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

# 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<br>2. Minor/Related Discipline<br>3. Languages,<br>4. Ability Enhancement Compulsory Courses<br>5. Skill Enhancement/ Development Courses | Understanding of Disciplines<br>Language Competency<br>Gaining perspective of context/Generic skills<br>Basic skills sets to pursue any vocation | 1+1<br>1+1<br>2+2<br>1+1<br>1+1 |
| **Exit option with Certification** | | | | |
| **$2^{nd}$ Year - ($3^{rd}$ & $4^{th}$ Semesters)** | Focus and Immersion | 1. Major Core Courses<br>2. Minor/ Related Discipline<br>3. Ability Enhancement<br>4. Skill based Vocational<br>5. Extra Curricular Activities | Understanding of disciplines<br>Gaining perspective of context<br>Skill sets to pursue vocation<br>Development of various<br>Domains of mind &Personality | 2+2<br>1+1<br>1+1<br>1+1<br>1+1 |
| **Exit Option with Diploma** | | | | |
| **$3^{rd}$ Year - ($5^{th}$ & $6^{th}$ Semesters )** | Real time Learning | 1. Major Discipline Core and Elective Courses<br>2. Minor Discipline/ Generic or Vocational Electives/Field based Learning/ Research Project | In depth learning of major and minor disciplines, Skill sets for employability.<br>Exposure to discipline beyond the chosen Subject<br>Experiential learning/ Research. | 2+2<br>1+1<br>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<br>Phy.DSCT6 | 1. Classical Mechanics and Quantum Mechanics- I<br>2. Elements of Atomic, Molecular Physics |
| SEMESTER -6 | Phy.DSCT7<br>Phy.DSCT8 | 1. Elements of Nuclear Physics and Nuclear Instruments<br>2. Elements of Condensed Matter Physics |
| SEMESTER -7 | Phy.DSCT9<br>Phy.DSCT10<br>Phy.DSCT11 | 1. Mathematical Methods of Physics – I<br>2. Classical Electrodynamics.<br>3. Experimental methods of Physics<br>4. Research Methodology |
| SEMESTER -8 | Phy.DSCT12<br>Phy.DSCT13<br>Phy.DSCT14 | 1. Classical Mechanics and Quantum Mechanics-II<br>2. Statistical Mechanics<br>3. Astrophysics & Astronomy<br>4. Research Project*<br>(Select Two DSE subjects from the Pool B-II shown below)<br>*In lieu of the research Project, two additional elective papers/ Internship may be offered. |
| SEMESTER -9 | Phy.DSCT15 | 1. Mathematical Methods of Physics – II<br>(Select One DSE subjects from the Pool B-III shown below)<br>2. Research Project |
| SEMESTER -10 | Phy.DSCT17 | 1. Quantum Mechanics – III<br>(Select One DSE subjects from the Pool B-IV shown below)<br>2. Research Project |

## Open Electives

| Sl. No. | 1 to 4 Semester<br>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)<br>Pool B-III | | 10th Sem Electives (Specialization papers)<br>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<br>Phy.DSCT1: Mechanics & Properties of Matter | | Hrs |
|---|---|---|
| **Unit – 1**<br>**(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<br>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.<br>iii). Measure volume of a liquid.<br>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.<br>v). Estimate standard deviations wherever possible. | |
| **Activity No. 2** | Understand conservation of energy in every day examples like<br>i) What happens in solar energy conversion panels<br>ii) Pushing an object on the table it moves<br>iii) Moving car hits a parked car causes parked car to move.<br>In these cases, it is known that energy is conserved. How? Understand and verify if possible. | |
| **Unit – 2**<br>**(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<br>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**<br>**(13 hours of teaching includes 3 hours of activities)** | | |
| **Chapter No. 7** | **Elasticity:**<br>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.<br>Work done in stretching and work done in twisting a wire, twisting couple on a cylinder.<br>Beams, bending of beams, expression for bending moment, theory of single cantilever.<br>Torsional pendulum, expression for time-period of torsional oscillations, determination of rigidity modulus (static and dynamic methods) and moment of inertia, determination of q, $\eta$ 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**<br>**(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:<br>**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<br>i) Why water has high ST? think of reasons.<br>ii) Check whether ST is a function of temperature? You can do it by heating the water to different temperatures and measure ST.<br>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.<br>i) Find out whether sticky or non sticky liquids are most viscous. Think of reasons.<br>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.<br>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.<br>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**<br>**Phy-DSCT2:Electricity and Magnetism** | | **Hrs** |
|---|---|---|
| **Unit – 1**<br>**(13 hours of teaching includes 3 hours of activities)** | | |
| **Chapter No. 1** | **Electric charge and field:**<br>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:**<br>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**<br>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.<br>(ii) Voltage and line frequency standards in different countries.<br>(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.<br>(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**<br>**(13 hours of teaching includes 3 hours of activities)** | | |
| **Chapter No. 4.** | **Conductors in electrostatic field:**<br>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:**<br>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.<br>(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<br>(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?<br>(iii) Prepare a small project report on street lighting and types of electrical bulbs. | |
| | Reference : Weblink/Youtube/Book | |

