Rayat Shikshan Sanstha's

Sadguru Gadge Maharaj College, Karad

(Autonomous College)

Revised Syllabus As per Maharashtra Gov. GR. dated-20 April, 2023 for Implementing NEP-2020

B.Sc. II (Physics Major) w.e.f. June 2024 (A. Y: 2024-2025)

❖ Preamble:

This syllabus of the subject as Major Physics for B. Sc. – II is framed to give sound knowledge with understanding of Physics to undergraduate students at second year of three years of B.Sc. degree course. The main aim of the syllabus is to create interest in Physics subject and to encourage the students for their 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 shape good and informed citizens from the students entering into the program.
2. To create a skilled work force to match the requirements of the society.
3. To nurture academicians with focus and commitment to their subject.
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.

❖ Program Outcomes:

1. The student will be eligible to continue higher studies in his subject.
2. The student will be eligible to pursue higher studies abroad.
3. The student will graduate with proficiency in the subject.
4. The student will be eligible to appear for the examinations for jobs in government.
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. It is expected to inspire and boost interest of the students in physics.
2. The students are expected to understand the fundamentals, principles, concepts and recent developments in the physics.
3. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in physics.
4. To develop the power of appreciations, achievements in science & role in nature.
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. Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
2. Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
3. Identify their area of interest in academic, research and development.
4. 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, clarityof thought, expression, and systematic approach.

❖ Structure of Course:

1. **Name of Course:** B.Sc.
2. **Title:** Physics
3. **Year of Implementation:** The syllabus will be implemented from June, 2024.
4. **Duration:** The course shall be a full time.
5. **Pattern:** Semester examination.
6. **Medium of Instruction:** English

B. Sc.-II Semester-III

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1.	HEAT AND THERMAL PHYSICS	MJ-BPT23-301	04	02	Physics Practical–III (MJ-BPP23-303)	08	04
2.	WAVES, OSCILLATIONS AND SOUND	MJ-BPT23-302		02			

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

B. Sc. -II Semester-IV

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1.	THERMAL PHYSICS AND STATISTICAL MECHANICS	MJ-BPT23-401	04	02	Physics Practical–IV (MJ-BPP23-403)	08	04
2.	OPTICS AND LASERS	MJ-BPT23-402		02			

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

Evaluation Structure: B. Sc. II Semester-III & IV (Physics)

SEM	Theory			Practical				Total
	Paper No. &Code	SEE	CCE	Paper Code	Exam	Journal	Day to Day Performance	
III	**Paper V: MJ-BPT23-301**	40	10	**Practical–III (MJ-BPP23-303)**	40	05	05	**50**
	Paper VI: MJ-BPT23-302	40	10					
	Total	**80**	**20**					**150**
IV	**Paper V: MJ-BPT23-401**	40	10	**Practical–IV (MJ-BPP23-403)**	40	05	05	**50**
	Paper VI: MJ-BPT23-402	40	10					
	Total	**80**	**20**					**150**
Total (Sem. III + IV)		**160**	**40**		**80**	**10**	**10**	**300**

Titles of Courses for B.Sc. II

B. Sc. II (Semester-III)

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

Paper –V: MJ-BPT23-301: HEAT AND THERMAL PHYSICS
Paper –VI: MJ-BPT23-302: WAVES, OSCILLATIONS AND SOUND

Physics Practical –III
Practical: 60 lectures: 60 hours (Total)

Practical: MJ-BPP23-303: HEAT, THERMAL PHYSICS, WAVES, OSCILLATIONS AND SOUND

B. Sc. II (Semester-IV)

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

Paper – VII: MJ-BPT23-401: THERMAL PHYSICS AND STATISTICAL MECHANICS
Paper VIII: MJ-BPT23-402: OPTICS AND LASERS

Physics Practical - IV
Practical: 60 lectures: 60 hours (Total)

Practical: MJ-BPP23-403: THERMAL PHYSICS, STATISTICAL MECHANICS, OPTICS

SYLLABUS

B.Sc. II: Semester-III

Paper V: MJ-BPT23-301: HEAT AND THERMAL PHYSICS (Credits: 02)

Learning Objectives: Students will be able to-

1. To understand kinetic interpretation of temperature, Andrew's Expt. and different types of thermometers.
2. To understand kinetic theory of gases and concept of Transport phenomena.
3. To understand thermo-dynamical state, thermodynamic equilibrium, various thermodynamic processes and first law of thermodynamics.
4. To understand second and third laws of thermodynamics, Carnot's theorem, working of Carnot's engine and concept of entropy.

