Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

(Lead College, Karmaveer Bhaurao Patil University, Satara)

Syllabus for B.Sc. I (Physics)

As per NEP 2020

w.e.f. 2023-24

Preamble:

This syllabus is framed to give sound knowledge with understanding of Physics to undergraduate students at first year of three years of B.Sc. degree course.

Students will learn Physics as a separate subject from B.Sc. I. The aim of the syllabus is to make the study of physics interesting, encouraging and popular to the students for higher studies including research.

The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

General Objectives of the Program:

1. To nurture academicians with focus and commitment to their subject.
2. To shape good and informed citizens from the students entering into the program.
3. To create a skilled work force to match the requirements of the society.
4. To impart knowledge of science is the basic objective of education.
5. To develop scientific attitude is the major objective to make the students open minded, critical, curious.
6. To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute the science.

Program Outcomes:

1. The student will graduate with proficiency in the subject.
2. The student will be eligible to continue higher studies in his subject.
3. The student will be eligible to pursue higher studies abroad.
4. The student will be eligible to appear for the examinations for jobs in government organizations.
5. The student will be eligible to appear for jobs with minimum eligibility as science graduate.
6. The student will be eligible to appear for industrial jobs with minimum eligibility as physics graduate.

Program Specific Objectives:

1. The students are expected to understand the fundamentals, principles, concepts and recent developments in the physics.
2. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in physics.
3. It is expected to inspire and boost interest of the students in physics.
4. To develop the power of appreciations, the achievements in science and role in nature and society.

5. To enhance student sense of enthusiasm for science and to involve the intellectually stimulating experience of course in a supportive environment.

Program Specific Outcomes:

1. Understand the basics of physics.
2. Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
3. Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
4. Identify their area of interest in academic, research and development.
5. Perform job in various fields like science, engineering, education, banking, business and public service, etc. or be an entrepreneur with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

1. Title: Physics

2. Year of Implementation: The syllabus will be implemented from June, 2023.

3. Duration: The course shall be a full time.

4. Pattern: Semester examination.

5. Medium of Instruction: English

6. Structure of Course:

Physics Major

B.Sc. I Semester I

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1	Mechanics	BPT111	5	2	Practical Course –I (BPP113)	4	2
2	Electrostatics and Electronics	BPT112		2			

B.Sc. I Semester II

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1	Gravitation and	BPT121	5	2	Practical	4	2

	Properties of matter				Course – II (BPP123)		
2	Electricity and Magnetism	BPT122		2			

B: B.Sc. P: Physics T: Theory, P: Practical

7. Titles of Courses of B.Sc. I:

B.Sc. I (Semester I)

Theory: 30 lectures, 30 hours (for each Course)

Course – I: BPT111: MECHANICS

Course – II: BPT112: ELECTROSTATICS and ELECTRONICS

Practical: 60 lectures: 60 hours (Total)

Practical Course I: BPP113: MECHANICS, ELECTROSTATICS and ELECTRONICS

B.Sc. I (Semester II)

Theory: 30 lectures, 30 hours (for each Course)

Course – III: BPT121: GRAVITATION and PROPERTIES OF MATTER

Course – IV: BPT122: ELECTRICITY and MAGNETISM

Practical: 60 lectures: 60 hours (Total)

Practical Course II: BPP123: PROPERTIES OF MATTER, ELECTRICITY and MAGNETISM

Physics Major

B.Sc. I Semester I

Course – I: BPT111: Mechanics (Credits: 02)

Course Objectives: Students should be able to:

1. learn the vector algebra and basic vector calculus and difference between scalars and vectors.
2. study different types of differential equations.
3. explain Newton's laws of motion, conservation laws for single and system of particles and their applications and corelate linear and angular motions.
4. know the concept of rotational motion and moment of inertia of various bodies.

Credits (Total Credits 2)	Semester I BPT111: Mechanics	No. of hours per unit/credit
Unit I	**Vectors Algebra and Elementary Calculus**	**07**
	Vector algebra, Scalar and vector products, Derivatives of a vector with respect to parameters (velocity and acceleration)	
Unit II	**Ordinary Differential Equations**	**08**
	Differential equations; degree, order, linearity and homogeneity of differential equation, ordinary and partial differential equations, Exact differentials, 1^{st} order homogeneous differential equations, 2^{nd} order homogeneous differential equation with constant coefficients, Problems.	
Unit III	**Dynamics of a system of particles**	**08**
	Frames of reference, Newton's Laws of motion, Conservation of linear and angular momentum, work and energy theorem, conservation of energy (Single Particle), Dynamics of a system of particles (linear momentum, angular momentum and energy), Centre of mass, Motion of rocket (qualitative treatments only), Problems.	
Unit IV	**Rotational Motion**	**07**
	Angular velocity and angular momentum, Torque, Analogy between translational and rotational motion, Relation between torque and angular momentum, Kinetic energy of rotation and moment of inertia, Moment of Inertia of spherical shell; solid cylinder (only about the axis of symmetry), Motion of spherical shell and solid cylinder	

	rolling down an inclined plane, Problems.	

Course Outcomes: After completion of the course, student will be able to:

1. define scalar, vector and their products and perform the basic algebra operations of scalars and vectors.
2. examine the order, degree, linearity of differential equation, solve 1st and 2nd order homogenous differential equation and distinguish between ordinary and partial differential equations as well as exact and inexact differential equations.
3. state Newton's laws of motion, law of conservation of linear momentum, angular momentum and energy for single and system of particles, describe physical significance of them and describe the concept of center of mass and use it extend conservation laws from single particle to system of particles
4. describe rotational kinematical variables, relate them to their linear counterparts and calculate the moment of inertia of a spherical shell and solid cylinder about axis of rotation and analyze their rolling motion.

Reference Books:

1. Walker, Halliday and Resnick, *Fundamentals of Physics* (Hoboken, New Jersey: John Wiley & Sons,11th Edition, 2018).
2. H. C. Verma, *Concepts of Physics –Part–I, (*Bharati Bhawan Publishers, Revised Edition, 2018).
3. Charles Kittel, Knight, Ruderman et al., *Mechanics,* (New York: Berkeley Physics Course, Vol.1, Tata McGraw Hill Publications, 2nd Edition, 2017).
4. H. K. Das, Dr. Rama Verma, *Mathematical Physics,* (New Delhi: S. Chand Publication,7th Edition,2014).
5. B. D. Gupta, *Mathematical Physics* (Mumbai: Vikas Publication House,4th Edition,2010).
6. D.S. Mathur, *Mechanics,* (New Delhi: S. Chand and Company Ltd.,2007).
7. K. F. Riley, M. P. Hobson, S.J. Bence, *Mathematical Methods for Physics and Engineering*, (Cambridge: Cambridge University Press,3rd Edition, 2006).

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Physics Major

B.Sc. I Semester I

Course – II: BPT112: Electrostatics and Electronics (Credits:2)

Course Objectives: Students should be able to:

1. learn the gradient, divergence and curl of vector fields and various integral calculus.
2. study Gauss's theorem of electrostatics and use it to calculate electric field, electric potential, electric energy density.
3. describe electric polarization of dielectric medium and interrelate different polarization parameters.
4. understand to simplify complex electric circuits using network theorems and study characteristics and different configurations of transistors.

Credits (Total Credits 2)	**Semester I BPT112: Electrostatics and Electronics**	**No. of hours per unit/credit**
Unit I	**Vector Analysis**	**07**
	Differentiation of vector, Del operator, scalar and vector fields, gradient, divergence, curl operations and their physical significance, Idea of line, surface and volume integrals, Gauss divergence theorem, Stokes' theorem (Statements only)	
Unit II	**Electrostatics**	**08**
	Electrostatic field, electric flux, Gauss's theorem of electrostatics, Applications of Gauss theorem –Electric field due to a point charge, uniformly charged spherical shell and solid sphere. Electrostatic potential, Electric potential due to a point charge, Electric field as line Integral of electric potential, Electric field as a gradient of scalar electric potential, Poisson and Laplace equations, Energy density in electrostatic field, Problems.	
Unit III	**Dielectrics**	**07**
	Dielectric medium, Concept of electric dipole, polar and non-polar molecules, Polarization, displacement vector, Gauss's theorem in dielectrics, parallel plate capacitor completely filled with dielectrics. Relation between three electric vectors D, E and P, relation between dielectric constant and electric susceptibility, Problems.	
Unit IV	**Network Theorems and Transistors (BJT)**	**08**
	Review of Ohm's and Kirchhoff's laws, Thevenin's theorem,	

	Norton's theorem, Application of simple networks with D.C. sources. PNP and NPN structure, Transistor characteristics in CB, CE and CC mode. Transistor as an amplifier in CE mode, Comparative study of CB, CE and CC configurations.	

