ST. PHILOMENA'S COLLEGE (AUTONOMOUS)

Affiliated to University of Mysore
Accredited by NAAC with 'B++' Grade
Bannimantap, Mysore, Karnataka,
India-570015

DEPARTMENT OF PHYSICS

The Board of Studies in Physics which met on 23-08-2024 has approved the syllabus and pattern of examination for Semesters V and VI for the Academic Year 2024-25

BOS COMMITTEE MEMBERS

Sl. No.	Name	Designation
01	Prof. M. Nagaraj Urs	Chairperson
02	Prof. Chandrashekar M.S.	University Nominee
03	Dr. Sreepad H.R.	Member
04	Prof. C. Nagesh Babu	Member
05	Prof. N. Bharathi	Member
06	Dr. Bindu Thomas	Member
07	Prof. A. Thomas Gunaseelan	Member
08	Mr. Eliezer Vishwas	Member
09	Ms. Chandana. S	Member
10	Dr. Felan Amal	Special Invitee

Semester V BSc
Core Course Content

Course Title: Classical Mechanics -I and Quantum Mechanics-I	Course Credits: 4
Course Code: PHY C9-T	L-T-P per week: 0-0-4
Total Contact Hours**:** 64	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/
Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Course Objectives:

By the end of the Third year,

1. students would have covered a range of topics in areas of physics like Atomic and Molecular Spectra, Quantum Mechanics, Classical Physics and Lasers.

2. Students would been introduced to Modern Physics topics, Solid State Physics, Electronic instrument and sensors.

3. Students would been exposed to almost all branches of physics and has experience of independent work such as presentations, seminars and project work.

Course Learning Outcomes

After the successful completion of the course, the student will be able to

- Identify the failure of classical physics at the microscopic level.
- Find the relationship between the normalization of a wave function and the ability to correctly calculate expectation values or probability densities.
- Explain the minimum uncertainty of measuring both observables on any quantum state.
- Describe the time-dependent and time-independent Schrödinger equation for simple potentials like for instance one-dimensional potential well and Harmonic oscillator.
- Apply Hermitian operators, the Eigen values and Eigen vectors to find various commutation and uncertainty relations.

COURSE CONTENT

B.Sc in Physics V Semester

Curriculum

Program Name	BSc in Physics	Semester	V
Course Title	Classical Mechanics and Quantum Mechanics-I(Theory)		
Course Code	PHYC9-T	No. of Credits	04
Contact Hours	60Hours	Duration of SEA/Exam	02Hours
Formative Assessment Marks	40	Summative Assessment Marks	60

Course Pre-requisite(s):	
Course Outcomes(COs): After the successful completion of the course, the student will be able to • Identify the failure of classical physics at the microscopic level. • Find the relationship between the normalization of a wave function and the ability to correctly calculate expectation values or probability densities. • Explain the minimum uncertainty of measuring both observables on any quantum state. • Describe the time-dependent and time-independent Schrödinger equation for simple potentials like for instance one-dimensional potential well and Harmonic oscillator. • Apply Hermitian operators, the Eigen values and Eigen vectors to find various commutation and uncertainty relations.	
Contents	**60Hrs**
Introduction to Newtonian Mechanics: Frames of references, Newton's laws of motion: first law statement, second law statement with derivation, third law statement with derivation to show that in an isolated system of two bodies is interacting among themselves then by measuring their accelerations the ratio of their masses can be determined, inertial and non-inertial frames with examples. Mechanics of a particle: position vector, velocity, acceleration of a particle Conservation of linear momentum: statement and proof, Angular momentum and torque, conservation of angular momentum statement and proof, work done by a force, conservative force and conservative energy. **Lagrangian formulation**: Constraints, Holonomic constraints, non-holonomic constraints, Scleronomic and Rheonomic constraints. Generalized coordinates, degrees of freedom, Principle of virtual work, D'Alembert's principle, Lagrange equations. Newton's equation of motion from Lagrange equations, simple pendulum, Atwood's machine and linear harmonic oscillator. Numerical Problems. **12Hours** **Activities:** **03Hours** • **Demonstration using rotating platforms**: Place an object (like a ball) on a rotating platform or merry-go-round and observe its motion from both the rotating (non-inertial) frame and the ground (inertial) frame. Students can analyze the forces (fictitious forces like centrifugal force) they feel while being on the rotating platform. • **Simulation software**: Use physics simulation software to visualize and compare motion in inertial	15