Credits (2)	Semester III : MJ-BPT23-301: HEAT AND THERMAL PHYSICS	No. of hours per unit/credit
Unit I	**Ideal, Real gas and Thermometry** Kinetic Interpretation of temperature, Andrew's experiment and curve, critical constants, Relation between critical constants and Van der waal's constants, Reduced equation of state. Principle of thermometry, types of thermometers, Scales of temperature (Celsius, Kelvin, Fahrenheit and Rankine), Mercury thermometer, thermoelectric thermometer, Platinum resistance thermometer, Thermistor.	**07**
Unit II	**Kinetic Theory of gases and Transport Phenomena** Review, Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path, Transport phenomena-Transport of momentum(viscosity), Transport of thermal energy (conduction), Transport of mass (diffusion), Degrees of freedom, Law of equipartition of energy (No derivation) and its application to specific heat of gases (mono and diatomic).	**08**
Unit III	**Thermodynamics-I** Thermodynamically system, Thermodynamic variables, Thermodynamic state, equation of state, Thermodynamic equilibrium, Zeroth law of thermodynamics, Internal energy, First law of thermodynamics, Conversion of heat into work, Various thermodynamic processes (Isothermal, Adiabatic, Isobaric, Isochoric), Reversible and irreversible processes, Work done in Isothermal and adiabatic processes, Application of first law (Isothermal, Adiabatic, Isobaric, Isochoric), Relation between Cp and Cv.	**07**
Unit IV	**Thermodynamics-II** Second law of thermodynamics (Explanation and different statements), Carnot's ideal heat engine, Carnot cycle (working and efficiency), Carnot's theorem, Entropy (concept and significance), Entropy changes in reversible and irreversible processes, Entropy - Temperature diagram, Third law of thermodynamics	**08**

❖ REFERENCE BOOKS:

1. Heat and Thermodynamics - Brijlal & N.Subramanyam, S. Chand Pub. (Unit No. I, II, III, IV)
2. Fundamentals of heat - D. S. Mathur, S. Chand and Sons publisher (Unit No. I)
3. Text book of heat - J.B. Rajam, S.Chand and company Ltd (Unit. No. I, IV)
4. A treatise on Heat - Meghnad Saha and B.N. Srivastava, Indian Press (unit II)
5. Heat & Thermodynamics, M.W. Zemansky & R.Dittman, Mc Graw Hill (Unit No. I, II, III, IV)
6. Heat Thermodynamics and Statistical physics by - J.P. Agrawal and Satya Prakash, Pragati Prakashan (Unit III, IV)

❖ Learning Outcomes:

After completion of the course, student should be able to:

1. Students will be able to explain kinetic interpretation of temperature, Andrew's Expt., Curve and different types of thermometers.
2. Students will be able to understand kinetic theory of gases and concept of Transport phenomena.
3. Students will be able to explain thermo-dynamical state, thermodynamic equilibrium, various thermodynamic processes and first law of thermodynamics.
4. Students will be able to explain second and third laws of thermodynamics, Carnot's theorem, working of Carnot's engine, of Carnot's engine and concept of entropy.

B.Sc. II: Semester-III

Paper-VI MJ-BPT23-302: Waves, Oscillations and Sound (Credits: 02)

Learning Objectives:

1. To understand SHM & its solution, superposition principle and Lissajous figures and their uses.
2. To understand travelling and standing waves on a string, plane waves and spherical waves.
3. To define transducers and their types, to understand concept of acoustics of buildings, Sabine'sexperimental work and reverberation time.
4. To understand the Piezo-electric effect, detection of Ultrasonic waves and applications ofultrasonic waves.