Course Outcomes: After completion of the course, student will be able to:

1. compute gradient, divergence, curl to interpret their physical significances and solve practical problems using integral theorems of vector fields, Gauss divergence theorem, Stokes' theorem.
2. state Gauss's law and apply it to calculate electric field for a point charge, uniformly charged spherical shell and solid sphere, interrelate electric field, electric potential, electric potential energy and electric potential difference.
3. describe Gauss law for dielectrics and interrelate three electric vectors E, P, D as well as dielectric constant and electric susceptibility, distinguish between polar and non-polar dielectrics and compute the expression for capacitance of parallel plate capacitor filled with dielectric medium.
4. use Thevenin's and Norton's theorem to simplify an electric circuit, draw and discuss NPN structure, PNP structure, transistor characteristics in CB, CE and CC mode.

Reference Books:

1. D. C. Tayal, *Electricity and Magnetism* (Mumbai: Himalaya Publishing House, 4th Edition, 2016).
2. S. Mahajan and Chaudhary, *Electricity, Magnetism and Electromagnetic Theory* (Tata McGraw Hill, 2012).
3. V. K. Mehta, *Principles of Electronics*, (New Delhi: S. Chand and Co., 11th Edition, 2009).
4. David J. Griffith, *Introduction to Electrodynamics* (New Jersey: Prentice Hall Publisher,3rd Edition, 1999).
5. Bagde and Singh, Elements *of Electronics*, (New Delhi: S. Chand and Co., 18thEdition, 1997).
6. B. B. Laud, *Electromagnetics*, (New Delhi: New age international (P) Ltd.,2nd Edition, 1987).
7. J. Yarwood & J. H. Fewkes, *Electricity & Magnetism* (London: University Tutorial Press, 2nd Edition,1965).

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Physics Major

B.Sc. I Semester I

Practical Course I: BPP113: Mechanics and Electrostatics and Electronics (Credits:2)

(Based on Theory Course – I: BPT111: Mechanics and Theory Course – II: BPT112: Electrostatics and Electronics)

Course Objectives: students should be able to:

1. develop fundamental experimental skills to perform an experiment and learn the experimental setup and procedure to perform given experiment.
2. develop skills in taking readings/observations obtained from these instruments and learn how to analyze and interpret experimental data, including error analysis, graphical representation.
3. perform calculations to obtain the experimental results and test whether the experimental results hold good with theoretical results.
4. acquire knowledge and practice safe laboratory procedures, including proper handling of equipment, electrical, and potential hazards.

Experiments:

Sr. No.	Titles of Experiment
1.	Measurements of length/diameter using Vernier caliper, Screw gauge and Travelling Microscope.
2.	To determine the Moment of Inertia of a Flywheel.
3.	To determine Moment of inertia of a disc using auxiliary annular ring.
4.	To determine ‘g’ by bar pendulum.
5.	To determine ‘g’ by Kater’s pendulum (fixed knife edges).
6.	To determine ‘g’ by Kater’s pendulum (movable knife edges).
7.	To study the motion of a spring and calculate (a) spring constant (b) value of ‘g’.
8.	To use a multimeter for measuring (a) Resistance, (b) AC and DC voltages, (c) DC current, and (d) checking electrical fuses.
9.	Input, output and transfer characteristics of common emitter (CE) transistor.
10.	To verify Kirchhoff ‘s laws.
11.	To verify Thevenin’s theorem.
12.	To verify Norton’s theorem.
13.	To determine the moment of inertia of a body using bifilar suspension method (with parallel thread)
14.	To study the oscillations in a bifilar suspension arrangement.
15.	To determine order and degree of given differential equation

Course Outcomes: After completion of the course, student will be able to:

1. demonstrate basic experimental skills by setting up laboratory equipment/ experiment set up safely and efficiently, instruments calibration, carry out experimental procedure, data

collection, analysis and report it in a written sheet manner.

2. exhibit practical skills in using various measuring instruments (vernier caliper, micrometer screw gauge, travelling microscope, multimeter, stopwatch etc.) and learn to select and use the appropriate instrument for a given measuring task.
3. display practical skills in measuring moment of inertia using various experimental setups such as flywheel, torsional oscillating annular disk and bifilar suspension arrangement.
4. exhibit practical skills in measuring time period of oscillation for Kater's and bar pendulum and demonstrate electronics practical skills by measuring various electronic components and verification of network theorems (Kirchhoff's laws, Thevenin's theorem, Norton's theorem).

Reference Books:

1. Gupta S.L. and V. Kumar., *Practical physics*. (Meerut: Pragati Prakashan,29thEdition.2017).
2. Chattopadhyay D. and P. C. Rakshit, *An advanced course in practical physics* (Calcutta: New Central Book,8th Edition,2013).
3. I. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal,11th Edition, 2011).
4. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011)
5. White, Marsh W. and Kenneth V. Manning, *Experimental college physics; a laboratory manual*, (New York: McGraw-Hill Publication,3rd Edition, 1954).
6. Worsnop B. L. and H. T. Flint., *Advanced practical physics for students*, (London: Methuen & Co., Ltd, 9th Edition, 1951).

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Physics Major

B.Sc. I Semester II

Course – III: BPT121: Gravitation and Properties of Matter (Credits:2)

Course Objectives: Students should be able to:

1. learn about the motion of a particle under central force field, Newton's Law of Gravitation, Kepler's laws of planetary motion and their applications.
2. study flow of liquid using concept of viscosity and various physical parameters affecting it.
3. understand basic behavior of beam under different types loading, torsional pendulum and correlation between elastic constants.
4. know the concept of surface tension, angle of contact and wettability of the liquid, excess pressure under a bubble and its experimental determination and application.

Credits (Total Credits 2)	**Semester II BPT121: Gravitation and Properties of Matter**	**No. of hours per unit/credit**
Unit I	**Gravitation**	**08**
	Newton's Law of Gravitation, Motion of particle in central force field (motion in a plane, angular momentum is conserved, areal velocity is constant), Kepler's laws of planetary motion (statements only), Satellite in circular orbit and its applications, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS), Problems.	
Unit II	**Viscosity**	**07**
	Introduction, rate of flow of liquid in a capillary tube, tubes of flow (streamline and turbulent), Poiseuille's formula (derivation) and determination of coefficient of viscosity of liquid by Poiseuille's method, Variation of viscosity of liquid with temperature and pressure, Problems.	
Unit III	**Elasticity**	**07**
	Bending of beam, bending moment, Cantilever (without considering weight of cantilever), Beam supported at both ends (without considering weight of beam), Torsional pendulum, Work done in twisting a wire, Twisting couple on a cylinder, Determination of modulus of rigidity, Determination of Y, n and σ by Searle's method, Problems.	
Unit IV	**Surface Tension**	**08**
	Surface tension (definition), concept of surface, Angle of contact and wettability, Relation between surface tension, excess pressure and radius of curvature, Experimental	

	determination of surface tension by Jaeger's method, Effect of temperature, impurity on surface tension, Applications of surface tension, Problems.	

Course Outcomes: After completion of the course, student will be able to:

1. state and explain Newton's law of gravitation and Kepler's laws of planetary motion, geosynchronous orbits and global positioning system (GPS), enlist and prove the properties of the particle moving in central force field and interpret the motion of satellite in circular orbit, its applications and geosynchronous orbits, basic idea of global positioning system (GPS)
2. distinguished between streamline and turbulent flow, explain the effect of temperature and pressure on viscosity of liquid and derive Poiseuille's formula for flow of liquid through a capillary tube and apply it to calculate coefficient of viscosity.
3. define beam, cantilever to formulate the expression of depression under various types of loading and describe torsional pendulum, twisting behavior of wire and corelate Y, n and σ.
4. define and corelate surface tension, angle of contact and wettability of the liquid, formulate the relation between surface tension, excess pressure and radius of curvature of liquid bubble, describe experimental determination of surface tension by Jaeger's method and effect of temperature, impurity on it.

Reference Books:

1. Walker, Halliday and Resnick, *Fundamentals of Physics* (Hoboken, New Jersey: John Wiley & Sons, 11th Edition, 2018).
2. J.C. Upadhyaya, *General Properties of Matter*, (Agra: Ram Prasad Publication,3rd Edition,2017).
3. R. Murugeshan, *Properties of Matter*, (New Delhi: S Chand & Company, 2017).
4. D. S. Mathur, *Elements of Properties of Matter*, (New York: S. Chand & Company, 2010).
5. Brij Lal and N. Subrahmanyam, *Properties of Matter*, (New Delhi: Eurasia Publishing House Limited, 1993).
6. S. G. Sterling and A. J. Woodal, *Physics* (London: Longman's & Green Co. Ltd.,2nd Edition, 1963).