and non-inertial frames. Students can change the reference frame and observe the effects on the motion of particles.	
Variational principle: Hamilton's principle, Deduction of Hamilton's principle, Lagrange's equation of motion from Hamilton's principle, Hamilton's principle for non-holonomic systems (using Lagrange multiplier method). **Hamiltonian Mechanics**: The Hamiltonian of a system, Hamilton's equations of motion, Hamilton's equations from variational principle, Integrals of Hamilton's equations energy integrals, Canonical Transformations, Poison Brackets, fundamental properties and equations of motion in Poison Brackets. Numerical Problems. **12Hours** **Activities:** **03Hours** • Provide students with mechanical systems like a free particle or a simple pendulum and guide them to derive the Lagrange's equations of motion using Hamilton's principle. Break the process into steps: identifying kinetic and potential energy, applying the principle of least action, and deriving the Euler-Lagrange equations. • Use a physics simulation tool to visualize the motion of systems governed by Hamilton's equations (e.g., a double pendulum or a charged particle in a magnetic field). Have students manipulate initial conditions and observe the resulting dynamics.	15
Introduction to Quantum Mechanics Brief discussion on failure of classical physics to explain black body radiation, Photoelectric effect, Compton effect, stability of atoms and spectra of atoms. Matter waves: de Broglie hypothesis of matter waves, Electron microscope, Wave description of particles by wave packets, Group and Phase velocities and relation between them, Experimental evidence for matter waves: Davisson- Germer experiment, G.P Thomson's experiment and its significance. Heisenberg uncertainty principle: Elementary proof of Heisenberg's relation between momentum and position, energy and time, angular momentum and angular position, illustration of uncertainty principle by Gamma ray microscope thought experiment. Consequences of the uncertainty relations: Diffraction of electrons at a single slit, why electron cannot exist in nucleus? Numerical Problems. **12Hours** **Activities:** **03Hours** • Have students work in small groups to derive the Compton shift expression. Provide the necessary formulas and guide them through the steps. After completing the derivation, have them relate this theoretical shift to experimental values. • Assign students to research and present the significance of G.P. Thomson's experiment, which confirmed the wave nature of electrons through diffraction. They can compare his experiment with the work of his father, J.J. Thomson, who discovered the electron as a particle.	15

Foundation of Quantum Mechanics Probabilistic interpretation of the wave function-Physical significance, Born's interpretation normalization and orthogonality of wave functions, Admissibility conditions on a wave function, Schrödinger equation: equation of motion of matter waves - Schrodinger wave equation for a free particle in one and three- dimension, time-dependent and time-independent wave equations, Probability current density, equation of continuity and its physical significance, Basic postulates of Quantum mechanics: States as normalized wave functions. Dynamical variables as linear Hermitian operators (position, momentum, angular momentum, and energy as examples). Expectation values of operators and their time evolution. Ehrenfest theorem (no derivation), Commutator brackets- Simultaneous Eigen functions, Commutator bracket using position, momentum and angular momentum operators. Particle in a one-dimensional infinite potential well(derivation). One-dimensional simple harmonic oscillator (qualitative)-concept of zero-point energy. Numerical Problems. **12 Hours** **Activities:** **03Hours** • Present students with different functions (some admissible and some not, such as discontinuous or non-normalizable functions). Ask them to analyze and identify which are valid quantum wave functions based on admissibility criteria (single-valued, continuous, differentiable, and normalizable). • Provide a qualitative discussion on the Ehrenfest theorem. Ask students to explain how it bridges classical and quantum mechanics by comparing the time evolution of expectation values in quantum mechanics with Newton's second law.	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/Conceptmapping/CaseStudiesexamples/Tutorial/Activity/FlippedClassroom/Jigsaw/Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ ProblemBasedLearning/GameBasedLearning/GroupDiscussion/CollaborativeLearning/Experiential Learning /Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Total	**40Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Classical Mechanics, H.Goldstein, C.P.Poole, J.L.Safko, 3rdEdn.2002, Pearson Education.
2	Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer
3	Classical Mechanics, G. Aruldhas, 2008, Prentice-Hall of India Private limited, New Delhi.
4	Classical Mechanics, Takwaleand Puranik-1989,Tata Mcgraw Hill, new Delhi
5	Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
6	Physics for Scientists and Engineers with Modern Physics, Serway and Jewett, 9th edition, Cengage Learning, 2014.
7	Quantum Physics, Berkeley Physics Course Vol. 4.E.H.Wichman,Tata McGraw-HillCo.,2008.
8	Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, Mc Graw Hill, 2003.
9	PM Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN: 9780070146174.
10	Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication, ISBN 978-1-4020-2130-5.
11	Modern Physics; R. Murugeshan & K. Sivaprasath; S. Chand Publishing.
12	G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN: 97881203363.
13	Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.
14	Physics for Degree Students B.Sc., Third Year, C.L.Aroraand P.S.Hemne, 1st edition, S.Chand & Company Pvt. Ltd., 2014.

Course Title	Classical Mechanics and Quantum Mechanics- I (Practical)	Practical Credits	02
Course Code	PHYC10-P	Contact Hours	04Hours
Formative Assessment	25 Marks	Summative Assessment	25Marks

Practical Content

Labexperiments:(atleast4experimentsfrom1-8and4experimentsfrom9-18)

1) To determine 'g', the acceleration due to gravity, at a given place, from the L – T^2 graph, for a simple pendulum.
2) Studying the effect of mass of the bob on the time period of the simple pendulum.

[Hint: With the same experimental set-up, take a few bobs of different materials (different masses) but of same size. Keep the length of the pendulum same for each case. Starting from a small angular displacementofabout10°findout, in each case, the time period of the pendulum, using masses. Does the time period depend on the mass of the pendulum bob? If yes, then see the order in which the change occurs. If not, then do you see an additional reason to use the pendulum as a time measuring device?

3) Studying the effect of amplitude of oscillation on the time period of the simple pendulum.