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| **Unit – 3**<br>**(13 hours of teaching includes 3 hours of activities)** | | |
| **Chapter No.6** | **Magnetism:**<br>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.<br>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:**<br>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.<br>(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:**<br>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:**<br>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<br>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.<br>(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.<br>(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,<br>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)<br>**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)<br>**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)<br>**Geothermal and hydro energy:**<br>Geothermal Resources, Geothermal Technologies (2 hours),<br>Hydropower resources, hydropower technologies, environmental impact of hydro power sources (3 hours),<br>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.<br>Modelling of the atmosphere: General principles, Overview of General Circulation Models(GCM) for weather forecasting and prediction. Limitations of the models.<br>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** | |

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|---|---|
| **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.<br>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.<br>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)<br>**Indian Astronomy:** Vedic Astronomy, Ancient Astronomy – Aryabhata, Varahamihira, Bhaskara, Astronomy in Indian Scriptures, Precession of the Equinox, Celebrations of Equinox (2 hours)<br>**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)<br>**Optical Tools for Astronomy:** Pin Hole, Binoculars, Telescopes & Imaging (1 hour)<br>**Mathematical Methods of Observations:** Angular Measurement, Trigonometric functions, Stellar Parallax (2 hour)<br>**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)<br>**The Moon:** Earth-Moon system – Phases, Lunar Eclipses, Ecliptic and Lunar Orbital Plane – Nodes, Lunar Month, Full Moon Names (3 hours)<br>**Inner Planets: Mercury & Venus** - Observational History, Observational Windows, Appearance, Apparitions, Elongations, Superior Conjunctions, Inferior Conjunctions, Transits. (4 hours)<br>**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)<br>**June to September:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours)<br>**September to December:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours)<br>**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.<br>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.<br>(No derivations; concepts to be discussed qualitatively). | **13** |
| **Unit-II** | |
| **Camera and microscopes:**<br>Human eye (constitution and working),<br>Photographic camera (principle, construction and working),<br>construction, working and utilities of<br>(i) Simple microscopes<br>(ii) Compound microscope<br>(iii) Electron microscopes<br>(iv) Binocular microscopes<br>**Self study:** Experimental determination of magnifying power of a microscope. | **13** |
| **Unit-III** | |
| **Telescopes and Spectrometer:**<br>Construction, working and utilities of<br>(i) Astronomical telescopes<br>(ii) Terrestrial telescopes<br>(iii) Reflecting telescopes,<br>Construction, working and utilities of Eyepieces or Oculars<br>(Huygen, Ramsden's, Gauss) Spectrometer – Construction, working and utilities, measurement of refractive index.<br><br>**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)<br>**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)<br>**Projectile motion**: Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw. (4 hours)<br><br>**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)<br>**Centre of mass**: Physics behind Cycling, Rock climbing, Skating (5 hours)<br>**Gravitation**: Origin, Newton's law of gravitation, Archimedes's principle, Buoyancy & Physics behind swimming (4 hours)<br><br>**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)<br>**Energy:** Different forms of Energy, Conservation of mass-energy (3 hours)<br>**Physical exercises:** Walking, Jogging and Running, Weight management. (3 hours)<br><br>**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:**<br><br>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:**<br><br>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:**<br><br>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)<br>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)<br>Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications. (5 hours)<br>**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)<br>Potentiometers: DC Potentiometer, Crompton potentiometer, construction, standardization, application. AC Potentiometer, Drysdale polar potentiometer; standardization, application. (3 hours)<br>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)<br>**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)<br>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)<br>Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. (4 hours)<br>**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<br>(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<br>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<br>(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 $10.94 \times 10^{-9}$ 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.