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Physics Major

B.Sc. I Semester-II

Course – IV: BPT122: Electricity & Magnetism (Credits:2)

Course Objectives: Students should be able to:

1. use complex number to study the concept of resonance phenomenon, sharpness and quality factor for a series LCR circuit.
2. study the concepts of magnetostatics using Biot - Savart's law and apply it to calculate magnetic field for various current carrying elements.
3. know various magnetization entities with their interrelations and different types of magnetic materials and impart knowledge on concepts of Faraday's law, Lenz law, electromagnetic induction and Ballistic galvanometer.
4. interpret importance of Maxwell's equations and electromagnetic Wave propagation.

Credits (Total Credits 2)	Semester II BPT122: Electricity & Magnetism	No. of hours per unit/credit
Unit I	**AC Circuits**	**07**
	Complex numbers and their application in solving AC series LCR circuit, Complex impedance, Reactance, Admittance and Susceptance, Resonance in LCR series circuit, Sharpness of resonance, (qualitative treatment only), Q-factor (definition only), AC Bridge- Owen's Bridge, Problems.	
Unit II	**Magnetostatics and Magnetism**	**08**
	Magnetostatics: Biot - Savart's law & its applications – straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field, Ampere's circuital law, Properties of magnetic materials –Magnetic intensity (H), magnetic induction (B), permeability, susceptibility, brief introduction of dia, para, and ferro magnetic materials, Problems.	
Unit III	**Electromagnetic Induction**	**07**
	Faraday's laws of electromagnetic induction, Lenz's law, self and mutual induction, Reciprocity Theorem, Self-inductance of solenoid, Energy stored in a magnetic field. Ballistic Galvanometer, construction and working (Revision), expression for charge flowing through ballistic galvanometer, correction for damping in galvanometer, Constants of ballistic galvanometer.	
Unit IV	**Maxwell's equations and Electromagnetic Wave propagation**	**08**

	Equation of continuity of current, Maxwell's correction to Ampere's law (displacement current), Maxwell's equations and its physical interpretation, Poynting vector, energy density in electromagnetic field (qualitative), electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.	

Course Outcomes: After completion of the course, student will be able to:

1. differentiate between alternating (AC), direct current (DC), complex impedance, reactance, admittance and susceptance and draw phasor diagram and formulate impedance, phase angle, resonance frequency, quality factor and sharpness in series LCR circuit.
2. state Biot-Savart Law and apply it to find magnetic field for straight conductor, circular coil & solenoid and describe nature and source of diamagnetism, paramagnetism and ferromagnetism as well as relate among magnetization vector (M), magnetic intensity (H), magnetic induction (B), permeability, susceptibility.
3. state Faraday's and Lenz's law and use it to determine direction and magnitude of an induced emf and differentiate between self-inductance and mutual inductance and determine energy stored in magnetic field.
4. explain the theory of ballistic galvanometer to measured small currents, Maxwell's correction of Ampere's law by including displacement current and enlist Maxwell's equations, interpret its physical interpretation and design wave equation from the Maxwell's equations.

Reference Books:

1. Matthew N. O. Sadiku, *Elements of Electromagnetism* (New York: Oxford University Press, 7th Edition, 2018).
2. D. C. Tayal, *Electricity and Magnetism* (Mumbai: Himalaya Publishing House, 4th Edition, 2016).
3. S. Mahajan and Chaudhary, *Electricity, Magnetism and Electromagnetic Theory* (Tata McGraw Hill,2012).
4. David J. Griffith, *Introduction to Electrodynamics* (New Jersey: Prentice Hall Publisher,3rd Edition, 1999).
5. B. B. Laud, *Electromagnetics,* (New Delhi: New age international (P) Ltd.,2nd Edition, 1987).
6. N. Subramanyam, Brij Lal, *Textbook of Electricity and Magnetism,* (Agra: Ratan Prakashan,1966).
7. J. Yarwood & J. H. Fewkes, *Electricity & Magnetism* (London: University Tutorial Press, 2nd Edition,1965).

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Physics Major

B.Sc. I Semester I

Practical Course II: BPP123: Properties of Matter and Electricity and Magnetism (Credits: 2)

(Based on Theory Course – III: BPT121: Gravitation and Properties of Matter and Theory Course – IV: BPT122: Electricity & Magnetism)

Course Objectives: Students should be able to:

1. develop fundamental experimental skills to perform an experiment and learn the experimental setup and procedure to perform given experiment.
2. develop skills in taking readings/observations obtained from these instruments and learn how to analyze and interpret experimental data, including error analysis, graphical representation.
3. perform calculations to obtain the experimental results and test whether the experimental results hold good with theoretical results.
4. acquire knowledge and practice safe laboratory procedures, including proper handling of equipment, electrical, and potential hazards.

Experiments:

Sr. No.	Titles of Experiment
1.	Young's modulus of material of bar by vibration method.
2.	Young's modulus of material of bar by cantilever method.
3.	Young's modulus of material of rectangular bar by method of bending (using travelling microscope)
4.	Modulus of rigidity of material of wire by torsional oscillations.
5.	Y and n of wire by Searle's method.
6.	Poisson's ratio for rubber using rubber tube.
7.	Coefficient of viscosity by Poiseiulle's Method.
8.	Surface Tension by Jaegar's method.
9.	Surface tension and angle of contact by Quincke's method.
10.	To study a series LCR circuit and determine its (a) resonant frequency (b) quality factor Q.
11.	To study a parallel LCR circuit and determine its (a) anti-resonant frequency (b) quality factor Q.
12.	Frequency of AC mains by sonometer using magnetic wire.
13.	Frequency of AC mains by sonometer using non- magnetic wire.
14.	To compare capacitance using De Sauty's bridge.
15.	Impedance of series LCR circuit.
16.	To determine Constants of B.G.

Course Outcomes: After completion of the course, students will be able to:

1. demonstrate basic experimental skills by setting up laboratory equipment/ experiment set up

safely and efficiently, instruments calibration, carry out experimental procedure, data collection, analysis and report it in a written sheet manner.

2. exhibit practical skills in using various measuring instruments (vernier caliper, micrometer screw gauge, travelling microscope, multimeter, stopwatch, measuring cylinder etc.) and learn to select and use the appropriate instrument for a given measuring task.
3. display practical skills in measuring elastic constants (Young's modulus, Modulus of rigidity, Poisson's ratio) using various experimental setups such as vibration of bar, Searle's method, rubber tube and torsional oscillations of disc.
4. exhibit practical skills in tunning vibrating length in sonometer and input frequency in series/ parallel LCR.

Reference Books:

1. Gupta S.L. and V. Kumar., *Practical physics,* (Meerut: Pragati Prakashan,29thEdition.2017).
2. Chattopadhyay D. and P. C. Rakshit, *An advanced course in practical physics* (Calcutta: New Central Book,8th Edition,2013).
3. I. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal,11th Edition, 2011).
4. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011)
5. White, Marsh W. and Kenneth V. Manning, *Experimental college physics; a laboratory manual*, (New York: McGraw-Hill Publication,3rd Edition, 1954).
6. Worsnop B. L. and H. T. Flint., *Advanced practical physics for students*, (London: Methuen & Co., Ltd, 9th Edition, 1951).

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Physics Minor

B.Sc. I Semester I

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1	Kinematic	BPT114	5	2	Practical Course –I (BPP116)	4	2
2	Electrostatics and Electronics	BPT115		2			

B.Sc. I Semester II

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1	Newtonian Mechanics	BPT124	5	2	Practical Course – II (BPP126)	4	2
2	Electricity and Magnetism	BPT125		2			

B: B.Sc. P: Physics T: Theory, P: Practical

7. Titles of Courses of B.Sc. I:

B.Sc. I (Semester I)

Theory: 30 lectures, 30 hours (for each Course)

Course – I: BPT114: KINEMATICS

Course – II: BPT115: ELECTROSTATICS and ELECTRONICS

Practical: 60 lectures: 60 hours (Total)

Practical Course I: BPP116: KINEMATICS, ELECTROSTATICS and ELECTRONICS

B.Sc. I (Semester II)

Theory: 30 lectures, 30 hours (for each Course)

Course – III: BPT124: NEWTONIAN MECHANICS

Course – IV: BPT125: ELECTRICITY and MAGNETISM

Practical: 60 lectures: 60 hours (Total)

Practical Course II: BPP126: NEWTONIAN MECHANICS, ELECTRICITY and MAGNETISM

Physics Minor

B.Sc. I Semester I

Course – I: BPT114: Kinematics (Credits:02)

Course Objectives: Students should be able to:

1. learn vectors, scalars and vector derivatives.
2. know the work energy theorem.
3. understand theory and applications of pendulums.
4. study the concept of rotational motion and M. I. of various bodies.