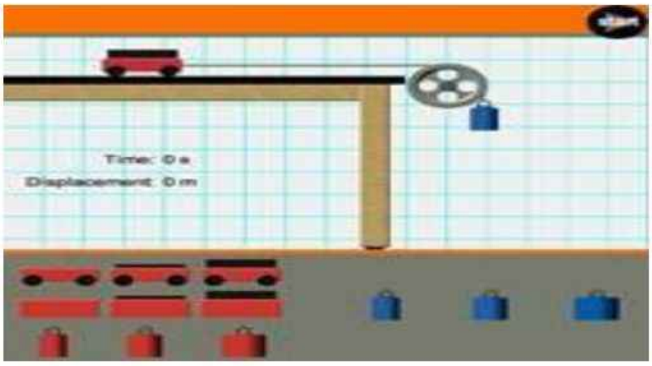
[Hint: With the same experimental set-up, keep the mass of the bob and length of the pendulum fixed. For measuring the angular amplitude, make a large protractor on the cardboard and have a scale marked on an arc from 0° to 90° in units of 5°. Fix it on the edge of a table by two drawing pins such that its 0°-line coincides with the suspension thread of the pendulum at rest. Start the pendulum oscillating with a very large angular amplitude (say70°) and find the time period T of the pendulum. Change the amplitude of oscillation of the bob in small steps of 5° or 10° and determine the time period in each case till the amplitude becomes small (say 5°). Draw a graph between angular amplitude and T. How does the time period of the pendulum change with the amplitude of oscillation? How much does the value of T for A= 10° differ from that for A= 50° from the graph you have drawn? Find at what amplitude of oscillation, the time period begins to vary? Determine the limit for the pendulum when it ceases to be a simple pendulum.]

4) Determine the acceleration of gravity is to use an Atwood's machine/Fly Wheel.
5) Study the conservation of energy and momentum using projectile motion.
6) Verification of the Principle of Conservation of Linear Momentum.
7) Acode in Python-Scilab to plotandanaly zethe trajectory of projectile motion.
8) Determination of acceleration due to gravity by Stoke's method.
9) Determination of Planck constant and work function of the material of the cathode using Photo-electric cell.
10) To study the spectral characteristics of a photo-voltaiccell(Solarcell).
11) Determination of electron charge'e' by Millikan's Oil drop experiment.
12) To study the characteristics of solar cell.
13) To find the value of e/m for an electron by Thomson's method using bar magnets.
14) To determine the value of e/m for an electron by magnetron method.
15) To study the tunneling in Tunnel Diode using I-V characteristics.
16) Determination of quantum efficiency of Photodiode.
17) A code in Python-Scilab to find the first seven eigen states and eigen functions of Linear Harmonic Oscillator by solving the Schrödinger equation.
18) A code in Python-Scilab to plot and analyse the wave functions for particle in an infinite potential well.

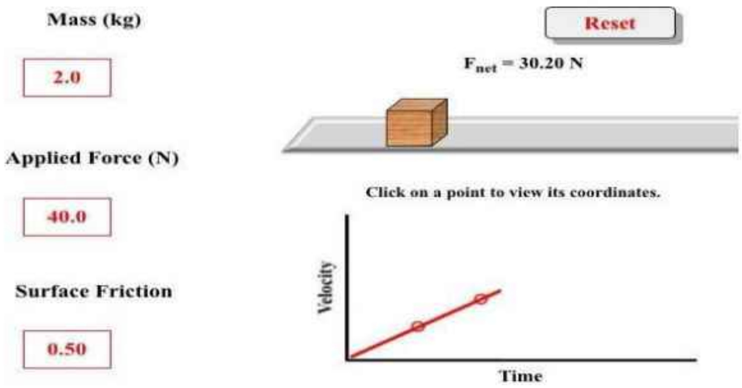
Pedagogy: Demonstration/Experiential Learning/Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasio n/ type	**Marks**
Total	**25Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	B.Sc Practical Physics by C. L Arora.
2	B.Sc Practical Physics by Harnam Singhand P.SHemne.
3	Practical Physics by G.S Squires.
4	Scilab ManualforCC-XI:Quantum Mechanics &Applications(32221501) by Dr. Neetu Agrawal, Daulat Ram College of Delhi.
5	Scilab Textbook Companion for Quantum Mechanics by M.C.Jain.
6	Computational Quantum Mechanics using Scilab, BIT Mesra.
7	Advanced Practical Physics for Students by Worsnop BL and Flint HT.

Activities	
1	 Atwood'sMachine Everyone is fascinated by pulleys. In this Interactive, learners will attach two objects together by a string and stretch the string over a pulley. Both an Atwood's machine and a modifiedAtwood'smachinecanbecreatedandstudies.Changetheamountofmassoneither object, introduce friction forces, and measure distance and time in order to calculate the acceleration.

Newton's Laws of Motion Force



When forces are unbalanced, objects accelerate. But what factors affect the amount of acceleration? This Interactive allows learners to investigate a variety of factors that affecttheaccelerationofaboxpushedacrossasurface,Theamountofappliedforce,themass,and the friction can be altered. A plot of velocity as a function of time can be used to determine the acceleration.

In theBalloon Car Lesson Plan, students build and explore balloon-powered cars. This lesson focuses mostly on energy, but it also demonstrates Newton's laws of motion. Guidanceisprovidedfortalkingspecificallyaboutthethirdlawofmotion.*Question*:how does the air escaping the balloon relate to Newton's third law of motion? Does the car continue to coast after the balloon is deflated? Why or why not?

Most of the activities and lessons below *focus* on one or two of the laws of motion. The Builda Balloon Car activity specifically **talks about all three of Newton's laws of motion** students can observe when building and experimenting with a simple balloon-powered car. This is an accessible hands-on activity that users cycled materials and balloons for a fun combined engineering design project and physics experiment. The activity can be used with a wide range of grade levels to introduce and demonstrate the laws of motion. See the "Digging Deeper" section for a straight forward discussion of how each law of motion. Can be identified in the balloon car activity.(For are lated lesson plan, see Balloon Car Lesson Plan, which is NGSS-aligned for middle school and focuses on the third law of motion.)

