Jankidevi Bajaj College of Science, Wardha (Autonomous)

Syllabus for B.Sc. II (Sem III) w.e.f. 2018-19

Physics III (BCSPHYT203)

Unit I: Waves in media and Applied Acoustics [10h]

Speed of transverse wave on a string, Standing waves, Harmonics, Quality of sound, Intensity and loudness, bel and decibel, musical scales(Diatonic and tempered). Applied acoustic: Transducers and their characteristics (Crystal microphone, Moving coil loud speaker), Recording and reproduction of sound (Magnetic tape, Cine film, Compact disc), Acoustics of building, Reverberation and reverberation period, Sabine's formula, Factors affecting the acoustics of building, Requirements for good acoustics.

Unit II: Ultrasonics and Power Supply [10h]

Ultrasonics: Introduction, Properties and production of ultrasonic waves, piezoelectric effect, piezoelectric generator, Magnetostriction effect and oscillators, Frequency of ultrasonic waves, Application of ultrasonic waves (measurement of depth of sea, SONAR system and Medical science).

Power supply**:** Introduction, rectification using half wave and full wave rectifiers (Find Id.c., Vd.c., Ir.m.s., η and ripple factor), Working of Full wave bridge rectifier, Filters, Difference between regulated and unregulated power supply, line and load regulation, voltage stabilization, Zener diode as voltage regulator, IC voltage regulation.

Unit III: Interference of light [10h]

Thick lens, thin lens and lens combinations. Interference in equal thickness thin film, Phase change on reflection, refraction and transmitted system. Newton's ring and its application to determine the wavelength and refractive index, Michelson Interferometer and its application to wavelength determination and wavelength difference, Fabry- Perrot Interferometer and its application.

Unit IV: Diffraction of light [10h]

Introduction, Fresnel's diffraction- Half period zones, Zone plates, Diffraction due to straight edge and due to narrow slit. Fraunhoffer diffraction- Fraunhoffer diffraction at a single slit, at circular aperture, Plane diffraction grating and its application, Resolving power of grating, Rayleigh's criterion for resolution.

Unit V: Polarization [10 h]

Introduction, Brewster's law, Polarization by scattering (concept only), Blue color of the sky(only idea), Uniaxial and biaxial crystal , positive and negative crystal, ordinary and extraordinary rays, Nicol prism, its application as an analyzer and polarizer, Double refraction in uniaxial crystal, phase retardation plate (Half and Quarter wave), Double image prism, polarimeter.

Unit VI: Electrodynamics [10 h]

Electromagnetic spectrum, Electromagnetic waves and their characteristics, Equation of continuity, Displacement current, Maxwell's equations and its significance, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves and applications of electromagnetic waves.

Laboratory-3

(BCSPHY P203)

List of Experiments: (Any 10) [40h]

1. To study the speed of waves on stretched string.
2. To determine unknown frequency and to verify the law of inverse variation of frequency and volume of air by Helmholtz resonator.
3. To determine the velocity of sound wave in air (gas) with Kundt's tube.
4. To study the characteristics of microphone.
5. To study the current regulation and ripple factor of half wave / full wave rectifier using semiconductor diodes with L and Π type filter.
6. To study the characteristics of Zener diode.
7. To study the Zener diode voltage regulating characteristics.
8. To determine the focal length of long focus convex lens using short focus convex lens.
9. To study the different lenses and eyepieces.
10. To determine the wavelength of monochromatic light using Newton's ring.
11. To determine the refractive index of material of double image prism.
12. To study of polarization of light by reflection (Brewster's law).
13. To determine the resolving power of a grating.
14. To determine the wavelength of prominent lines of mercury by plane transmission grating.
15. To determine the concentration of sugar solution by half shade polarimeter.

Reference Books for theory:

1. A Text Book of sound, by- Khanna, Bedi.
2. A Text Book of sound, by- L. P. Sharma, Saxena (S. Chand)
3. Properties of Matter and Acoustics, by- R. Murugeshan, Kiruthign Sivaprakash.
4. Fundamental of Acoustics 4th Edition, by- Kinsler , John Wiley and Sons.
5. A Text Book of Oscillations, Waves and Acoustics, by- Dr. M. Ghosh, Dr. D. Bhattacharya (S. Chand)
6. Oscillation, Waves and Sound, by- Sharma and Saxena.