Credits (Total Credits 2)	Semester I BPT114: Kinematics	No. of hours per unit/ credits
Unit - II	**Vectors Algebra and Elementary Calculus**	**(7)**
	Vector algebra, Scalar and vector products, Derivatives of a vector with respect to parameters (velocity and acceleration)	
Unit - II	**Work, Energy and Power**	**(8)**
	Definition of Work, energy and power, work and kinetic energy relation, work done by gravitational force, work done by spring force, work done by general variable force, conservation of mechanical energy, work done on a system by an external force, problems.	
Unit - III	**Mechanical Oscillatory Systems**	**(7)**
	Introduction, simple pendulum, theory of compound pendulum, Bar pendulum, Kater's Pendulum, Bassel's Theory, Bifilar pendulum (parallel suspensions of equal lengths), Torsional Pendulum, problems.	
Unit - IV	**Rotational Motion**	**(8)**
	Angular velocity, angular momentum and Torque, Relation between torque and angular momentum, Analogy between translational and rotational motion, Kinetic energy of rotation and moment of Inertia, Moment of Inertia of spherical shell; Motion of spherical shell rolling down an inclined plane, problems.	

Course Outcomes: After completion of the course, students will be able to:

1. recall the definitions and properties of vector algebra, including scalar and vector
2. explain the concepts of work, energy, power and apply the concepts of work, energy, and power to solve problems involving different types of forces and systems.
3. analyze the behavior and characteristics of different types of pendulums.
4. evaluate the relationship between torque and angular momentum, and analyze the analogy between translational and rotational motion and calculate the kinetic energy of rotation and moment of inertia for specific objects, such as a spherical shell and a solid cylinder about the axis of symmetry.
5. create solutions to problems involving the motion of spherical shells and explain the concepts of angular velocity, angular momentum, torque, and moment of inertia.

Reference Books:

1. H. C. Verma, *Concepts of Physics –Part–I, (*Bharati Bhawan Publishers, Revised Edition, 2018).
2. Walker, Halliday and Resnick, *Fundamentals of Physics* (Hoboken, New Jersey: John Wiley & Sons,11th Edition, 2018).
3. Charles Kittel, Knight, Ruderman et al., *Mechanics,* (New York: Berkeley Physics Course, Vol.1, Tata McGraw Hill Publications,2nd Edition, 2017).
4. H. K. Das, Dr. Rama Verma, *Mathematical Physics,* (New Delhi: S. Chand Publication,7th Edition,2014).
5. B. D. Gupta, *Mathematical Physics* (Mumbai: Vikas Publication House,4th Edition,2010).
6. D.S. Mathur, *Mechanics*, (New Delhi: S. Chand and Company Ltd.,2007).
7. K. F. Riley, M. P. Hobson, S.J. Bence, *Mathematical Methods for Physics and Engineering*, (Cambridge: Cambridge University Press,3rd Edition, 2006).

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Physics Minor

B.Sc. I Semester I

Course – II: BPT115: Electrostatics and Electronics (Credits:2)

Course Objectives: Students should be able to:

1. define gradient, divergence, curl and their physical significance.
2. understand the concept of electric charges and fields.
3. study electrostatic field, electrostatic theorem.
4. learn dielectric medium and three electric vectors.

Credits (Total Credits 2)	**Semester I** **BPT115: Electrostatics and Electronics**	**No. of hours per unit/ credits**
Unit - I	**Vector Analysis**	**(7)**
	Concept of scalar and vector fields: Del operator, Gradients, divergence, curl and their physical significance, problems.	
Unit - II	**Electric Charges and Fields**	**(7)**
	Electric charge, conductors and insulators, Basic properties of electric charges, concept of electric field, Electric potential as line Integral of electric field, Potential due to point charge, energy density in electrostatic field, problems.	
Unit - III	**Electrostatics and Dielectrics**	**(8)**
	Revision of Coulomb's Law, Vector form of Coulomb's Law, Concept of electric flux, Gauss's Law, Coulomb's Law from Gauss's Law, Gauss's Law Applications in- cylindrical, planer and spherical symmetry. Electric dipole and dipole moment, Polar and non- polar molecules, Polarization,	
Unit - IV	**Network Theorems and Transistors (BJT)**	**(8)**
	Review of Ohm's and Kirchhoff's laws, Thevenin's theorem, Norton's theorem, Application of simple networks with D.C. sources. PNP and NPN structure, Transistor characteristics in CB, CE and CC mode. Transistor as an amplifier in CE mode, Comparative study of CB, CE and CC configurations	

Course Outcomes: After completion of the course, students will be able to:

1. recall the concepts of scalar and vector fields, including the Del operator, gradients, divergence, and curl, and their physical significance, solve problems related to scalar and vector fields.

2. explain the basic properties of electric charges, conductors, insulators and explain the concept of an electric field and its relation to electric potential as a line integral of the electric field and apply the concepts of electric potential to calculate the potential due to a point charge and determine the energy density in an electrostatic field.
3. analyze and interpret Coulomb's Law in vector form, understand the concept of electric flux and apply Gauss's Law and Coulomb's Law to problems involving cylindrical, planar, and spherical symmetry, evaluate the polarization of electric dipoles and determine dipole moments.
4. create comparative studies of the PNP and NPN transistor structures and analyze their characteristics in CB, CE, and CC modes.

Reference Books:

1. D. C. Tayal, *Electricity and Magnetism* (Mumbai: Himalaya Publishing House, 4th Edition, 2016).
2. S. Mahajan and Chaudhary, *Electricity, Magnetism and Electromagnetic Theory* (Tata McGraw Hill, 2012).
3. David J. Griffith, *Introduction to Electrodynamics* (New Jersey: Prentice Hall Publisher,3rd Edition, 1999).
4. B. B. Laud, *Electromagnetics,* (New Delhi: New age international (P) Ltd.,2nd Edition, 1987).
5. J. Yarwood& J. H. Fewkes, *Electricity & Magnetism* (London: University Tutorial Press, 2nd Edition,1965).

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Physics Minor

B.Sc. I Semester I

Practical Course I: BPP116: Kinematics, Electrostatics and Electronics (Credit 2)

(Based on Theory Course BPT114: Kinematics and BPT115: Electrostatics and Electronics)

Course Objectives: Students should be able to:

1. develop fundamental experimental skills to perform an experiment and learn the experimental setup and procedure to perform given experiment.
2. develop skills in taking readings/observations obtained from these instruments and learn how to analyze and interpret experimental data, including error analysis, graphical representation.
3. perform calculations to obtain the experimental results and test whether the experimental results hold good with theoretical results.
4. acquire knowledge and practice safe laboratory procedures, including proper handling of equipment, electrical, and potential hazards.

Sr. No.	Titles of Experiments
1.	Measurements of length/diameter using Vernier caliper, Screw gauge and Travelling Microscope.
2.	To determine the Moment of Inertia of a Flywheel.
3.	To determine Moment of inertia of a disc using auxiliary annular ring.
4.	To determine ‘g’ by bar pendulum.
5.	To determine ‘g’ by Kater’s pendulum (fixed knife edges).
6.	To determine ‘g’ by Kater’s pendulum (movable knife edges).
7.	To study the motion of a spring and calculate (a) spring constant (b) value of ‘g’.
8.	To use a multimeter for measuring (a) Resistance, (b) AC and DC voltages, (c) DC current, and (d) checking electrical fuses.
9.	Input, output and transfer characteristics of common emitter (CE) transistor.
10.	To verify Kirchhoff ‘s laws.
11.	To verify Thevenin’s theorem.

12.	To verify Norton's theorem.
13.	To determine the moment of inertia of a body using bifilar suspension method (with parallel thread)
14.	To study the oscillations in a bifilar suspension arrangement.
15.	To determine order and degree of given differential equation

Course Outcomes: After completion of the course, **students will be able to:**

1. demonstrate basic experimental skills by setting up laboratory equipment/ experiment set up safely and efficiently, instruments calibration, carry out experimental procedure, data collection, analysis and report it in a written sheet manner.
2. exhibit practical skills in using various measuring instruments (vernier caliper, micrometer screw gauge, travelling microscope, multimeter, stopwatch etc.) and learn to select and use the appropriate instrument for a given measuring task.
3. develop skills in taking precise and accurate measurement to minimize errors.
4. display practical skills in measuring moment of inertia using various experimental setups such as flywheel, rotating annular disk and exhibit practical skills in measuring time period of oscillation for Katers and bar pendulum.

Reference Books:

1. Gupta S.L. and V. Kumar., *Practical physics*. (Meerut: Pragati Prakashan, 29th Edition.2017).
2. Chattopadhyay D. and P. C. Rakshit, *An advanced course in practical physics* (Calcutta: New Central Book,8th Edition,2013).
3. I. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal,11th Edition ,2011).
4. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011).
5. White, Marsh W. and Kenneth V. Manning, *Experimental college physics; a laboratory manual*, (New York: McGraw-Hill Publication,3rd Edition, 1954).
6. Worsnop B. L. and H. T. Flint., *Advanced practical physics for students*, (London: Methuen & Co., Ltd, 9th Edition, 1951).