In the Push Harder — Newton's Second Law, students build their own cars using craft materials and get hands-on exploring Newton's second law of motion and the equation "force equals mass times acceleration" (F=ma). Options for gathering real-time data include using a mobile phone and a sensor app or using a meter stick and a stopwatch. *Questions*: What is the relationship between force, mass, and acceleration? As force increases, what happens to acceleration?

	 In the [Sky dive Into Forces], students make parachutes and then in vestigate how they work to slow down a falling object. As students investigate the forces that are involved, educators can introduce Newton's second law of motion and how different forces change the resulting speedo fafalling object. *Questions*: What forces helps low down the speed of a falling object? How do esaparachute helps low the fall? 
2	Both standard cameras(DSLRs, phone cameras)and our scientific cameras work on the Principle of photoelectric effect to produce an image from light, involving the use of **Photo detectors** and **sensor pixels. Prepare are proton the working of digital camera.**
3	Demonstration of Heisenberg uncertainty principle in the context of diffraction at a single slit:The uncertainty in the momentum Δp_x correspond to the angular spread of principal maxima θ. Then, $\Delta p_x = \sin\theta . p$ where p is the momentum of the incident photon. Conduct the diffraction at as lit experiment virtually using the following link *https://www.walter-fendt.de/html5/phen/singleslit_en.htm* **1.**Measure the angular spread (θ) for different slit widths (Δx) for given wavelength of the incident photon. **2.**Determine the momentum of the incident photon using $p = \frac{h}{\lambda}$ **3.**Create a line of best fit through the points in the plot against $\frac{\Delta x}{\Delta p_x}$ and find its slope. How this exercise is related to Heisenberg Uncertainty principle. Make are port of the observations.
4	Virtual lab to demonstrate Photo electric effect using *Value@ Amritha*: Conduct the virtual Experiment using the following link *https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=1* **1**.Determine the minimum frequency required to have Photo electric effect for an E Mradiation,

	When incident on a zinc metal surface. **2.** Determine the target material if the threshold frequency of EM radiation is $5.5x10^{15}$Hz in a particular photoelectric experimental set up. **3.** Determine the maximum kinetic energy of photo-electrons emitted from a Zinc metal surface, if the incident frequency is $3x10^{15}$Hz. **4.** What should be the stopping potential for photoelectrons if the target Material used is Platinum and incident frequency is $2x10^{15}$ Hz? Make are port of the calculations.
5	Visualization of wave packets using Phys let @ Quantum Physics: The concept of group velocity and phase velocity of a wave packet can be studied using this link https://www.compadre.org/PQP/quantum-need/section5_9.cfm Students can take up the exercises using the link which is as follows https://www.compadre.org/PQP/quantum-need/prob5_11.cfm Six different classical wave packets are shown in the animations. Which of the wave packets have a phase velocity that is greater than/less than/equal to the group velocity? Make a Report of the observations.
6	Superposition of eigenstates in an infinite one-dimensional potential well using QuV is (Quantum Mechanics Visualization Project): Construct different possible states by considering the first three Eigen states and study the variation of probability density with position. Take the challenges after understanding the simulation and submit the report. The link is as follows https://www.standrews.ac.uk/physics/quvis/simulations_html5/sims/SuperpositionStates/SuperpositionStates.html
7	Determination of expectation values of position, momentum for a particle in infinite one -dimensional potential well using Phys let @ Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob10_3.cfm A particle is in a one-dimensional box of length $L = 1$. The states shown are normalized. The results of the integrals that give $<x>$ and $<x^2>$ and $<p>$ and $<p^2>$. You may vary n from 1 to 10. a) What do you notice about the values of $<x>$ and $<x^2>$ as you vary n? b) What do you think $<x^2>$ should become in the limit of $n \rightarrow \infty$? Why? c) What do you notice about the values of $<p>$ and $<p^2>$ as you vary n? Make a report of the calculations.
8	Determination of expectation values for a particle in a one-dimensional harmonic oscillator Using Physlet @ Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob12_2.cfm A particle is in a one-dimensional harmonic oscillator potential ($\hbar=2m=1;\omega=k=2$). The states how nare normalized. Shown are ψ and the results of the integrals that give $<x>$and$<x^2>$and$<p>$and$<p^2>$.Vary$n$from1to10. a) What do you notice about how $<x>$and$<x^2>$and$<p>$and$<p^2>$change? b) Calculate $\Delta x.\Delta p$ for$n=0$.Whatdoyounoticeconsidering$\hbar=1$? c) What is E_n? How does this agree with or disagree with the standard case for the harmonic oscillator? d) How much average kinetic and potential energies are in an arbitrary energy state? Make are port of the calculations.
9	Calculate uncertainties of position and momentum for a particle in a box using Physlet@QuantumPhysics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob6_3.cfm A particle is in a one-dimensional box of length $L= 1$.The states shown are normalized. The results of the integrals that give$<x>$and$<x^2>$, and$<p>$and$<p^2>$.Youmayvary$n$from1to 10.

	a. For$n$=1, what are Δx and Δp?
	b. For$n$=10, what are Δx and Δp?
10	Write expressions for the three wave functions using Physlet@QuantumPhysics: The link to the Visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob8_1.cfm These an imations show the real(blue) and imaginary (pink) parts of three time-dependent energy eigen functions. Assume x is measured in cm and time is measured in seconds. a. Write an expression for each of the three time-dependent energy eigen functions in the form:$e^{i(kx-wt)}$. b. What is the mass of the particle? c. What would the mass of the particle be if time was being shown in ms? Make a report of the calculations.
11	If you store a file on your computer today, you probably store I ton asolid-state drive(SSD), Make a detailed report on the role of quantum tunneling in these devices.

