheres

Reference Books

1. The Stargazer's Guide - How to Read Our Night Sky by Emily Winterburn
2. A guide to the Night Sky – Beginner's handbook by P.N. Shankar
3. The Complete Idiot's guide to Astronomy by Christopher De Pree and Alan Axelro

Phy-OE7: Medical Physics (Credits:3)
3 hours of teaching per week

Unit-I: Human Anatomy and Physiology	
Overview of human anatomy - cells, cell structure, type of cells and their functions, tissues, organs, and their functions. Different systems in the human body, their structure and function, physiological properties of the circulatory system, digestive system, respiratory system, reproductive system, excretory system, endocrine system and nervous system	(13 hours)
Unit-II: Physics of Medical Diagnostics	
Principle of production of X-rays. Use of X-rays in medical diagnosis, X-ray imaging systems. Computed Tomography (CT): principle and generation of CT. Magnetic Resonance Imaging (MRI): basic principle and image characteristics. Ultrasound Imaging: Interaction of sound waves with body tissues, production of ultrasound, transducers, acoustic coupling, image formation, modes of image display and color Doppler.	(13 hours)
Unit-III: Physics of Radiotherapy	
Clinical aspects of radiation therapy: Biological basis of radiotherapy, radiation sources, radiation dose, time dose fractionation. External beam radiation therapy, radiation therapy modalities, production of radioisotopes, use of radioisotopes in therapy, particle and ion beam radiotherapy. Brachytherapy - principle of brachytherapy and classification of brachytherapy techniques.	(13 hours)

Suggested Activities

Unit I: Students may demonstrate the shape, size, positions and functions of different organs in the body with the help of models.

Unit II: The use of X-rays in the diagnosis of the fractured bone can be demonstrated with the help of a gamma source and a gamma ray survey meter. As the density of materials between the source and the detector changes the reading on the meter (or intensity of the beefing sound) changes.

Unit III: (i) Students can be asked to list out different type of cancers and possible causative factors. They can be asked to list out the healthy practices to reduce the risk of cancers.

(ii) As there will be students from different disciplines in the OE course, group discussion can be arranged to discuss about their programme and outcome. This will be an opportunity for the students to know about other disciplines.

Other related activities/projects

1. Visit to nearby hospitals/diagnostic centers to study the working of X-ray machines.
2. Visit to ultrasound diagnostic centers to study the principle and use of ultrasound in diagnosis.
3. Project on principle and use of X-ray films in imaging.
4. Visit to radiotherapy centers to study the modalities of radiotherapy.

Text Books

1. C. H. Best and N. B. Taylor. A Test in Applied Physiology. Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick. Anatomy and Physiology for Radiographers. Oxford University Press, 2001.
3. Jerrold T. Bushberg. The Essential Physics for Medical Imaging (2nd Edition). Lippincott Williams & Wilkins, 2002.
4. Jean A. Pope. Medical Physics: Imaging. Heinemann Publishers, 2012.
5. Faiz M. Khan and Roger A. Potish. Treatment Planning in Radiation Oncology. Williams and Wilkins, USA, 2003.
6. D. Baltas. The physics of modern brachytherapy for oncology. Taylor and Francis, 2007.