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Physics Minor

B.Sc. I Semester II
Course – III: BPT124: Newtonian Mechanics (Credits:2)

Course Objectives: Students should be able to:

1. understand motion of particle in central force field, Kepler's laws and basic idea of GPS system.
2. learn about equation of continuity for flow of liquid.
3. study equivalence of shear strain to compression and extension strains.
4. know angle of contact and wettability of the liquid and experimental determination of surface tension and examples.

Credits (Total Credits 2)	Semester II BPT124: Newtonian Mechanics	No. of hours per unit/ credits
Unit - I	**Gravitation**	**(8)**
	Newton's Law of Gravitation, Motion of particle in central force field (motion in a plane, angular momentum is conserved, areal velocity is constant), Kepler's laws (statements only), Satellite in circular orbit and its applications, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS), problems.	
Unit - II	**Viscosity**	**(7)**
	Introduction, Newton's law of viscosity, streamline and turbulent flow, Critical velocity and Reynolds number, Equation of continuity, Energy possessed by liquid, Bernoulli's theorem and its applications to 1) Venturimeter, 2) Automizer. Factors affecting on viscosity, problems.	
Unit - III	**Mechanics of Elasticity**	**(8)**
	Introduction, Equivalence of shear strain to compression and extension strains, Relation between elastic constants, Poisson's ratio of rubber tube (Theory and experimental method) Hook's law and coefficient of elasticity, Young's modulus, Bulk modulus and Modulus of rigidity, Work done during longitudinal strain	
Unit - IV	**Surface Tension**	**(7)**
	Surface tension (definition), Angle of contact and wettability, Relation between surface tension, excess pressure and radius of curvature, Experimental determination of surface tension by Jaeger's method, Applications of surface tension, problems.	

Course Outcomes: After completion of the course, students will be able to:

1. recall Newton's Law of Gravitation and its application to the motion of particles in central force fields and explain the concept of satellites in circular orbits, including their applications and the idea of geosynchronous orbits.
2. apply Newton's law of viscosity to understand streamline and turbulent flow, critical velocity,

Reynolds number, equation of continuity, and the energy possessed by liquids and apply Bernoulli's theorem to analyze its applications, such as Venturimeters and atomizers. Solve related problems, analyze the factors affecting viscosity and solve problems related to viscosity.

3. evaluate Hook's law and the coefficient of elasticity, Young's modulus, bulk modulus, and modulus of rigidity. calculate the work done during longitudinal strain.
4. create solutions and explanations for surface tension, including its definition, angle of contact and wettability.

Reference Books:

1. S. G. Sterling and A. J. Woodal, *Physics* (London: Longman's & Green Co. Ltd.,2nd Edition,1963).
2. Walker, Halliday and Resnick, *Fundamentals of Physics* (Hoboken, New Jersey: John Wiley & Sons, 11th Edition, 2018).
3. D. S. Mathur, *Elements of Properties of Matter*, (New York: S. Chand & Company, 2010).
4. Brij Lal and N. Subrahmanyam, *Properties of Matter*, (New Delhi: Eurasia Publishing House Limited, 1993).
5. R. Murugeshan, Properties *of Matter*, (New Delhi: S Chand & Company, 2017).
6. J.C. Upadhyaya, *General Properties of Matter*, (Agra: Ram Prasad Publication,3rd Edition,2017).

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Physics Minor
B.Sc. I Semester II
Course – IV: BPT125: Electricity & Magnetism (Credits:2)

Course Objectives: Students should be able to:

1. study LCR series circuits and AC bridges.
2. know magnetostatics and magnetic properties of materials.
3. learn electromagnetic induction laws.
4. understand Maxwell's equations and electromagnetic wave propagation.

Credits (Total Credits 2)	Semester II BPT125: Electricity & Magnetism	No. of hours per unit/credits
Unit - I	**AC Circuits**	**(7)**
	Complex numbers and their application in solving AC series LCR circuit, Complex impedance, Reactance, Admittance and Susceptance, Resonance in LCR series circuit, Sharpness of resonance, (qualitative treatment only), Q-factor (definition only), AC Bridge- Owen's Bridge, problems.	
Unit - II	**Magnetism**	**(8)**
	Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current, Divergence and curl of magnetic field, Ampere's circuital law, properties of magnetic materials – Magnetic intensity, magnetic induction, permeability, susceptibility, brief introduction of dia, para, and ferro magnetic materials, problems.	
Unit - III	**Electromagnetic Induction**	**(7)**
	Faraday's laws of electromagnetic induction, Lenz's law, self and mutual induction, Ballistic Galvanometer, construction and working (Revision), expression for charge flowing through ballistic galvanometer, correction for damping in galvanometer, Constants Ballistic Galvanometer.	
Unit - IV	**Maxwell's Equations and Electromagnetic Wave Propagation**	**(8)**
	Equation of continuity of current, displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation, through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.	

Course Outcomes: After completion of the course, students will be able to:

1. recall the concepts of complex numbers and their application in solving AC series LCR

circuits, remember the definitions and properties of complex impedance, reactance, admittance, and susceptance and explain the qualitative treatment of Q-factor, AC bridges (specifically Owen's Bridge), and their applications.

2. apply Biot-Savart's law to solve problems involving the magnetic field generated by straight conductors, circular coils, and solenoids carrying current and apply Ampere's circuital law to analyze magnetic fields. Solve problems related to the properties of magnetic materials, such as magnetic intensity, magnetic induction, permeability, and susceptibility.
3. analyze the concepts of divergence and curl of the magnetic field and evaluate the expression for charge flowing through a ballistic galvanometer.
4. create explanations and interpretations of electromagnetic wave propagation through vacuum.

Reference Books:

1. D. C. Tayal, *Electricity and Magnetism* (Mumbai: Himalaya Publishing House, 4th Edition, 2016).
2. B. B. Laud, *Electromagnetics*, (New Delhi: New age international (P) Ltd.,2nd Edition, 1987).
3. David J. Griffith, *Introduction to Electrodynamics* (New Jersey: Prentice Hall Publisher,3rd Edition, 1999).
4. J. Yarwood & J. H. Fewkes, *Electricity & Magnetism* (London: University Tutorial Press, 2nd Edition,1965).
5. N. Subramanyam, Brij Lal, *Textbook of Electricity and Magnetism*, (Agra: Ratan Prakashan,1966).
6. Matthew N. O. Sadiku, *Elements of Electromagnetism* (New York: Oxford University Press, 7th Edition, 2018).
7. S. Mahajan and Chaudhary, *Electricity, Magnetism and Electromagnetic Theory* (Tata McGraw Hill,2012).

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Physics Minor

B.Sc. I Semester II

Practical Course II: BPP126: Properties of Matter and Electricity and Magnetism (Credits:2)
Course Objectives: Students should be able to:

1. develop fundamental experimental skills to perform an experiment and learn the experimental setup and procedure to perform a given experiment.
2. develop skills in taking readings/observations obtained from these instruments and learn how to analyze and interpret experimental data, including error analysis, graphical representation.
3. perform calculations to obtain the experimental results and test whether the experimental results hold good with theoretical results.
4. acquire knowledge and practice safe laboratory procedures, including proper handling of equipment, electrical, and potential hazards.

Sr. No.	Titles of Experiments
1.	Young's modulus of material of bar by vibration method.
2.	Young's modulus of material of bar by cantilever method.
3.	Young's modulus of material of rectangular bar by method of bending (using travelling microscope)
4.	Modulus of rigidity of material of wire by torsional oscillations.
5.	Y and n of wire by Searle's method.
6.	Poisson's ratio for rubber using rubber tube.
7.	Coefficient of viscosity by Poiseiulle's Method.
8.	Surface Tension by Jaegar's method.
9.	Surface tension and angle of contact by Quincke's method.
10.	To study a series LCR circuit and determine its (a) resonant frequency (b) quality factor Q.
11.	To study a parallel LCR circuit and determine its (a) anti-resonant frequency (b) quality factor Q.
12.	Frequency of AC mains by sonometer using magnetic wire.

13.	Frequency of AC mains by sonometer using non- magnetic wire.
14.	To compare capacitance using De Sauty's bridge.
15.	Impedance of series LCR circuit.
16.	To determine Constants of B.G.