7. Science and Technology of Ultrasonics, by- Baldevraj, Narosa publication .
8. Elements of Electronics, by- M. K. Bagde, S. P. Singh, K Singh S- Chand.
9. Solid State Physics and Electronics, by- R. K. Puri, and V. K. Babbar.
10. Solid State Electronic Devices II Edition, by- B. G. Streetman
11. Physics for Degree students for B. Sc. Second year, by- C. L. Arora, Dr. P. S. Hemne.
12. Optics and Spectroscopy, by- R. Murugeshan , Kiruthign Sivaprakash.
13. Optics, by- Brijlal and Subramayam.
14. Optics, by- Ajoy Ghatak.
15. A text book of Optics, by- Dr. Subrahmanyam, Brijlal and M. N. Avadhanulu.
16. Optics, by- J. K. Sharma, K. K. Sarkar.
17. Fundamentals of optics, by-Jenkins and White.
18. Optics, by- D. P. Khandelwal.
19. Foundation of Electromagnetic theory, by- John R. Retitz, Fredrick, J. Milford.
20. Electromagnetics, by- B. B. Laud.

Reference Books for Practicals:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Physics through experiments, B Saraf et. al.,Vikas Publications 1987.
6. Advanced practical physics, Chauhan & Singh, Pragathi Publications.
7. Practical Physics, D Chattopadhyaya et al, Central Publications.
8. An Advanced Course in Practical Physics , D Chattopadhyay, PC Rakshit, B Saha, New Central Book Agency (P) Limited, Kolkata, Sixth Revised Edition, 2002.
9. Practical Physics, D. C. Tayal 2002.

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Syllabus for B. Sc. II (SEM-IV) w.e.f. 2018-19

Physics IV (BCSPHYT204)

Unit I : Crystallography [10h]

Solids: Amorphous and Crystalline Materials. Lattice translation vectors. Lattice with a Basis. Unit Cell. Miller Indices. Types of Lattices. Packing fraction, density calculation. Closed pack structures (fcc, hcp). Crystal structure of CsCl, NaCl, Diamond. Concept of reciprocal Lattice and its construction.

Unit II: X-rays and X-ray diffraction [10h]

Production of X-rays, X-ray spectra, Brehmstrahlung, Characteristic X-rays. **X-ray tubes & types**: Coolidge tube's construction and working. Application of X-rays (Imaging, diffraction, Auger effect). Diffraction of X-rays by crystals. Bragg's Law. Different methods of X-ray diffraction. Bragg's spectrometer. Diffraction in Reciprocal space. Bragg's law in reciprocal space.

Unit III: Molecular Physics [10h]

Quantization of vibrational and rotational energies, types of molecules based on moment of inertia, rigid diatomic molecules, Intensity distribution in rotational levels, Diatomic molecules as harmonic and anharmonic oscillator (concept only), Rotational-vibrational spectra, Born Oppenheimer approximation. Raman effect, Applications of Raman effect, Electronic spectra, Dissociation energy, Frank-Condon principle.

Unit IV: LASER [10h]

Spontaneous and stimulated emissions, Theory of laser action, three and four level Lasing action, Einstein's coefficients, components of LASER system, Characteristics of laser beam, Ruby LASER, He-Ne laser, Semiconductor lasers, CO_2 LASER, Nd: Yag LASER. Comparison of laser systems, Applications of lasers.

Unit V: Solid State Electronics [10h]

Light emitting diode, Photovoltaic cell, bipolar transistor- Construction and static characteristics, transistor as an amplifier, working in CB, CE and CC Modes, Graphical analysis of CE configuration, Current gains α and β, Relations between α and β, Load Line analysis of Transistors, DC Load line and Q-point,. Hybrid parameters, Equivalent circuit at low frequency in CE mode, Thermal Runaway, Heat sink, Stabilization, Stability factor, Bias stabilizing circuits.

Unit VI: Field Effect Transistor [10h]

Construction, working and principle of JFET, Characteristics of JFET, Parameters, JFET as an amplifier (input and output impedance, voltage gain), Advantage of JFET over BJT. **MOSFET**- Types of MOSFET, Construction and working of MOSFET, Characteristics of MOSFET, Special features and applications of MOSFET. Thin film transistors (TFT), single electron transistors (SET).

Laboratory-4

(BCSPHY P204)

List of Experiments: (Any 10) [40h]

1. To study the divergence of LASER beam.
2. To determine the wavelength of LASER beam using plane diffraction grating.
3. To construct SC,BCC, FCC structures and to find packing fraction and co-ordination number.
4. To determine lattice parameter 'a' of a unit cell of cubic crystal using X-ray diffraction pattern.
5. Identification of unknown wavelength /element from line emission spectra.
6. Study of vibrational spectra through infra red spectroscopy.
7. To determine Planck's constant by using LED.
8. Study of solar cell as photovoltaic cell.
9. To study the characteristics of transistor in C-E mode.
10. To study the characteristics of transistor in C-B mode.
11. To study the characteristics of Field Effect Transistor (FET).
12. To study the frequency response of single stage common emitter amplifier.
13. To study the frequency response of two stage RC coupled common emitter amplifier.
14. To determine the hybrid parameters of a transistor.
15. To determine the value of Boltzmann's constant using transistor.