Reference Books

1. J. R. Brobek. Physiological Basis of Medical Practice. Williams and Wilkins, London, 1995.
2. Edward Alcamo, Barbara Krumhardt. Barron's Anatomy and Physiology the Easy Way. Barron's Educational Series, 2004.
3. Lippincott, Anatomy and Physiology. Lippincott Williams & Wilkins, 2002.
4. W. E. Arnould Taylor. A textbook of anatomy and physiology, Nelson Thornes, 1998.
5. G. S. Pant. Advances in Diagnositc Medical Physics. Himalaya Publishing House, 2006.
6. Sabbahaga, Diagnositc Ultrasound applied to OBG. Maryland, 1980.
7. Faiz M Khan. The Physics of Radiation Therapy (3rd edition). Lippincott Williams & Wilkins, USA, 2003.
8. Jatinder R. Palta and T. Rockwell Mackie. Intensity Modulation Radiation Therapy. Medical Physics publishing, Madison, Wisconsin, 2003.
9. AAPM Report No. 72. Basic Applications of Multileaf collimators, AAPM, USA, 2001.
10. AAPM Report No. 91. Management of Respiratory motion in radiation oncology, 2006.
11. CA Joslin, A. Flynn, E. J. hall. Principles and Practice of Brachytherapy. Arnold publications, 2001.
12. Peter Hoskin, Catherine Coyle. Radiotherapy in Practice. Oxford University Press, 2011.
13. W. R. Handee. Medical Radiation Physics. Year Book Medical Publishers Inc., London, 2003.
14. Donald T. Graham, Paul J. Cloke. Principles of Radiological Physics. Churchill Livingstone, 2003.
15. Thomas S. Curry. Christensen',s Physics of Diagnostic Radiology (4th Edition). Lippincott Williams & Wilkins, 1990.
16. Madison. MRI – Perry Sprawls – Medical Physics Publishing. Wisconsin, 2000.
17. Steve Webb. The Physics of Three–Dimensional Radiotherapy. Institute of Physics Publishing, Bristol and Philadelphia, 2002.
18. Radiation oncology physics: A Handbook for teachers and students. IAEA publications, 2005.

19. F. M. Khan. The Physics of Radiation Therapy (3rd Edition), Lippincott Williams and Wilkins, U.S.A., 2003.

Phy-OE8: Electrical Instruments (Credits:3)
3 hours of teaching per week

Content		Hrs
Unit – 1		
Chapter No. 1	Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Ammeters, voltmeters: (DC/AC)	03
Chapter No. 2	Representation of sinusoidal waveforms, peak and rms values, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. Wattmeters: Induction type, single phase and three phase wattmeter, Energy meters: AC. Induction type single phase and three phase energy meter	05
Chapter No. 3	Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications.	05
Topics for self study (If any)	Types of switches and Circuits, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Fuses, MCB, ELCB and Relays, Filament lamp, Tube light, CFL and LED	
	Suggested Activities	
Activity No. 1	Identify variety of electrical switches and note down their applications/utility.	
	Reference: Weblink/Youtube/Book	
Activity No. 2	Identify the hazards involved in handling electrical circuits and instruments, make a list of safety precautions as well as first aid for electrical shocks.	
	Reference : Weblink/Youtube/Book	
Unit – 2		
Chapter No. 4.	Galvanometers: General principle and performance equations of D'ArsonvalGalvanometers, Vibration Galva nometer and Ballistic Galvanometer.	03
Chapter No. 5.	Potentiometers: DCPotentiometer, Crompton potentio meter, construction, standardization, application. AC Potentio meter, Drysdalepolarpotentio meter; standardization, application.	03

Chapter No. 6.	DC/AC Bridges: General equations for bridge balance, measurement of self inductance by Maxwell's bridge (with variable inductance & variable capacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device, Kelvin's double bridge.	07
Topics for self study (If any)	Importance of grounding and Earthing, Methods for Earthing,	
Suggested Activities		
Activity No. 3	Make a study of importance of grounding in electrical circuits. Reference : Weblink/Youtube/Book	
Activity No. 4	Prepare a detailed account of various methods of earthing and their utility/applications Reference : Weblink/Youtube/Book	
Unit - 3		
Chapter No.7	Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer	06
Chapter No. 8	CRO: Block diagram, Sweep generation, vertical amplifiers, use of CRO in measurement of frequency,phase, Amplitude and rise time of a pulse. Digital Multi-meter: Block diagram, principle of operation	03
Chapter No. 9	Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing.	04
Topics for self study (If any)	Basic study of Fuses, MCB, ELCB and Relays, Filament lamp, Tube light, CFL and LED	
Suggested Activities		
Activity No. 5	Prepare a document on evolution of incandescent bulbs to the present-day LED lights Reference : Weblink/Youtube/Book	
Activity No.6	Make a comparative study of Fuses, MCB, ELCB and Relays highlighting their use and applications Reference : Weblink/Youtube/Book	

Text Books

1. AK.Sawhney, ACourseinElec.&Electronics Measurements&Instrumentation **,Dhanpatrai& Co. 1978**
2. A.D. Helfrick& W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques **PHI,2016**

References Books

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications,**2019**
2. David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
3. Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall India**2009**