Credits (2)	SEM - III : MJ-BPT23-302: WAVES, OSCILLATIONS AND SOUND	No. of hours per unit/credit
Unit- I	**Oscillations** Simple harmonic motion, Differential equation of SHM and its solutions, Kinetic and potential energy, Kater's pendulum, Damped oscillations, **Superposition of two collinear harmonic Oscillations**- Linearity and superposition principle: 1) Oscillations having equal frequencies along the line and 2) Oscillations having different frequencies along the same straight line (beats), Lissajous figures with equal and unequal frequencies and their uses	**07**
Unit-II	**Wave motion** Transverse waves on a string, travelling and standing waves on a string, normal modes of a string, Laws of vibration, Energy density and energy transport of transverse wave along a stretched string, group velocity, phase velocity, plane waves and relation between them, spherical waves, intensity of a wave.	**08**
Unit-III	**Sound and Acoustics of Buildings** Acoustics Transducers (Qualitative), pressure microphone, moving coil loud speaker, Digital audio system. **Acoustics of Buildings:** Reverberation time, factors affecting acoustics of buildings, Sabine's experimental work and formula, optimum reverberation time, Requirements of good acoustics.	**07**

Unit-IV	**Ultrasonic Waves** Piezo-electric effect, Magnetostriction effect, production of ultrasonic waves- magnetostriction oscillator, Piezo-electric oscillator, detection of ultrasonic waves- Kundt's tube, sensitive flame method, thermal detector, quartz crystal method, Magnetostrictive method, application of ultrasonic waves- medical field, SONAR, chemical field, cracks in metals, formation of alloy, sterilization, enemy of lower life.	**08**

Learning Outcomes:

1. Students will be able to understand the SHM and its solution, superposition principle, Lissajousfigures and their uses.
2. Students will be able to understand travelling and standing waves on a string, plane waves andspherical waves.
3. Students will be able to define transducers and their types, concept of acoustic of buildings,Sabine's experimental work and reverberation time.
4. Students will be able to understand the Piezo-electric effect, detection of Ultrasonic waves andtheir application.

REFERENCE BOOKS:

1. Physics volume I - Halliday and Resnick.
2. A text book of Sound- Subrahmanyam & Brijlal (Unit No. I, III, IV)
3. Properties of matter - D.S.Mathur.
4. Sound - Khanna and Bedi.
5. A Treatise on oscillations, waves and acoustics- D. chattopadhyay, Books and allied PVT Ltd.(Unit No. I, II, III, IV)
6. Principles of physics (10^{th} edition) – J. Walker, David Halliday and Robert Resnick. Oscillations and waves- Satya Prakash- Pragati Prakas

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B.Sc. II: Semester-III

Practical-III: MJ-BPP23-303: HEAT, THERMAL PHYSICS, WAVES, OSCILLATIONS AND SOUND (Credits: 04)

Practical: 60 lectures: 60 hours (Total)

Learning Objectives:

1. To learn measuring skills in practical.
2. To determine period of oscillations, frequency of a wave and acceleration due to gravity.
3. To understand the length of vibrating air columns, Resonance & can measure velocity of sound.
4. To determine thermal conductivity, temperature coefficient of resistance, thermo-emf and specificheat.

Experiments:

Group - A

1. To determine Coefficient of Thermal Conductivity of a bad conductor by Lees method.
2. To determine Coefficient of Thermal Conductivity of copper by Searle's apparatus.