Reference Books for Theory:

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
3. Material Science and Engineering, William Callister, Wiley.
4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
5. Elements of Spectroscopy, by –Pragati Prakashan, Gupta, Kumar, Sharma.
6. Optics and Spectroscopy by-R. Murugeshan and Kiruthiga Sivaprakash, S Chand publication.
7. Advanced Molecular Physics by-Shriram and Sharma.
8. Electronics Principles by Malvino and Bates: Mcgraw Hill Education.
9. Electronic Devices and Circuit Theory by Boylsted : Pearson Publication.
10. Textbook of Electrical Technology by B.L. Thareja: S. Chand Publication.
11. Optics and Spectroscopy, by- R. Murugeshan , Kiruthign Sivaprakash.

12. Physics for Degree students for B. Sc. Second year, by- C. L. Arora, Dr. P. S. Hemne.
13. Solid State Physics and Electronics, by- R. K. Puri, and V. K. Babbar.
14. A text book of Optics, by- Dr. Subrahmanyam, Brijlal and M. N. Avadhanulu.

Reference Books for Practicals:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Physics through experiments, B Saraf et. al.,Vikas Publications 1987.
6. Advanced practical physics, Chauhan & Singh, Pragathi Publications 1ed.
7. Practical Physics, D. Chattopadhyaya et al, Central Publications.
8. An Advanced Course in Practical Physics , D Chattopadhyay, PC Rakshit, B Saha, New Central Book Agency (P) Limited, Kolkata, Sixth Revised Edition, 2002.
9. Practical Physics, D C Tayal 2002.

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Syllabus for B. Sc. III (SEM-V) w.e.f. 2019-20

Physics V (BCSPHYT305)

Unit I: Atomic Physics [10h]

Introduction (Revision of Bohr's model, Sommerfeld and Chadwick Model), Vector Atomic model, Stern-Gerlach experiment, spinning of electron, space quantization, selection rules, quantum numbers, L-S and J-J coupling, Pauli's exclusion principle, Hund's rule, Zeeman Effect: Normal Zeeman effect and Anomalous Zeeman effect.

Unit II: Relativity [10h]

Frame of references, Inertial and Non-Inertial frames, Galilean transformation equations, Galilean invariance and conservation laws, Michelson-Morley experiment and its negative result. Postulates of special theory of relativity, Lorentz transformation, Length contraction, Time dilation, velocity addition theorem, variation of mass with velocity, Mass Energy equivalence, Particle with zero rest mass.

Unit IV: Quantum Mechanics - I [10h]

Failure of Classical Physics, black body radiations, photoelectric effect, Einstein's explanation of photoelectric effect, Compton Effect, Wave Particle Duality, de Broglie's Hypothesis, Davisson and Germer experiment, concept of phase velocity and group velocity, wave packet, Heisenberg's Uncertainty Principle: Non-existence of electron inside the nucleus. Thought experiment: Gamma Ray Microscope.

Unit IV Nuclear Physics I [10h]

G.M counter, Linear Accelerator, Cyclotron, velocity selector, Bainbridge Mass Spectrograph, Nuclear reactions, Discovery of neutron, Packing fraction, Mass defect and binding energy, Nuclear fission, Liquid drop model, shell model of the nucleus, chain reaction, Nuclear reactors, Nuclear fusion, cosmic rays .

Unit V Nanomaterials and Characterizations [10h]

Nanomaterials- Introduction to Nanoscience and Nanotechnology, Difference between nanomaterials and bulk materials, reduction of dimensions, 3D, 2D, 1D & 0D materials, various morphologies of nanomaterials, Bottom up and top down approaches of synthesis, size dependent physical properties. Determination of size of nanocrystallites by Scherrer's formula, **Characterization Techniques**- Scanning Electron Microscope (SEM), Transmission Electron Microscopy (TEM), Polarimeter, Colorimeter and UV-vis. Spectrophotometry.