COURSE PATTERN & SCHEME OF EXAMINATION for B.Sc. / B.Sc. (Hons.) as per NEP-2020

Semester	Title of the Paper	Total No of hours	Hours per week	Marks		Duration of Examination (hours)	Total Marks	Credits
				Theory/ Practicals	Internal Assessment (IA)			
				Max	Max			
3rd Sem.	Phy-DSCT3: Wave motion and Optics	52	4	60	40	$2\frac{1}{2}$	100	4
	Phy-DSCP3-Lab III	40	4	25	25	3	50	2
	Phy-OE5:Optical Instruments OR Phy-OE6: Elements of Astronomy and Astrophysics	39	3	60	40	$2\frac{1}{2}$	100	3
4th Sem.	Phy-DSCT4: Thermal Physics & Electronics	52	4	60	40	$2\frac{1}{2}$	100	4
	Phy-DSCP4-Lab II	40	4	25	25	3	50	2
	Phy-OE7: Medical Physics OR Phy-OE8: Electrical Instruments	39	3	60	40	$2\frac{1}{2}$	100	3

Formative/Internal Assessment for Theory Papers	
Assessment Occasion	Marks
Test-1 (Attendance+Activity + Self-study related)	20
Test-2 (Theory based)	20
Total	40

***Questions should not be set on activity and self-study topics during end semester examinations.**

Distribution of Marks for the Practical Examination (Phy-DSCP1 & Phy-DSCP2)		
Sl No	Particulars	Marks
1	Writing Principle/Statement/Formulae with symbols, units and explanations.	03
2	Drawing illustrative diagrams and expected graphs	03
3	Setting up of the experiment& taking readings	06
4	Calculations and graphs drawn based on experimental data.	05
5	Accuracy of results with units	03
6	Valuation of Practical Record	05
Total Marks		25

3rd/4th Semester B.Sc Examination, April/May (September/October) 2023

CBCS - 2021 ONWARDS

Subject: Physics

Phy-DSCT3/Phy-DSCT4: …….

Time: 2.30 hours **Max. Marks: 60**

Instruction: Answer *any* FOUR questions from *each* part

PART- A

Each question carries 2 marks (concept based)

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 1,2,3,4,5,6)

PART-B (20 marks)

Each question carries 5 marks (numerical problems)**

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 7,8,9,10,11,12)***

PART-C (32 marks)

Each question carries 8 marks

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 13,14,15,16,17,18)**

*In each part of the question paper first three questions should be set from the first TWO units of the syllabus and next three questions should be set from second half (last TWO units) of the syllabus.
**Questions in Part-B should contain numerical problems in the specific cases of discipline core subjects, where problem solving is an essential component of learning.
*** Questions of Part B and Part C may contain subdivisions i.e., (i) questions 7 to 12 of Part B may be split into a, b & division of marks in such cases should be clearly indicated – for example 2 + 3=5 marks or 1+4=5 marks. Similarly (ii) question 13 to 18 of Part C may be split into a, b, c with division of marks clearly indicated – for example 3+5=8 marks or 2+6=8 marks or 2+3+3=8 marks and so on).

3rd/4th Semester B.Sc Examination, April/May (September/October) 2023

CBCS - 2021 ONWARDS

Subject: Physics

Phy-OE5/OE6/OE7/OE8 :……..(Open Elective)

Time: 2 hours **Max. Marks: 60**

Instruction: Answer*any* FOUR questions from *each* part

PART- A

Each question carries 2 marks (concept based)

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 1,2,3,4,5,6)

PART-B (20 marks)

Each question carries 5 marks **

6 QUESTIONS TO BE SET*

(Question Numbers: 7,8,9,10,11,12)***

PART-C (32 marks)

Each question carries 8 marks

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 13,14,15,16,17,18)**

* All parts should have TWO questions each from 3 units of the open elective syllabus.
** Questions of Part B and Part C may contain subdivisions i.e., (i) questions 7 to 12 of Part B may be split into a, b & division of marks in such cases should be clearly indicated – for example 2 + 3=5 marks or 1+4=5 marks. Similarly (ii) question 13 to 18 of Part C may be split into a, b, c with division of marks clearly indicated – for example 3+5=8 marks or 2+6=8 marks or 2+3+3=8 marks and so on).