Semester V BSc
Core Course Content

Course Title: Elements of Atomic, Molecular & Laser Physics	Course Credits: 4
Course Code: PHYC11-T	L-T-P per week: 0-0-4
Total Contact Hours**:** 64	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/
Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Curriculum

Program Name	BSc in Physics		Semester	V
Course Title	**Elements of Atomic, Molecular & Laser Physics (Theory)**			
Course Code	PHYC11-T		No. of Credits	04
Contact Hours	60Hours		Duration of SEA/Exam	02 Hours
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Pre-requisite(s): PUC Science Knowledge	
Course Outcomes(COs): After the completion of the course, the student will be able to • Describe atomic properties using basic atomic models. • Interpret atomic spectra of elements using vector atom model. • Interpret molecular spectra of compounds using basics of molecular physics. • Explain laser systems and their applications in various fields.	
Contents	**60Hours**
Basic Atomic models Thomson's atomic model-Drawback; Rutherford atomic model -Drawback, Theory of alpha particle scattering (no derivation); Rutherford scattering formula -Derivation; Bohr atomic model – postulates, Derivation of expression for radius, total energy of electron; Origin of the spectral lines; Spectral series of hydrogen atom -Drawback; Effect of nuclear motion on atomic spectra – derivation; Ritz combination principle; Correspondence principle; Critical potentials – critical potential, excitation potential and ionization potential; Franck-Hertz experiment; Sommerfeld's atomic model, Derivation of condition for allowed elliptical orbits. Numerical problems. **12Hours** **Activities:** **03Hours** 1. Students to estimate radii of orbits and energies of electron in case of hydrogen atom in different orbits and plot the graph of radii /energy versus principal quantum number 'n'. Analyze the nature of the graph and draw the inferences. 2. Students to search critical, excitation and ionization potentials of different elements and plot the graph of critical /excitation/ionisation potentials versus atomic number/mass number/neutron number of element. Analyze the nature of the graph and draw the inferences.	15
Vector atomic model and optical spectra Vector atom model – model fundamentals, spatial quantization, spinning electron; Quantum numbers associated with vector atomic model; Coupling schemes– L-S and j-j schemes; Pauli's exclusion principle; Magnetic dipole moment due to orbital motion of electron – derivation; Magnetic dipole moment due to spin motion of electron; Lande g-factor and its calculation for different states; Stern-Gerlach experiment–Experimental arrangement and Principle; Fine structure of spectral lines with examples; Spin-orbit coupling/Spin-Orbit Interaction – qualitative; Optical spectra – spectral terms, spectral notations (Examples), selection rules, intensity rules; Fine structure of the sodium D-line; Zeeman effect: Types, Experimental study shift expression (no derivation), Numerical problems. **12Hours**	15

Activities: **03Hours** 1. Students to couple a p-state and s-state electron via L-S and j-j coupling schemes for a systemwithtwoelectronsandconstructvectordiagramsforeachresultant.Analyze the coupling results and draw the inferences. 2. Students to estimate magnetic dipole moment due to orbital motion of electron for different states $^2P_{1/2}$, $^2P_{3/2}$, $^2P_{5/2}$, $^2P_{7/2}$, $^2P_{9/2}$and $^2P_{11/2}$and plot the graph of dipole momentversustotalorbitalangularmomentum"J'.Analyzethenatureofthegraph and draw the inferences.	
Molecular Physics Types of molecules based on their moment of inertia ;Types of molecular motions and energies; Born-Oppenheimer approximation; Origin of molecular spectra; Nature of molecular spectra; Theory of rigid rotator- theory of pure rotational spectrum of a molecule , energy levels and spectrum, Qualitative discussion on Non- rigid rotator and centrifugal distortion; Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum (derivation :an expression for the frequency of vibration of a diatomic molecule) Electronic spectra of molecules – fluorescence and phosphorescence; Raman effect Experimental arrangement , quantum theory of Raman effect – Stoke's and anti-Stoke's lines, characteristics of Raman spectra, intensity and polarization of Raman lines, Applications of Raman effect. Numerical problems. **12Hours** **Activities:** **03Hours** 1. Students to estimate energy of rigid diatomic molecules CO, HCl and plot the graph of rotational energy versus rotational quantum number 'J'. Analyse the nature of the graph and draw the inferences. Also students study the effect of isotopes on rotational energies. 2. Students to estimate energy of harmonic vibrating molecules CO, HCl and plot the graph of vibrational energy versus vibrational quantum number 'v'.Analyse the nature of the graph and draw the inferences.	15
Laser Physics Ordinary light versus laser light; Characteristics of laser light; Interaction of radiation with matter - Induced absorption, spontaneous emission and stimulated emission with mention of rate equations; Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density; Possibility of amplification of light; Population inversion; Methods of pumping; Metastable states; Requisites of laser – energy source, active medium and laser cavity; Types of lasers with examples; Construction and Working principle of Ruby Laser and He-Ne Laser; Application of lasers (qualitative)in science & research, isotope separation, communication, fusion, medicine, industry, war and space. Numerical problems. **12Hours** **Activities:** **03Hours** 1. Students to search different lasers used in medical field (ex: eyes surgery, endoscopy, dentistry etc.), list their parameters and analyse the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study. 2. Students to search different lasers used in defense field (ex: range finding, laser weapon, etc.), list their parameters and analyse the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study.	15