Unit VI: Statistical Physics [10h]

Introduction: Phase space, μ-space, Gamma space, probability distribution, thermodynamic probability, principle of a prior probability, Boltzmann's entropy relation, Macro and micro states, Maxwell-Boltzmann distribution law, its application to molecular speeds, limitations of M-B law, distinction between mean, RMS and most probable speed, Bose-Einstein Statistics (no derivation), Indistinguishability of particles and its consequences, Derivation of

Planck's radiation law, Wein's displacement law and Rayleigh's law, Estimation of temperature of sun. Fermi-Dirac distribution law (no derivation), Fermi energy, Fermi level, Fermi Temperature. Comparisons between M-B, B-E and F-D statistics.

Laboratory-5
(BSCPHYP305)
List of Experiments (Any 10) [40h]

1. To determine the Rydberg's constant by hydrogen spectra.
2. To study the absorption spectra of iodine vapours.
3. To determine the e/m ratio by Thomson method.
4. To determine e/m by Helical method.
5. To determine the Planck's constant by using photocell/solar cell.
6. To determine the Planck's constant by using LED.
7. To study the random decay of nuclear disintegration and determination of decay constant using one colored face dices.
8. To study the statistical distribution from the given data and to find most probable average and RMS value.
9. To draw the plateau curve of a Geiger Mueller counter.
10. To determine the size of nanocrystals by using Scherrer formula.
11. To determine the unknown concentration of $KMnO_4$ solution using colorimeter.
12. To determine the electric charge of an electron by Millikan's oil drop method.
13. To determine the electronic charge and work function of a cathode material using photocell.
14. To study inverse square law using static characteristics of photocell.
15. To determine the specific rotation of a given optically active compound glucose using half shade polarimeter.
16. To analyze the image of SEM/TEM of nanoparticles.
17. To calculate the optical band gap of nanomaterial by UV visible spectrum.

Reference Books for Theory:

1. Atomic Physics by J. B. Rajam.
2. Nuclear Physics by S.N. Ghoshal (S. Chand).
3. Introductory Nuclear Physics by Kenneth Krene(John Wiley and sons)
4. Concepts of Modern Physics: Arthur Beiser (Tata Mc Graw Hill)
5. Physics for Degree Students BSc-III by C.L. Arora and P.S. Hemne.(S. Chand)
6. Elements of Special Theory of Relativity by M.K. Bagde and S.P. Singh (S. Chand)
7. Introduction to theory of Relativity by P.G. Bergmann
8. Introduction to Special Theory of Relativity by Shrivastava.
9. Material Science and Engineering, William Callister, Wiley.
10. Fundamentals of statistical and thermal physics - by F. Reif.
11. Fundamental of Statistical Mechanics - By B.B. Laud.
12. Statistical Physics: Berkeley Physics Course Volume-5 by F. Reif Tata McGraw-Hill Company Ltd, 2008).

13. Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education.
14. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
15. Quantum Mechanics by Chatwal and Anand (Himalaya Publications)
16. Introduction to Nanotechnology by Charles Poole
17. Nanotechnology: Principles and Practices by Sulabha K. Kulkarni

Reference Books for Practicals:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Physics through experiments, B Saraf *et al*, Vikas Publications 1987.
6. Advanced practical physics, Chauhan & Singh, Pragathi Publications 1st Ed.
7. Practical Physics, D. Chattopadhyaya *et al*., Central Publications.
8. An Advanced Course in Practical Physics , D Chattopadhyay, P C Rakshit, B Saha, New Central Book Agency (P) Limited, Kolkata, Sixth Revised Edition, 2002
9. Practical Physics, D C Tayal, 2002.

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Syllabus for B. Sc. III (SEM-VI) w.e.f. 2019-20

Physics VI (BCSPHYT306)

Unit I: Quantum II [10h]

Schrodinger's Equation: Time dependent and time independent equations, wave function Ψ and its physical significance, Operators, Expectation values of dynamical quantities, Ehrenfest theorem, Eigen values and Eigen functions, Free particle, Free Particle in a one-dimensional box and three-dimensional box.

Unit II: Nuclear II [10h]

Radioactivity: stability of nucleus, Law of radioactive decay, mean life & half-life; α-decay, Range of alpha particles, Geiger Nuttal law, Magnetic spectrometer for the energy of α particles, Tunneling, Gamow's theory of α-decay, β-decay, measurement of energy of β-decay and end point energy, Neutrino theory of β-decay, Gamma decay, energy of gamma photon.

Unit III: Physics of Solid State [10h]

Drude Lorentz model, Mean free path, Electrical and thermal conductivity, Weidmann Franz law (derivation), thermoelectric effect, Density of states, Fermi energy, Fermi temperature. Band theory of solids- Bloch theorem (statement only), Kroning Penny model, concept of hole, Hall effect, Energy bands in solid, distinction between metal, semiconductor, and insulator.