3. To study the variation of thermo-emf with temperature across two junctions of a thermocouple.
4. To determine temperature coefficient of resistance by platinum resistance thermometer.
5. To determine temperature coefficient of resistance of a given coil by P. O. box.
6. To calibrate Resistance Temperature Device (RTD) using null method / off-balance bridge.
7. To determine the thermal conductivity of a metal rod by Forbe's method.
8. To determine Coefficient of Thermal Conductivity of glass in the form of a tube.
9. To determine the specific heat of a liquid (turpentine oil) by law of cooling.
10. To determine the ratio of specific heats of air by Clement and Desorme's method.
11. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

Group - B

1. To investigate the motion of coupled oscillations.
2. To determine acceleration due to gravity by using Bifilar Pendulum.
3. To study Lissajous figures.
4. Measurement of velocity of sound by Kundt's tube method.
5. Measurement of Velocity of Sound by CRO.
6. Measurement of Velocity of Sound by Resonating Bottle.
7. Measurement of frequency of tuning fork by Melde's Experiment.
8. Measurement of log decrement by Exponential Decay.
9. Measurement of Velocity of Sound by Sonometer.
10. To determine the frequency of Crystal oscillator.
11. To determine the frequency of A.C. mains Stroboscope.

Learning Outcomes:

1. Students will be able to learn measuring skills in practical.
2. Students will be able to measure period of oscillations, frequency of a wave and acceleration dueto gravity.
3. Students will be able to measure the length of vibrating air columns and velocity of sound.
4. Students will be able to determine thermal conductivity, temperature coefficient of resistance,thermo-emf and specific heat.

REFERENCE BOOKS:

1. Advanced Practical Physics for Students: B. L. Worsnop and H. T. Flint, 1971 Asia Publ. House.
2. Practical Physics: S. L. Gupta and V. Kumar, Pragati Prakashan, 27th Edition, 2010.
3. An Advanced course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, 7th edition, 2005 New Central Book Agency Pvt. Ltd.
4. Experimental College Physics: White and manning, McGRAW-HILL 3rd edition.
5. B.Sc. Practical Physics - H. Singh and P.S. Hemne, S. Chand Publication
6. Practical Physics – Arora, S. Chand Publication

B.Sc. II: Semester-IV

Paper VII: MJ-BPT23-401: THERMAL PHYSICS AND STATISTICAL MECHANICS (Credits: 02)

Learning Objectives:

1. To understand various thermo dynamical functions, Maxwell's Relations, Joule – Thompson effectand Clausius- Claperyon Equation.
2. To understand Black body radiation, Planck's law, Rayleigh-Jean's law, Stefan Boltzmann law andWien's displacement law.
3. To understand Phase Space, Macrostate, Microstate, Ensembles, Priori Probability.
4. To understand thermodynamic Probability and Maxwell Boltzmann Distribution law.

Credits (2)	SEM- IV: MJ-BPT23-401: THERMAL PHYSICS AND STATISTICAL MECHANICS	No. of hours per unit/credit
Unit- I	**Thermodynamic Potential** Enthalpy, Gibbs function, Helmholtz and Internal Energy function, Maxwell's Relations and applications, Joule –Thompson effect, Clausius- Clapeyron Equation, Expressions for (Cp-Cv) and Cp/Cv, TDS equation.	**07**
Unit-II	**Theory of Radiation** Black body radiation, Spectral Distribution, Experimental Study of black body radiation Spectrum, Concept of energy density, radiation Pressure, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jean's law, Stefan Boltzmann law and Wien's displacement law from Planck's law	**08**
Unit-III	**Basics of Statistical Mechanics** Phase Space, Macrostate and Microstate, Ensembles, Accessible Microstate, Priori Probability, Thermodynamic probability.	**07**
Unit-IV	**Classical Statistical Mechanics** Fundamental postulates of statistical mechanics, Probability distribution, Maxwell Boltzmann Distribution law (Evaluation of constants α and β), Entropy and Thermodynamic Probability, Maxwell distribution of molecular speed.	**08**

Learning Outcomes:

Students will be able to

1. Explain thermodynamical functions, Maxwell's relations, Joule-Thompson effect and Clausius-Claperyon Equation
2. Explain Black body radiation, Planck's law, Rayleigh-Jean's law, Stefan Boltzmann law andWien's displacement law.
3. Explain Phase Space, macrostate, microstate, Ensembles, Priori and thermodynamic Probability.
4. Students will be able to understand Maxwell Boltzmann Distribution law.