Course Outcomes: After completion of the course, students will be able to:

1. demonstrate basic experimental skills by setting up laboratory equipment/ experiment set up safely and efficiently, instruments calibration, carry out experimental procedure, data collection, analysis and report it in a written sheet manner.
2. exhibit practical skills in using various measuring instruments (vernier caliper, micrometer screw gauge, travelling microscope, multimeter, stopwatch, measuring cylinder etc.) and learn to select and use the appropriate instrument for a given measuring task.
3. display practical skills in measuring elastic constants (Young's modulus, Modulus of rigidity, Poisson's ratio) using various experimental setups such as vibration of bar, Searle's method, rubber tube and torsional oscillations of disc.
4. exhibit practical skills in tunning vibrating length in sonometer and input frequency in series/ parallel LCR.

Reference Books:

1. Worsnop B. L. and H. T. Flint., *Advanced practical physics for students*, (London: Methuen & Co., Ltd, 9th Edition, 1951).
2. Gupta S.L. and V. Kumar., *Practical physics*. (Meerut: Pragati Prakashan,29thEdition.2017).
3. Chattopadhyay D. and P. C. Rakshit, *An advanced course in practical physics* (Calcutta: New Central Book,8th Edition,2013).
4. White, Marsh W. and Kenneth V. Manning, *Experimental college physics; a laboratory manual*, (New York: McGraw-Hill Publication,3rd Edition, 1954).
5. I. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal,11th Edition ,2011).
6. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011).

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Physics Open Elective

Open Elective (OE) Course Name: Sound and Music Art

Semester – I

OE Paper - I: BPT117: Fundamental of Music-I

Course Objectives: Students should be able to:

1. introduce students to the fundamental principles of acoustics and their application in the creation and perception of music.
2. explore the subjective and objective descriptions of music, emphasizing the interplay between personal experiences and scientific analysis.
3. familiarize students with the nature of sound, including its production, propagation, and interaction with the human auditory system.
4. examine the development of new vocabularies in music and their impact on expanding expressive possibilities and cross-cultural understanding.

Credits (Total Credits 2)	SEMESTER – I OE Paper – I BPT117: Fundamental of Music-I	No. of hours per unit
Unit - I	**The Art and Science of Music** Music of the Spheres, The Science of Acoustics, Subjective and Objective Descriptions, Sound, The Modern Metric System of Units, New Vocabularies	**(08)**
Unit – II	**Vibrating Systems** Periodic Motion, Frequency of Vibration, Time Graphs, Simple Harmonic Motion, Phase Angles, Damped Vibrations	**(08)**
Unit – III	**Transverse Waves** Classification of Waves, Traveling Transverse Waves, Wavelength, The Wave Speed, Standing Transverse Waves.	**(08)**
Unit - IV	**Longitudinal Waves** Traveling Longitudinal Waves, Standing Longitudinal Waves, Pressure Nodes and Antinodes	**(06)**

Course Outcomes: After completion of the course, students will be able to:

1. demonstrate a foundational understanding of the principles of acoustics and apply them to analyse and interpret musical phenomena.
2. differentiate between subjective and objective descriptions of music, and articulate the ways in which personal experiences shape musical perception.
3. explain the production, propagation, and perception of sound, and identify how these processes influence musical composition and performance.
4. utilize the modern metric system of units to measure and analyse various aspects of music,

such as frequency, amplitude, and timbre.

Reference Books:

1. White. H.E. and White D.E., *Physics of Music: the science of musical sound, (*USA, Dover Publications Inc., Reprint edition, 2014)
2. Ballou G, *Electroacoustic Devices: Microphones and Loudspeakers, (USA,* Routledge; 1st edition 2009)
3. Olson H.F, *Music, Physics and Engineering, (*USA, Dover Publications Inc., second edition, 2003)
4. Pierce J.R, *The Science of Musical Sound, (*W H Freeman & Co; Revised, Subsequent edition, 1992)

OE Paper - II: BPT118: Musical Instrument -I

Course Objectives: Students should be able to:

1. analyse the behaviour of strings, bar, membrane under various boundary conditions.
2. understand the unique characteristics and construction of each instrument.
3. demonstrate proficiency in playing techniques and articulations specific to wind instruments.
4. learn the fundamental playing techniques of various percussion instruments.

Credits (Total Credits 2)	SEMESTER – I OE Paper – II BPT118: Musical Instrument -I	No. of hours per unit
Unit - I	**Strings, Bars, Membrane and Plates** string, transverse vibration of bars: bar clamped at one end, bar free at both ends, stretched membranes, circular plates: circular clamped plate, circular free plate, circular plate supported at the centre, circular plate supported at the outside, longitudinal vibration of bars, open and closed pipes.	**(08)**
Unit – II	**String Instruments** 1. Plucked strings: a. Lyre,b. Lute, c. Harp,d. Zither,e. Guitar, f.Ukulele, g. Mandolin, h. Banjo, i. Harpsichord, 2. Bowed strings: a. Violin, b. Viola, c. Violoncello,d. Double bass (contrabass) 3. Struck strings: a. Piano, b. Dulcimer	**(08)**
Unit – III	**Wind Instruments** 1. Air reed: a. Whistle, b. Flue organ pipe, c. Recorder, d. Flageolet, e. Ocarina, h. Flute, g. Piccolo, h. Fife 2. Single mechanical reed: a. Free-reed organ, b. Heed organ pipe, c. Accordion, d. Harmonica, e. Clarinet and bass clarinet, f. Saxophone (soprano, alto, tenor, and bass), g. Bagpipe, 3. Double mechanical reed: a. Oboe, b. English horn, c. Oboe, d. amore, d. Bassoon and contra bassoon, e. Sarrusophone 4. Organ (combination mechanical reed and air reed instrument) 5. Lip reed: a. Bugle, b. Trumpet, c. Cornet, d. French horn, e. Trombone and bass trombone 6. Vocal-cord reed	**(08)**
Unit - IV	**Percussion Instruments** 1. Definite pitch: a. Tuning fork, b. Xylophone, c. Marimba,	**(06)**

	d. Chimes, e. Glockenspiel, f. Celesta, g. Kettledrums (timpani), h. Bell, i. Carillon 2. Indefinite pitch: a. Side or snare druir, b. Military drum, c. Bass drum, d. Gong, e. Triangle, f. Cymbals, g. Tambourine, h, Castanets	

Course Outcomes: After completion of the course, students will be able to:

1. analyse the vibrational characteristics of strings, bars, membranes, and plates.
2. demonstrate their understanding of the distinctive features of different string instruments.
3. develop a strong command of their chosen wind instruments.
4. demonstrate advanced proficiency and musicality in playing a variety of percussion instruments.

Reference Books:

1. White. H.E. and White D.E., *Physics of Music: the science of musical sound,* (USA, Dover Publications Inc., Reprint edition, 2014)
2. Rossing T.D., *The Science of String Instruments, (*Springer; 0th edition ,2010)
3. Ballou G, *Electroacoustic Devices: Microphones and Loudspeakers, (USA,* Routledge; 1st edition 2009)
4. Hall D.E., *Musical Acoustics, (*Cengage Learning; 2nd edition, 1990)

OE Practical Paper - I: BPP119: Sound and Musical Art Practical

Course Objectives: Students should be able to:

1. determine whether there is a significant correlation between the amplitude and time period of a simple pendulum, and to analyse the nature of this relationship.
2. examine how the initial amplitude (displacement) of a flat spring affects its time period of oscillation.
3. find whether there is an interaction between the initial amplitude and the attached mass in relation to the time period, and to analyse the nature of this interaction.
4. explore the combined effect of the initial amplitude (displacement) and the attached mass on the time period of a vibrating stripe.

Sr. No.	SEMESTER – I OE Practical Paper – I: BPP119: Sound and Music Art I List of Practical (15)	No. of hours per unit/credits
1	Simple pendulum: Dependence of initial amplitude on time period.	**(02)**
2	Simple pendulum: Dependence of weight of the bob amplitude on time period.	**(02)**
3	Flat Spring: Dependence of initial amplitude on time period.	**(02)**
4	Flat Spring: Dependence of mass on time period.	**(02)**
5	Vibrating Stripe: Dependence of length of stripe on time period.	**(02)**
6	Vibrating Stripe: Dependence of initial amplitude and attached mass on time period.	**(02)**
7	To determine the frequency of electrically maintain tuning fork using melse's experiment (Transverse Arrangement).	**(02)**
8	To determine the frequency of electrically maintain tuning fork using melse's experiment (Longitudinal Arrangement).	**(02)**
9	Determine the Logarithmic decrement of Damped oscillations.	**(02)**
10	Kundt's tube: To determine velocity of sound wave in air.	**(02)**
11	To determine velocity of sound by using resonance bottle.	**(02)**
12	Kundt's tube: To determine velocity of sound wave in material of the given rod.	**(02)**
13	To determine (i) the wavelength of sound produced in an air column, (ii) the velocity of sound in air at room temperature using a resonance column and a tuning.	**(02)**
14	To compare the frequencies of two tuning forks by finding the first and second resonance positions in a resonance tube.	**(02)**
15	To establish graphically the relation between the tension and length of the string of a sonometer resonating with a given tuning fork. Use the graph to determine the mass per unit	**(02)**

	length of the string.	