Unit IV: Operational Amplifier and Oscillators [10h]

Operational Amplifier: Direct coupled amplifier, Difference amplifier, parameters of Op-Amp, Basic idea of IC-741, Application of Op-Amp as Inverting amplifier, non-Inverting amplifier, Adder, substractor, Integrator, Differentiator.
Oscillators: Concept of feedback, Physical considerations of tuned circuits, Phase shift oscillators, Hartley Oscillator, Colpitt's oscillator.

Unit V: Digital Electronics [10h]

Number Systems- Unitary systems, Binary, decimal, octal, hexadecimal and their inter-conversions, Binary coded decimal (BCD), Addition and subtraction of binary numbers, 1S, 2S and 10S compliment, basic logic gates, NOR, NAND, Ex-OR Ex-NOR gates and their truth table, Half adder, Full adder, Half substractor and full substractor, Boolean equations, De Morgan's theorem and its verification.

Unit VI: Communication and Fiber Optics [10h]

Communication: Modulations and its needs, Amplitude modulation. Frequency spectrum, modulation factor, over modulation, percentage modulation, Expression for power and currents in AM wave. Disadvantages. Frequency modulation. Frequency deviation, carrier swing, modulation index, Deviation ratio, Expression for FM wave, frequency spectrum, significant side band terms, F M bandwidth, merits and demerits.
Fiber Optics- Importance of optical fiber, Propagation of light waves in optical fiber, Basic structure, step index mono mode fiber, Graded index fiber, Acceptance angle and acceptance cone, Numerical aperture, Fiber losses and their units (basic concept), Electrical and optical band width, band width length product, Dispersion in optical fiber, applications.

Laboratory-6
(BSCPHYP306)
List of Experiments (Any 12) [40h]

1. To determine the energy gap of semiconductor using PN junction diode in reverse bias mode.
2. To determine the Hall coefficient of charge carriers in semiconductor.
3. Study of thermo emf.
4. To study the Op-Amp as an inverting and non-inverting amplifier.
5. To study the Op-Amp as adder/subtractor.
6. To study the Op-Amp as integrator/differentiator.
7. To study the phase shift/Wein's bridge oscillator.
8. To study the Hartley/Colpitts oscillator.
9. To study the Amplitude modulation
10. To study Diode as detector.
11. To study the Frequency modulation.
12. To organize basic operations (AND, OR, NOT) using universal gates (NAND, NOR).
13. To verify the De Morgan's theorem.
14. To study the characteristics of NOR/NAND gate and verification of truth table.
15. To verify the laws of Boolean algebra.
16. To study the Ex-OR gate as half adder and full adder.
17. To study the Ex-OR gate as half subtractor and full subtractor.
18. Determination of step index of optical fiber.
19. To study total internal reflection and determination of critical angle.

Reference Books for Theory:

1. Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education.
2. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
3. Introductory Nuclear Physics by Kenneth Krene (John Wiley and sons)
4. Nuclear Physics by S.N. Ghoshal (S. Chand).
5. Perspectives of modern physics - By A. Beiser.
6. Concepts of Modern Physics: Arthur Beiser (Tata Mc Graw Hill)
7. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley IndiaPvt. Ltd
8. Solid State Physics and Electronics, by R. K. Puri, and V. K. Babbar.
9. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hallof India
10. Op-Amp and Linear Integrated Circuits, 2nd edition by Ramakant Gaikwad (PHI)
11. Digital and Analog Technique by Navneet, Gokhale, Kale (Kitab Mahal)
12. Basic Electronics by B.C. Theraja(S. Chand)
13. An Introduction to Fiber Optics by Allen Shotwell
14. Optical Fiber Communication by John M. Senior.
15. Digital Principle and Application by Malvino and Leach.
16. Digital Electronics by V.K. Jain.
17. Communication Electronics by A. Kumar

Reference Books for Practicals:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.

2. A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S.Panigrahi & B. Mallick,2015, CengageLearning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Physics through experiments, B Saraf et. al.,Vikas Publications 1987.
6. Advanced practical physics, Chauhan & Singh, Pragathi Publications 1ed.
7. Practical Physics, D. Chattopadhyaya et al., Central Publications.
8. An Advanced Course in Practical Physics, D Chattopadhyay, PC Rakshit, BSaha, New Central Book Agency (P) Limited, Kolkata, Sixth RevisedEdition, 2002
9. Practical Physics, D C Tayal, 2002.