Reference Books:

1. Heat, Thermodynamics and Statistical Physics *by S.S. Singhal, J.P. Agrawal, Satya PrakashPragati Prakashan, Meerut.* (Unit No. I, II, III, IV)
2. Heat and Thermodynamics by *Brijlal, N. Subramanyam S. Chand Pub.* (Unit No. I, II, III, IV)
3. Heat and Thermodynamics *M.W. Zermansky, R.H. Dittman, McGraw Hill Education Pvt Ltd.Chennai.(8th Edition)* (Unit No. I, IV)

4. Heat & Thermodynamics *B.S. Agrawal Keda Math Ram Nath Publisher, Meerut* (Unit No. I, II)
5. Heat & Thermodynamics by *Rajam and C.L. Arora.* (Unit No. I, II, III, IV)
6. A Treatise on Heat *M.N. Saha & B.N. Srivastava Indian Press Pvt. Ltd. Allahabad.* (Unit No.I)
7. Thermodynamics, *K.T. and Statistical Thermodynamics- Sears, Salinger , Narosa Publishinghouse.* (Unit No. I, III, IV)
8. Statistical &Thermal Physics- *S. Lokanathan and R.S. Gambhir*. *PHI publication House.*(Unit No. I,III,IV)

B.Sc. II: Semester-IV

Paper VIII: MJ-BPT23-402: OPTICS AND LASERS (Credits: 02)

Learning Objectives:

1. To understand the concept of cardinal points, working of Searle's goniometer, optical magnifications, relations between them and the idea of resolution, difference between resolvingand magnifying powers.
2. To understand division of amplitude, division of wavefront, formation of interference in variousfilms, Fresnel diffraction, Fraunhofer diffraction, concept of half period zones, zone plates and difference between zone plate and a convex lens.
3. To understand structure and types of optical fibers, principle and working of fiber optic communication system, fundamental phenomenon in laser, Einstein's coefficients, constructionand working of some lasers and idea of Holography.
4. To understand double refraction, polarization, optical rotation, principle, construction andworking of polarimeter.

Credits (2)	SEM- IV: MJ-BPT23-402: OPTICS AND LASERS	No. of hours per unit/credit
Unit - I	**Geometrical optics** Definition and properties of cardinal points of a lens system, coincidence of principal points and nodal points, Image formation by cardinal points, Newton's formula, relation between focal lengths of an optical system, axial, lateral and angular magnifications; Abbe's sine condition.	**07**
Unit -II	**Polarization of light:** Polarization by double refraction, Huygens explanation of double refraction through uniaxial crystals, optical rotation- laws of rotation of plane of polarization, polarimeter. **Resolving power:** Resolving power, Rayleigh's criterion for the limit of resolution, comparison between magnifying power and resolving power, resolving power of plane diffraction grating, resolving power of prism.	**09**
Unit -III	**Interference of light:** Principle of superposition of waves, Division of amplitude, division of wavefront, Newton's rings, its applications for determination of wavelength of light and R.I. of liquid. **Diffraction of light:** Types of diffraction, Fraunhofer diffraction: plane diffraction grating, theory of plane diffraction grating, its application to determine wavelength of monochromatic light, Fresnel diffraction: half period zones, zone plate,	**08**

Unit -IV	**Laser system** Absorption, spontaneous and stimulated emission, Einstein coefficients (only definitions), population inversion, optical and electrical pumping, properties of lasers, Ruby laser, Helium-Neon laser, uses of laser, idea of holography (qualitative treatment only).	**06**

Learning Outcomes:

1. Students will be able to understand cardinal points, working of Searle's goniometer, optical magnifications, relations between them, the idea of resolution, difference between resolving andmagnifying powers.
2. Students will be able to understand division of amplitude, division of wavefront, formation of interference in various films, Fresnel diffraction, Fraunhofer diffraction, half period zones, zoneplates and difference between zone plate and a convex lens.
3. Students will be able to understand structure and types of optical fibers, principle and working of fiber optic communication system, fundamental phenomenon in laser, Einstein's coefficients, construction and working of some lasers and idea of Holography.
4. Students will be able to understand double refraction, polarization, optical rotation, principle,construction and working of polarimeter.