Course Outcomes: After completion of the course, students will be able to:

1. successful measurement and determination of the frequency of the electrically maintained tuning fork using Melsens' experiment.
2. analysis and interpretation of the experimental data obtained from the transverse arrangement of the tuning fork.
3. comparison of the measured frequency with the expected or known value to assess the accuracy of the experimental setup and methodology.
4. demonstrates the application of resonance phenomena and enables the estimation of the speed of sound in the specific conditions of the experiment.

Reference Books:

1. Wilsen J, Physics Laboratory Experiments, (United Kingdom, Brooks/Cole; 8th edition,2014)
2. Chattopadhyay. D and Rakshit P.R., *An Advanced Course in Practical Physics* (New S. L. Gupta and V. Kumar Central Book Agency, 10th edition ,2011)
3. Gupta S.L. and Kumar V. *Practical Physics*, (Pragati Prakashan, 27th Edition, 2010)
4. French A.P., *Vibrations and Waves*, (W.W. Norton & Company,2003)

Semester – II

OE Paper - III: BPT127: Fundamental of Music-II

Course Objectives: Students should be able to:

1. understand the fundamental properties and behaviour of sound waves in various mediums.
2. know the principles and applications of resonance in various systems and phenomena.
3. develop a comprehensive understanding of the principles of diffraction and interference as they relate to sound waves.
4. learn the principles and concepts of dynamical analogies and their applications in representing electrical, mechanical, and acoustical systems.

Credits (Total Credits 2)	SEMESTER – II OE Paper - III BPT127: Fundamental of Music-II	No. of hours per unit
Unit - I	**Sound Transmission** Sound Waves, The Speed of Sound, Reflection of Sound Waves, Refraction of Sound Waves, Acoustic Impedance, Impedance-matching.	**(8)**
Unit – II	**Resonance, Beats, and the Doppler Effect** Resonance, Cavity Resonators, Acoustical Filters, Resonance Damping, Beats, The Doppler Effect	**(8)**
Unit – III	**Diffraction and Interference** Diffraction of Sound Waves, Directionality of Loudspeakers, Public-Address Speaker Arrays, Acoustical Interference, Interference in Stereophonic Sound	**(7)**
Unit - IV	**Resonators and Radiators** Dynamical analogies: Definitions, Elements, Resistance, Inductance, Mass, inertance, Electrical Capacitance, Compliance, Acoustical Capacitance, Representation of Electrical, Mechanical, and Acoustical Elements	**(7)**

Course Outcomes: After completion of the course, students will be able to:

1. establish the ability to apply their understanding of sound wave properties
2. analyse resonance phenomena in various systems and applications.
3. analyse the impact of these phenomena on sound propagation and reproduction in loud speaker.
4. develop the ability to evaluate and compare the performance of different system configurations using dynamical analogies.

Reference Books:

1. Ballou G, *Electroacoustic Devices: Microphones and Loudspeakers, (USA,* Routledge; 1st edition 2009)
2. Gardonio P and Fahy F.J., Sound and Structural Vibration: Radiation, Transmission, and Response, (Academic Press; 2nd edition, 2007)
3. Kinsler L.E., *Fundamentals of Acoustics, (*Wiley; 4th edition, 2000)
4. Hall D.E., *Musical Acoustics, (*Cengage Learning; 2nd edition, 1990)

OE Paper - IV: BPT128: Musical Instrument -II

Course Objectives: Students should be able to:

1. understand the principles and operation of microphones, including their various types and characteristics.
2. analyse and compare different audio transducers
3. gain an appreciation for the importance of good acoustic design in architectural spaces
4. learn the principles and applications of acoustic devices such as Helmholtz resonators and acoustic filters in sound control and manipulation.

Credits (Total Credits 2)	SEMESTER – II OE Paper – IV BPT128: Musical Instrument -II	No. of hours per unit/credits
Unit - I	**Microphones:** Carbon Microphones, Crystal and Ceramic Microphones, Dynamic Microphones, Capacitor Microphone	**(08)**
Unit – II	**Loudspeaker:** Direct radiation moving coil loudspeaker, Horn Loudspeaker, Hearing aids, Earphone and Headphone	**(08)**
Unit – III	**Architectural Acoustic:** Reverberation of time, Sebine's formula, Need of good acoustic, Reverberation time in dead room, measurement of absorption coefficient.	**(08)**
Unit - IV	**Acoustic Devices and Measurements** Measurement of frequency, Helmholtz resonator, Acoustic filter, Measurement of velocity of sound, Measurement of intensity, determination of quality.	**(06)**

Course Outcomes: After completion of the course, students will be able to:

1. develop the skills to evaluate and compare different microphone types and their application.
2. improvement the skills to design and optimize audio systems
3. apply their knowledge of good acoustic design principles to propose solutions for optimizing sound quality in architectural spaces.
4. use the skills to conduct accurate and reliable acoustic measurements.

Reference Books:

1. Kinsler, L. E., Austin R. Frey, Alan B. Coppens, and James V. Sanders., Fundamentals *of Acoustics*., (Masood *Books UP, 2019)*
2. Ballou G, *Electroacoustic Devices: Microphones and Loudspeakers, (USA*, Routledge; 1st edition 2009)

3. Randall R.H., *An Introduction to Acoustics, (Dover* Publications Inc.; Illustrated edition, 2005)
4. Benade A.H., *Fundamental of Acoustic, (*Dover Publications Inc.; New edition,1990)

OE Practical Paper - II: BPP129: Sound and Music Art II

Course Objectives: Students should be able to:

1. investigate and analyse the frequency response of each loudspeaker component (woofer, squaker, and tweeter) and understand their respective frequency ranges and capabilities.
2. compare the sound dispersion patterns, efficiency, and distortion characteristics of different loudspeaker components and evaluate their suitability for various audio applications.
3. analyse the frequency response of the microphone and understand its sensitivity and range of operation.
4. understand how the directional characteristic of a microphone affects its sensitivity to sounds coming from different angles and evaluate its suitability for specific recording or sound reinforcement applications.

Credits (Total Credits 2)	**SEMESTER – II** **OE Practical Paper – II: BPP129: Sound and Music Art II** **List of Practical (15)**	**No. of hours per Practical**
1.	Propagation of sound in air: visualization with the aid of a styrofoamsphere pendulum.	**2**
2.	Sound and noise: analyse the acoustic signals of different sound sources with the "measure Acoustics" software	**2**
3.	Fundamental, overtone and tone colour: Examine the tone colour of different tones in this experiment. Analyse the frequency spectrum of your voice. Compare the tone colours of various different instruments. Simulate the sound of an instrument with the PC.	**2**
4.	Reflection and absorption of sound: Measure the sound transmission through solid walls made of paper or cardboard	**2**
5.	Reflection and absorption of sound: Measure the reflection of a sound pulse on a solid wall and investigate the influence of felt arrangements infront of the wall.	**2**
6.	Chladni figures: Determine the frequencies at which resonance occurs and drive the plate specifically at these frequencies.	**2**
7.	Resonance: examine the frequencies at which a glass tube and a frame drum reach a resonant state.	
8.	Coupled pendula with measure Dynamics: Determination and adjustment of the characteristic frequency of the uncoupled pendulum.	**2**
9.	Coupled pendula with measure Dynamics: Graphical representation of the oscillation of the two pendula as a function of time and determination of the oscillation frequency compared to the theoretical oscillation frequency for	**2**

	A) the "in phase" oscillation. B) the "antiphase" oscillation. C) the beat case.	
10.	Interference and diffraction of water waves with the Ripple Tank: Use the comb to generate two circular waves and observe the resulting interference. Increase the number of interfering circular waves up to ten by using all teeth of the comb to demonstrate Huygens' Principle	**2**
11.	Interference and diffraction of water waves with the Ripple Tank: Generate plane water waves and use a barrier to demonstrate diffraction at an edge. Then, form a slit and observe diffraction behind the slit. Repeat this experiment for a double-slit.	**2**
12.	Study of interference with two coherent sources of sound and determination of velocity of sound in air.	**2**
13.	Study of the characteristic of loudspeaker (woofer, squaker and tweeter)	**2**
14.	Study of characteristic of a microphone	**2**
15.	Study of directional characteristic of microphone	**2**

Course Outcomes: After completion of the course, students will be able to:

1. comparing the sound dispersion patterns, efficiency, and distortion characteristics of different loudspeaker components to evaluate their suitability for specific audio applications.
2. assessing the directional characteristic (polar pattern) of the microphone to evaluate its suitability for specific recording or sound reinforcement applications.
3. compare the microphone's performance to its specified specifications and identifying any deviations or anomalies.
4. measuring the interference patterns and using them to determine the velocity of sound in air through the application of relevant principles and calculations.