Pedagogy: Lecture/PPT/Videos/Animations/RolePlays/Think-Pair-Share/Predict-Observe-Explain/Demonstration/Conceptmapping/CaseStudiesexamples/Tutorial/Activity/FlippedClassroom/Jigsaw/

Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ ProblemBasedLearning/GameBasedLearning/GroupDiscussion/CollaborativeLearning/Experiential Learning /Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Total	**40Marks**
Formative Assessment as per UNIVERSITY guide lines are compulsory	

References	
1	Modern Physics, R.Murugeshan,KiruthigaSivaprakash,RevisedEdition,2009,S.Chand& Company Ltd.
2	Atomic& Molecular spectra: Laser, Raj Kumar, Revised Edition,2008,KedarNathRamNath Publishers, Meerut.
3	AtomicPhysics,S.N.Ghoshal,RevisedEdition,2013, S.Chand & Company Ltd.
4	ConceptsofAtomicPhysics,S.P.Kuila,FirstEdition,2018,New Central Book Agency(P) Ltd.
5	Concepts of Modern Physics, Arthur Beiser, Seventh Edition,2015,ShobhitMahajan,S.Rai Choudhury,2002,McGraw-Hill.
6	Fundamentals of Molecular Spectroscopy, C.N. Ban well and E.M. Mc Cash, Fourth Edition,2008, Tata McGraw-Hill Publishers.
7	Elements of Spectroscopy–Atomic, Molecular and Laser Physics, Gupta, Kumar and Sharma, 2016,PragatiPublications.

Course Title	Elements of Atomic, Molecular &Laser Physics(Practical)	Practical Credits	02
Course Code	PHYC12-P	Contact Hours	04Hours

Formative Assessment	25Marks	Summative Assessment	25Marks

Practical Content

NOTE: Students have to per format –least EIGHT Experiments from the list below

LIST OF EXPERIMENTS

1. To determine Planck's constant using Photocell.
2. To determine Planck's constant using LED.
3. To determine wavelength of spectral lines of mercury source using spectrometer.
4. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.
7. To determine the ionization potential of Mercury/Xenon.
8. To determine the absorption lines in the rotational spectrum of Iodine vapour.
9. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
10. To determine the wavelength of laser using diffraction by singles lit/doubles lits.
11. To determine wavelength of He-Ne laser using plane diffraction grating.
12. To determine angular spread of He-Ne laser using plane diffraction grating.
13. Study of Raman scattering by CCl_4 using laser and spectrometer/CDS.
14. To determine the diameter of the given wire by LASER diffraction.
15. Analysis of Stellar Spectra.
16. Analysis of Band Spectra.

Pedagogy: Demonstration/ Experiential Learning/Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Total	**25Marks**
Formative Assessment as per UNIVERSITY guide lines are compulsory	

References	
1	Practical Physics, D.C.Tayal, First Millennium Edition, 2000, Himalaya Publishing House.
2	B.Sc. Practical Physics, C.L.Arora, Revised Edition, 2007, S.Chand & Comp.Ltd.
3	An Advanced Course in Practical Physics, D.Chatopadhyaya, P.C.Rakshith, B.Saha, Revised Edition, 2002, New Central Book Agency Pvt. Ltd.
4	Physics through experiments, B.Saraf, 2013,Vikas Publications.

Semester VI BSc
Core Course Content

Course Title: Elements of Condensed Matter & Nuclear Physics	Course Credits: 4
Course Code: PHYC14 - T	L-T-P per week: 0-0-4
Total Contact Hours: 64	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/
Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

B.Sc. in Physics VI Semester

Curriculum

Program Name	BSc in Physics	**Semester**	**VI**
Course Title	**Elements of Condensed Matter & Nuclear Physics(Theory)**		
Course Code	**PHYC14 - T**	**No. of Credits**	**4**
Contact Hours	**60Hours**	**Duration of SEA/Exam**	**2Hours**
Formative Assessment Marks	**40**	**Summative Assessment Marks**	**60**

Course Pre-requisite(s):

Course Out comes(COs): After the successful completion of the course, the student will be able to:

- Explainthebasicpropertiesofnucleusandgettheideaofitsinnerinformation.
- Understand the concepts of binding energy and binding energy per nucleon v/s mass number graph.
- Describe the processes of alpha, beta and gamma decays based on well-established theories.
- Explain the basic aspects of interaction of gamma radiation with matter by photoelectric effect, Compton scattering and pair production.
- Explain the different nuclear radiation detectors such as ionization chamber, Geiger-Mueller counter etc.
- Explain the basic concept of scintillation detectors, photo-multiplier tube and semiconductor detectors.

