Karmaveer Bhaurao Patil University, Satara

Syllabus for

B. Sc. I Physics

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2024-2025

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, 2024.

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

4. Pattern: Semester examination.

5. Medium of Instruction: English

6. Structure of Course:

Physics

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	Physics 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 Properties of matter	BPT121	5	2	Physics Practical Course –II (BPP123)	4	2
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)

Physics 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)

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

Physics

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

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

B.Sc. I Semester I

Physics 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

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

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

B.Sc. I Semester I

Physics 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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