Reference Books:

1. Wilsen J, Physics Laboratory Experiments, (United Kingdom, Brooks/Cole; 8th edition,2014)
2. Chattopadhyay. D and Rakshit P.R., *An Advanced Course in Practical Physics* (New S. L. Gupta and V. Kumar Central Book Agency, 10th edition ,2011)
3. Gupta S.L. and Kumar V. *Practical Physics*, (Pragati Prakashan, 27th Edition, 2010)
4. French A.P., *Vibrations and Waves*, (W.W. Norton & Company,2003)

Physics Indian Knowledge System (IKS)

B.Sc. I Semester I
BPTIKS 1: Indian Knowledge System

Credit 2

Course Name: Indian Astronomy and Metallurgy

Course Objective: Students should be able to:

1. **understand motion of equinoxes and solstices.**
2. **describe Indian calendar system.**
3. **list astronomical endeavours of Indian scholars.**
4. **compare specimens of metal workmanship preserved and found.**

Unit No.		No. of Lectures
1	**Indian Astronomy I** Ancient records of the observation of the motion of celestial bodies in the Vedic corpus. Sun, Moon, Nakshatra & Graha, Astronomy as the science of determination of time, place and direction by observing the motion of the celestial bodies. The motion of the Sun and Moon. Motion of equinoxes and solstices. Elements of Indian calendar systems as followed in different regions of India.	8
2	**Indian Astronomy II** Important texts of Indian Astronomy. Basic ideas of the planetary model of Aryabhata and its revision by Nilakantha, Large corpus of inscriptions recording observation of eclipses. Astronomical instruments, How Indian astronomy continued to flourish in the 18/19th centuries. Astronomical endeavours of Jaisingh, Sankaravarman, Chandrasekhara Samanta.	8
3	**Indian Metallurgy I** Vedic references to metals and metal working. Mining and manufacture in India of Zinc, Iron, Copper, Gold, etc., from ancient times, Indian texts which refer to metallurgy. Important specimens of metal workmanship preserved/found in different parts of India.	7
4	**Indian Metallurgy II** The significance and wide prevalence of ironsmith and other metal workers in the pre-modern era., European observers on the high quality and quantity of Indian iron and steel in the 18/19th centuries.	7

Course Outcomes: Students will be able to

1. **describe fundamental concepts of Indian astronomy.**
2. **outline development of Indian astronomy in ancient times.**
3. **asses the ancient metallurgical specimens.**
4. **explain Vedic references to metals and metal workmanship.**

Suggested Readings:

1. History of Astronomy: A Handbook, Edited by K. Ramasubramanian, Aniket Sule and Mayank Vahia, Sand HI, IIT Bombay, and T.I.F.R. Mumbai, 2016.
2. Tantrasaṅgraha of Nīlakaṇṭha Somayājī, Translation and Notes, K. Ramasubramanian and M.S. Sriram, Hindustan Book Agency, New Delhi 2011.
3. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., A Concise History of Science in India, 2nd Ed., Universities Press, Hyderabad, 2010.
4. S. N. Sen and K. S. Shukla, History of Astronomy in India, 2nd Ed., INSA, Delhi, 2001.
5. S. Balachandra Rao, Indian Astronomy An Introduction, Universities Press, Hyderabad, 2000

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Physics Skill Enhancement Course (SEC)

B.Sc. I Semester II

BPTSEC 1: Optical Spectrometer and CRO (Credits: 02)

Course Objectives: Students should be able to:

1. learn panel control knobs of CRO and testing the components.
2. study internal hardware of CRO with block diagram.
3. understand various performing parameters of CRO.
4. know various leveling to focus for parallel light.
5. observe spectrum due to refraction of light through prism.

Credits (Total Credits 2)	Semester-I	No. of hours per unit/credits
Unit - I	**Spectrometer**	**(7)**
	Introduction, Different parts of the spectrometer-Collimator, prism table, Telescope, Circular scale, Adjustment of spectrometer (Telescope leveling, Collimator leveling, Prism table leveling, Optical leveling of prism, focusing for parallel rays by Schuster's method), Maintenance.	
Unit - II	**CRO**	**(8)**
	Introduction, Principle of operation, Block diagram of CRO, Different measurement techniques such as measurement of peak-to-peak voltage, Measurement of D.C. voltage, Measurement of frequency, Testing of electronic components.	

Course Outcomes: After completion of the course, **Student should be able to:**

1. use spectrometer to analyze spectra.
2. demonstrate refraction of light by prism.
3. test electronic components using CRO
4. develop ability to take different measurements using CRO.

Reference Books:

1. V. K. Mehta, *Principles of Electronics*, (New Delhi: S. Chand and Co.,2001).
2. Bagde and Singh, *Elements of Electronic*, (New Delhi: S. Chand and Co.,2002).

Course Objectives: Students will be able to:

1. develop fundamental experimental skills to perform an experiment.
2. learn the experimental setup and procedure to perform given experiment.
3. develop skills to interpret waveforms, measure voltage levels, measure characteristics such as amplitude, period, and frequency.
4. learn to operate spectrometer and its calibration for the precise and accurate measurements.

Practical:

Sr. No.	Titles of Experiments
1.	Determination of least count of spectrometer and its calibration.
2.	Spectrometer focusing for parallel rays by Schuster's method.
3.	Calibration of spectrometer to measure unknown wavelength.
4.	Measurement of angle of prism using spectrometer.
5.	Mounting of grating normally to incident light on spectrometer.
6.	Setting an oscilloscope to display sinusoidal waveform.
7.	Determination of time period and frequency using CRO.
8.	To determine unknown frequency using CRO (Lissajous Figures).
9.	Testing and identification of electronic components.

Course Outcomes: After completion of the course, **Student should be able to:**

1. demonstrate basic experimental skills by setting up laboratory equipment/ experiment set up safely and efficiently, instruments calibration, carry out experimental procedure, data collection, analysis and report it in a written sheet manner.
2. exhibit practical skills in using CRO and spectrometer for a given measuring task.
3. demonstrate skills for measuring voltage levels, amplitude, period, frequency and also to test the electronic components.
4. analyze the different spectral components produced by the prism using spectrometer.

Reference Books:

1. Worsnop, B. L., and H. T. Flint., *Advanced practical physics for students*, (London: Methuen & Co., Ltd,1962)
2. I. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal,11th Edition, 2011).
3. Gupta, S. L., and V. Kumar, *Practical physics*. (Meerut: Pragati Prakashan, 27th Edition. 1973)

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Physics Value Education Course (VEC)

B.Sc. I Semester II

BPTVEC 1: Understanding India (Credits: 02)

Course Objective: - Students will be able to

1. Develop a deep understanding of the ethical principles and values of physics
2. Engage in discussions and case studies related to current ethical issues.
3. Identify gender equities and disparities in the field of physics.
4. Explore the historical roots of physics in different cultures.

Unit No.		No. of Lectures
1	**Universal Human Values** Ancient civilizations and the emergence of universal values: truth, harmony, compassion, justice, Principles of justice and fairness, understanding compassion and empathy, Defining integrity and honesty, The relationship between universal values and human rights	8
2	**Ethical conduct and Ethical reasoning in physics** Ethical theories, virtue ethics, Application of ethical frameworks in physics, Scientific misconduct and fraud, Plagiarism and data fabrication, Peer review and ethical publication	8
3	**Importance of gender equity in physics** Overview of gender equity in physics, defining gender equity and its importance, historical context of gender disparities in physics, contribution of women scientist in development of physics, Strategies for promoting gender equity in the field	7
4	**Importance of culture and heritage in the development of physics** Historical development of physics in different cultures, Contributions of diverse cultures to physics, A cultural history of physics, Scientific and technological development in Indian culture	7

Course Outcomes: Students should be able to

1. discuss importance of ethical conduct in research
2. define and describe the concept of universal human values and recognize their importance in human interactions.
3. describe strategies for creating a gender-inclusive scientific community.
4. differentiate how physics developed in various cultural and historical context.

Suggested Readings:

1. Shamoo, Adil & Resnik, David. (2007). Responsible Conduct of Research. Journal of biomedical optics. 12.
2. Heisenberg, Werner. Physics and Philosophy: The Revolution in Modern Science. New York: Harper & Row, 1958.
3. Hickman, Larry A. Cultural Perspectives on Science, Technology, and Ethics. Charlottesville: University of Virginia Press, 1994.
4. National Academy of Sciences. On Being a Scientist: A Guide to Responsible Conduct in Research. Washington, DC: National Academy Press, 1995.

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