REFERENCE BOOKS:

1. Geometrical & physical optics by D.S. Mathur (Unit No.I, II)
2. A text book of optics (new edition) by Subrahmanyam & Brijlal (Unit No.I, II)
3. Optics (second edition) by Ajay Ghatak
4. Laser and non-linear optics by B.B. Laud (Unit No. IV)
5. Optics – Singh, Agarwal Pragati Prakashan (Unit No. I, II, III)
6. Principles of Optics – B. K. Mathur (Unit No. I, II, III)
7. Lasers – Thayagarajan and Ghatak
8. Lasers and Nonlinear Optics – B. B. Laud (Unit No. IV)
9. Optics and Spectroscopy – R. Murugeshan and K. Sivaprasath (Unit No. IV)

B.Sc. II: Semester-III

Practical-IV: MJ-BPP23-403: Thermal Physics, Statistical Mechanics, Optics and Lasers (Credits: 04)

Practical: 60 lectures: 60 hours (Total)

Learning Objectives:

1. To develop practical skills.
2. To determine mechanical equivalent of heat, specific heat of solids and liquids.
3. To study the laws of probability distribution, black body radiation.
4. To determine dispersive power, refractive index, resolving power and wavelengths of different sourcesby various methods.
5. To study the cardinal points of an optical system.

Experiments:

Group - A

1. To determine Mechanical Equivalent of Heat J by Callendar and Barne's constant flow method.
2. To determine specific heat capacity of liquid by Callendar and Barne's constant flow method.
3. To determine Stefan's Constant.
4. Measurement of Planck's constant using black body radiation.
5. To verify the laws of Probability Distribution and to verify laws of probability of throwing one coin, two coins and then coins (or more).
6. The study of Statistical Distribution from the given data and to find most probable, average andrms values.
7. Specific Heat Capacity of Graphite and its variation with temperature.
8. To determine the specific heat of a liquid (turpentine oil) by law of cooling.
9. To determine the ratio of specific heat of air by Kundt's tube.
10. To determine the ratio of specific heat of air by Clement and Desorme's method.

Group - B

1. Determination of dispersive power of material of prism.
2. Study of cardinal points by using Goniometer.
3. Determination of R.I. of given liquid by Liquid Lens.
4. Determination of Cauchy's Constants.
5. Determination of specific rotation of sugar solution by using Polarimeter.
6. Determination of Resolving Power of plane diffraction grating.
7. Determination of wavelength of Sodium Light by Fresnel's Bi-prism.
8. Determination of Wavelength of sodium source by Newton's rings.
9. Determination of Wavelength of He-Ne Laser using grating.
10. Study of cardinal points by Newton's Method.
11. Determination of equivalent focal length of a system of lenses by using Goniometer.

Learning Outcomes:

1. Students will be able to take measurements and readings with practical skills.
2. Students will be able to determine mechanical equivalent of heat, specific heat of solids and liquids.
3. Students will be able to study the laws of probability distribution, black body radiation.
4. Students will be able to determine dispersive power, refractive index, resolving power of variousmaterials, wavelengths of different sources by various methods.
5. Students will be able to plot the cardinal points of an optical system.

REFERENCE BOOKS:

1. Advanced Practical Physics for Students: B. L. Worsnop and H. T. Flint, 1971 Asia Publ. House.
2. Practical Physics: S. L. Gupta and V. Kumar, Pragati Prakashan, 27th Edition, 2010.
3. An Advanced course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, 7th edition, 2005,New Central Book Agency Pvt. Ltd.
4. Experimental College Physics: White and manning, McGRAW-HILL Book Company. 3rd edition.
5. B.Sc. Practical Physics-H. Singh and P.S. Hemne, S. Chand Publication, Practical Physics-Arora S. Chand Publication