Tribhuvan University
Institute of Science and Technology

B.Sc. Physics

Course Title: Optics, Modern Physics and Electronics	**Year:** II
Course Code: PHY201	**Full Marks:** 100
Nature of Course: Theory	**Pass Marks:** 35
Duration: 150 hours	

Course Objectives

At the end of this course the students will be able to acquire sufficient basic knowledge on such topics in Physics as Optics, Modern Physics and Electronics and apply their knowledge to learning major courses.

OPTICS [50]

Course Contents:

1. **Wave Nature of Light: 1.1** Nature of light, 1.2 Huygen's wave theory and its application for propagation of waves [2 hours]
2. **Aberration at Spherical Surfaces: 2.1** Refraction through spherical surfaces from Huygen's wave theory, 2.2 chromatic aberrations; astigmatism, coma, curvature, distortion and their elimination, 2.3 Ramsden's and Huygen's eyepieces [7 hours]
3. **Interference: 3.1** Condition for obtaining interference, 3.2 spatial and temporal coherence, 3.3 interference by division of wave front, Fresnel's biprism, Lloyd's mirror, 3.4 division of amplitude, thin and wedge films, Newton's ring, Michelson interferometer, Fabry-Perot interferometer, 3.5 intensity distribution, 3.6 antireflection gratings [10 hours]
4. **Diffraction: 4.1** Huygen's principle, 4.2 Fresnel and Fraunhoffer diffraction, 4.3 Fresnel's diffraction: zone plate, circular aperture, straight edge, disc. 4.4 Fraunhoffer's diffraction: diffraction through a single and double slit, circular aperture and disc, 4.5 dispersive and resolving power of grating, 4.6 microscope and telescope [10 hours]
5. **Polarization: 5.1** Unpolarized plane, circular and elliptically polarized light, double refraction, crystal polarizer, 5.2 Malus law, polarization by reflection and scattering, 5.3 double refraction and Huygen's explanation, production and analysis of polarized light, 5.4 optical activity, 5.5 Laurent half shade polarimeter and its applications [8 hours]
6. **Dispersion and Scattering: 6.1** Dispersion of a Prism, 6.2 Normal and anomalous dispersion, 6.3 Cauchy's equation, scattering of light, 6.4 Scattering by small particles, 6.5 Scattering and Refractive Index, 6.6 Raman Effect [6 hours]

7. **Lasers: 7.1** Spontaneous and stimulated emission, 7.2 conditions for laser action, population inversion, optical pumping, 7.3 Ruby and He-Ne lasers and applications [4 hours]
8. **Holography: 8.1** Basic principles of holography, 8.2 applications [3 hours]

MODERN PHYSICS [50]

Course Contents:

9. **Atomic Structure: 9.1** The nuclear atom, 9.2 Rutherford scattering and its conclusions, 9.3 limitations of Rutherford model of atom, electron orbits, 9.4 atomic spectra, 9.5 the Bohr's atom, energy level diagram and spectra of hydrogen atom, 9.6 Frank-Hertz experiment and limitations of Bohr's model, 9.7 the Sommerfeld atom [8 hours]
10. **Many Electron Atom: 10.1** Electron spin, 10.2 Stern-Gerlach experiment, 10.3 Pauli's exclusion principle, 10.4 shells and subshells of electrons, 10.5 vector atom model, 10.6 LS coupling and s, p, d, f notation [5 hours]
11. **Atomic Spectra: 11.1** Fine structures of H, Na, He and Hg, 11.2 Paschen-Back effect, 11.3 Stark effect, 11.4 normal and 11.5 anomalous Zeeman effect [7 hours]
12. **Particle properties of waves: 12.1** Electromagnetic waves and its interaction with matter, 12.2 absorption, 12.3 photoelectric effect, 12.4 Compton scattering, 12.5 pair production, 12.6 photons and gravity [6 hours]
13. **X-ray Spectrum: 13.1** Characteristic X-ray, 13.2 X-ray diffraction and spectrometer, 13.3 fine structure of X-ray transitions, 13.4 Moseley's law and its application [4 hours]
14. **Nuclear Structure: 14.1** Proton-electron and proton-neutron hypothesis, 14.2 nuclear composition and its properties (mass, charge, density, magnetic and electric properties), 14.3 nuclear stability and binding energy, 14.4 Meson theory of nuclear forces [6 hours]
15. **Nuclear Transformations: 15.1** Radioactivity, law of radioactive disintegration, 15.2 law of successive disintegration, 15.3 half-life, mean life, natural radioactive series, 15.4 alpha, beta and gamma ray spectra, 15.5 absorption of α particles, range, 15.6 straggling and stopping power, 15.7 theory of α decay, 15.8 neutrino hypothesis of β-decay, 15.9 biological effects of ionizing radiation [7 hours]
16. **Particle Detectors and Accelerators: 16.1** Ionization chamber, 16.2 G. M. counter, 16.3 scintillation counter, 16.4 bubble chamber, 16.5 Cerenkov detectors, 16.6 semiconductor detectors, 16.7 linear accelerator, 16.8 cyclotron, 16.9 synchrocyclotron, 16.10 betatron, the 16.11 LHC project [7 hours]