Contents	**60 Hours**
Crystal systems and X-rays: Crystal structure**:** Space Lattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells.. Seven crystal system, Coordination numbers, Miller Indices, Expression for inter planner spacing. **X Rays**: Production and properties of X rays, Coolidge tube, Continuous and characteristic X-ray spectra; Moseley's law. **X-Ray diffraction**, Scattering of X-rays, Bragg's law. **Crystal diffraction:** Bragg's X-ray spectrometer- powder diffraction method, Intensity v/s 2θ plot (qualitative), Compton effect- expression for Compton shift (derivation). Numerical problems. **Free electron theory of metals:** Classical free electron model (Drude-Lorentz model), expression for electrical and thermal conductivity, Weidman-Franz law, Failure of classical free electron theory; Quantum free electron theory, Fermi level and Fermi energy, Fermi-Dirac distribution function (expression for probability distribution F(E), statement only); FermiDirac distribution at T=0 and $E<E_f$, at T≠ 0 and $E>E_f$, F(E) vs E plot at T = 0 and T≠ 0.Density of states for free electrons (statement only, no derivation). Hall Effect in metals. Numerical problems. **12HOURS** **ACTIVITIES: 03HOURS** • Ask students to build 3D models of crystal lattices using materials like Styrofoam balls and toothpicks. They can model simple cubic, face-centred cubic (FCC), and body-centred cubic (BCC) lattices, helping them visualize lattice structures.	15

• Ask students to create physical models of each of the seven crystal systems (cubic, tetragonal, orthorhombic, hexagonal, monoclinic, triclinic, and rhombohedral). This activity will help them understand the geometric differences between the systems. • Use graphing tools or simulations to visualize the density of states for free electrons. Students can compare the density of states in 1D, 2D, and 3D systems and discuss how the dimensionality affects the electronic properties.	
Magnetic Properties of Matter, Dielectrics and Superconductivity **Magnetic Properties of Matter:** Review of basic formulae: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, magnetization(M),Relation between magnetic susceptibility and relative permeability, Classification of Dia, Para, and ferromagnetic materials-Characteristics; Langevin Classical Theory of dia and Para magnetism. Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of B-H Curve. Hysteresis and Energy Loss, Hard and Soft magnetic materials. **Dielectrics**:Definition and types of dielectric, Static dielectric constant, polarizability (electronic, ionic and orientation), calculation of Lorentz field(derivation), Clausius-Mosotti equation (derivation),dielectric loss. **Superconductivity:** Definition, Experimental results – Zero resistivity and Critical temperature– The critical magnetic field–Meissner effect, Type I and type II superconductors, applications. Numerical Problems. **12Hours** **ACTIVITIES:** **03Hours** • Provide samples or descriptions of various materials and ask students to classify them as diamagnetic, paramagnetic, or ferromagnetic. Students should discuss the properties that lead to their classification. • Conduct a lab experiment to measure dielectric loss in various materials using an impedance analyzer. Students can analyze the frequency dependence of dielectric loss and discuss its practical implications. • Show videos of experiments demonstrating zero resistivity and the Meissner effect. Students can discuss the significance of these observations in the context of superconductivity.	15
General Properties of Nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about nuclear mass, nuclear radius, nuclear charge, nuclear density (matter density), binding energy, main features of binding energy versus mass number curve, packing fraction, angular momentum of the nucleus, parity, nuclear magnetic dipole moment, electric quadrupole moment. **Radioactivity decay:** definition of radioactivity, definition and derivation of half-life, definition and derivation of mean life, Successive disintegration radioactivity equilibrium (secular and Transient). (a) Alpha decay: basics of α-decay processes, a brief theory of α emission, Gamow factor, Geiger-Nuttal law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. Nuclear isomerism and internal conversion. (c) Gamma decay: Gamma rays' emission & kinematics, Numerical Problems. **12Hours** **ACTIVITIES:** **03Hours** • Use a simulation tool to visualize the structure of the nucleus, including protons, neutrons, and their interactions. Students can explore how changing the number of protons and neutrons affects the nucleus's properties.	15

• Organize a class discussion or lab session where students analyze the shape of the binding energy curve and explain why certain regions are more stable than others. • Assign problems where students calculate the half-life and mean life of radioactive materials from given decay data. Include exercises on radioactive equilibrium, where students calculate the activity of radioactive series.	
Interaction of Nuclear Radiation with matter: Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production. **Detector for Nuclear Radiations**: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility) qualitative only, Accelerators: Cockcroft-Walton voltage multiplier, LINAC, Cyclotrons and Synchrotrons. Numerical Problems. **12Hours** **ACTIVITIES: 03Hours** • Use a simulation tool to visualize how gamma rays interact with different materials. Students can observe how gamma rays are absorbed, scattered, or transmitted through various thicknesses of matter. • Use interactive simulations to demonstrate how gas detectors like ionization chambers and Geiger-Müller (GM) counters work. Students can explore how these detectors measure radiation and how their efficiency depends on the electric field and gas properties. • Organize a discussion on the principles of semiconductor detectors, including charge carriers and mobility. Students can compare silicon and germanium detectors and their applications in detecting charged particles and photons.	15
Suggested Activities:	
1) Students to constructs even crystal systems with bam boo sticks and rubber bands. Use foam Balls atoms and study the BCC and FCC systems. 2)Students to search the characteristic X-ray wave length of different atoms/ elements and plot characteristic wavelength v/s atomic number and analyse the result and draw the inference. 3)Magnetic field lines are invisible. Students to trace the magnetic field lines using bar magnet and needle compass.https://nationalmaglab.org/magnet-academy/try-this-at-home/drawing-magnetic-field-lines/, 4)Using vegetable oil and iron fillings students to make ferro fluids and see how it behave sin the presence of magnetic field. https://nationalmaglab.org/magnet-academy/try-this-at- home/making-ferro fluids/ 1)Study the decay scheme of selected alpha, beta & gamma radioactive sources with the help of standard nuclear data book. 2)Calculate binding energy of some selected light, medium and heavy nuclei. Plot the graph of binding energy versus mass number A 3)Study the decay scheme of standard alpha, beta and gamma sources using nuclear data book. 4)Make the list of alpha emitters from Uranium series and Thorium series. Search the kinetic energy of alpha particle emitted by these alpha emitters. Collect the required data such as half life or decay constant. Verify Geiger- Nuttal in each series. 5)Study the Z dependence of photoelectric effect cross section. 6)Study the Z dependence of common cross section for selected gamma energies and selected elements through theoretical calculation.	
7) List the materials and their properties which are used for photo cathode of PMT. 8) Study any two types of PMT and their advantages and disadvantages.	