ELECTRONICS [50]

Course Contents:

17. **Network Theorems: 17.1** Superposition Theorem, 17.2 Ideal constant-voltage source, 17.3 Ideal constant current source, 17.4 Thevenin's and Norton's Theorem and their applications, 17.5 maximum power transfer theorem [4 hours]
18. **Semiconductor and Diodes: 18.1** Review of semiconductor, types of semiconductor, 18.3 energy bands in semiconductors, 18.3 Different types of diodes, P-N junction diode, characteristics, 18.4 application of junction diode as half wave and full wave rectifier, 18.5 bridge rectifier, R-C filter, ripple factors, 18.6 zener diode and it's application in voltage regulation circuit [6 hours]
19. **Bipolar Junction Transistors: 19.1** PNP and NPN transistors, transistor input, output and transfer characteristics in different configurations, 19.2 α and β of transistor, 19.3 transistor biasing, load lines, Q-point, optimum Q-point, bias stabilization, stability factor, 19.4 CB, CE, and CC amplifiers and their DC and AC equivalent circuits, 19.5 amplifier gain (voltage, current, power) calculations, 19.6 AC-input and output impendances of different amplifiers, 19.7 phase inversion in CE amplifier [10 hours]
20. **Amplifiers: 20.1** Cascaded amplifiers, 20.2 R-C coupled amplifier, 20.3 overall voltage gain, 20.4 frequency response, 20.5 power amplifiers. [4 hours]
21. **Operational amplifiers: 21.1** Differential amplifiers, ac analysis of differential amplifier, 21.2 differential gain, input impedance, common mode gain, 21.3 common mode rejection ratio (CMRR), 21.4 Operational amplifier, 21.5 inverting and non-inverting mode of Op-Amp [5 hours]
22. **Feedback Amplifier: 22.1** Introduction of feedback and their types, 22.2 Negative feedback and positive feedback, advantages of negative voltage feedback, 22.3 different types of feedback amplifier: voltage-series feedback, 22.4 voltage shunt feedback, current series feedback, current shunt feedback [4 hours]
23. **Oscillators: 23.1** Barkhausen criterion, 23.2 working principle of Hartely, Colpitt's and phase shift oscillators, 23.3 Multivibrators and their working principle. [5 hours]
24. **FET and UJT: 24.1** Field effect transistor, its characteristics, 24.2 FET as an amplifier with infinite input impedance. 24.3 Unijunction transistor and its characteristics, 24.4 UJT as a relaxation oscillator [4 hours]
25. **Digital Electronics and Logic gates: 25.1** Decimal, Binary, Octal and Hexadecimal number of systems and their inter-conversion, 25.2 Addition and subtraction of binary numbers, 25.3 Boolean algebra and de Morgan's theorem, 25.4 OR, AND, NOT, NOR, NAND, X-OR and X-NOR gates NOR and NAND gate as basic building block, 25.5 Half adders and full adders, 25.6 RS, JK, D-flip flops [8 hours]

Text books:

1. *Jenkins F. A. and White H. E*. - **Fundamentals of Optics**, McGraw Hill Book Co. Ltd., 4th Edition (2011)

2. *Beiser A., Mahajan S. and Choudhury S. R*. - **Concepts of Modern Physics**, Tata McGraw Hill Education, New Delhi (2011)

3. *Murugeshan R. and Sivaprasad K*. - **Modern Physics**, S. Chand and Company, New Delhi (2012)

4. *Malvino A. P.* - **Electronic Principles**, Tata McGraw Hill Publishing House, New Delhi (1984)

Reference books:

1. *Subrahmanyam N. and Lal B*. - **Text Book of Optics***,* S. Chand and Co., Ltd. (1994)

2. *Blatt F. J*. - **Modern Physics**, McGraw Hill International (1992)

3. *Wahr M. R., Richard J. A. and Adir T. W.* - **Physics of the Atom**, Addison Wesley (1984)

4. *Leighton R. B.* - **Principles of Modern Physics**, McGraw-Hill Education (1959)

5. *Theraja B. L.* - **Basic Electronics**, S.Chand & Co.Ltd., New Delhi (2002)

6. Mehta V. K. and Mehta Rohit - **Principles of Electronics**, , S. Chand & co. Ltd., New Delhi (1996)

7. *Malvino A. P.* - **Semiconductor circuit approximation (4th edition),** Tata McGraw Hill Publishing House, New Delhi (1986)

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B.Sc. Physics

Course Title: Physics Laboratory	**Year:** II
Course Code: PHY202	**Full Marks:** 50
Nature of Course: Practical	**Pass Marks:** 20
Duration: 180 hours	

Course Description:

Physics Laboratory (General) Practical course consists of three sections: (a) Optical Experiments, (b) Nuclear Experiments, and (c) Electronics Experiments. Students have to perform at least 15 experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. Students should complete at least 20 experiments in the second year. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

Course Objectives:

1. To provide students with skill and knowledge in the experimental methods.
2. To make them able to apply knowledge to practical applications.
3. To make them capable of presenting their results/conclusions in a logical order.

B.Sc. Second Year Lab Works [180]

1. To determine the wave length of given source of light by Newton's Ring method.

2. To determine the wavelength of given source of light using a plane diffraction grating.

3. To determine the resolving power of a prism.

4. To determine the resolving power of a plane transmission diffraction grating.

5. To determine the refractive index of the material of a prism for light of different wavelengths.

6. To determine the value of Cauchy’s constants for the material of the given prism using a spectrometer.

7. To determine the specific rotation of sugar solution using Laurent half-shade polarimeter

8. To determine the charge of an electron by Millikan’s method.

9. To determine the specific charge of an electron (e/m) by magnetron tube method.

10. To determine the specific charge of an electron (e/m) by Thomson's method.

11. To study the characteristics of Geiger Muller (G.M.) counter and its reliability.

12. To determine the linear absorption coefficient of β-particles in a matter using a G.M. counter.

13. To determine the resonant frequency and quality factor of series LCR circuit.

14. To study oscilloscope and calibrate it for the measurement of voltage and frequency.

15. Determine the unknown frequency of a given source using Lissajous figure.

16. To verify the maximum power transfer theorem.

17. To verify the network theorems: Thevenin's theorem and Norton's theorem.

18. To study the CB characteristics of a PNP and NPN junction transistor.

19. To study the CE characteristics of a PNP and NPN junction transistor.

20. To study the CC characteristics of a PNP and NPN junction transistor.

21. To study the characteristics of regulated power supply using Zener diode.

22. To study the characteristics of regulated power supply by using integrated circuit (IC).

23. To study logic gates OR, AND and NOT by using DTL and TTL.

24. To study logic gates NOR and NAND by using DTL and TTL.

25. To verify NAND and NOR gates are universal gates.

Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)
2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme

1. Student must perform three hours laboratory work twice a week to complete PHY202 lab works.
2. PHY202 will be examined for the duration of six hours in two different three hours sessions.
3. The practical exam will be graded on the basis of the following marking scheme:

Record file:	20%	Experiment:	50%
Error Analysis:	10%	Viva:	20%