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/Conceptmapping/CaseStudiesexamples/Tutorial/Activity/FlippedClassroom/Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ ProblemBasedLearning/GameBasedLearning/GroupDiscussion/CollaborativeLearning/Experiential Learning /Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
Total	**40Marks**
Formative Assessment as per UNIVERSITY guide lines are compulsory	

References

1. Solid State Physics- R. K. Puri and V. K. Babber. , S. Chand publications, 1st Edition(2004).
2. Fundamentals of Solid State Physics- B. S. Saxena, P.N. Saxena, Pragatiprakashan Meerut(2017).
3. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
4. Nuclear Physics, Irving Kaplan, Narosa Publishing House
1. Introduction to solid State Physics, ***Charles Kittel***, VII edition, (**1996**)
5. Solid State Physics-**AJ Dekker**, MacMillan India Ltd,(**2000**)
6. Essential of crystallography**, MA Wahab**, Narosa Publications (**2009)**
7. Solid State Physics-**SO Pillai** –New Age Int. Publishers (**2001**).
8. Concepts of nuclear physics by BernardL. Cohen.(Tata Mc Graw Hill,1998).
9. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia,2004).
10. Introduction to High Energy Physics, D. H. Perkins, Cambridge Univ. Press
11. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP) Publishing, 2004).
12. Radiation detection and measurement, G. F. Knoll (John Wiley &Sons, 2000).
13. Physics and Engineering of Radiation Detection, Syed NaeemAhmed (Academic Press, Elsevier, 2007).

Course Title	Elements of Condensed Matter & Nuclear Physics (Practical)	Practical Credits	02
Course Code	PHYC15–P	Contact Hours	04Hours
Formative Assessment	25Marks	Summative Assessment	25Marks

Practical Content

(At least 4 experiments from CMP and 4 experiments from NP are to be performed)

CONDENSED MATTER PHYSICS(CMP)

1. Hall Effect in semiconductor: determination of mobility, hall coefficient.
2. Energy gap of semiconductor (diode/transistor).
3. Temperature coefficient of resistance of a Thermistor.
4. Fermi Energy of Copper.
5. Analysis of X-ray diffraction spectra and calculation of lattice parameter.
6. Specific Heat of Solid by Electrical Method
7. Determination of Dielectric Constant of polar liquid.
8. Determination of dipole moment of organic liquid
9. B-H Curve Using CRO.
10. Determination of particle size from XRD pattern using Debye-Scherrer formula.
11. Measurement of susceptibility of paramagnetic solution (Quinck`sTubeMethod).
12. Measurement of susceptibility of paramagnetic solid (Gouy's Method)
13. Determination of particle size from XRD pattern using Williamson Hall Plot.

NUCLEARPHYSICS(NP)

1. Study the characteristics of Geiger-Mùller Tube. Determine the threshold voltage, plateau region and operating voltage.
2. Study of inverses quare law of gamma rays using GM tube.
3. Detrmination of range of electrons in aluminium using GM Counter.
4. Study the absorption of beta particles in aluminium foils using GM counter. Determine mass attenuation coefficient of Aluminium foils.
5. Study the absorption of betaparticles in thin copper foils using GM counter and determine mass attenuation coefficient.
6. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculate mass attenuation coefficient of Lead for Gamma.
7. DeterminetheendpointenergyofTl-204sourcebystudyingtheabsorptionofbetaparticlesin aluminium foils.
   Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source andG M counter.
8. Cockroft-Walton Voltage multiplier.

Pedagogy: Demonstration / Experiential Learning/ Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Total	**25Marks**
Formative Assessment as per UNIVERSITY guide lines are compulsory	

References	
1	IGNOU: Practical Physics Manual
2	Saraf : Experiment in Physics, Vikas Publications
3	S. P. Singh : Advanced Practical Physics
4	Melissons : Experiments in Modern Physics
5	Misra and Misra, Physics Lab. Manual, South Asian publishers, (**2000**)
6	Gupta and Kumar, Practical physics, Pragatiprakashan, (**1976**)

Semester VI BSc
Core Course Content

Course Title: Electronic Instrumentation & Sensors	Course Credits: 4
Course Code: PHYC16 - T	L-T-P per week: 0-0-4
Total Contact Hours**:** 64	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
	C2 First component	10
	C2 Second Component	10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/
Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Curriculum

Program Name	BSc in Physics	**Semester**	**VI**
Course Title	**Electronic Instrumentation & Sensors(Theory)**		
Course Code:	**PHYC16 - T**	**No. of Credits**	**04**
Contact Hours	**60Hours**	**Duration of SEA/Exam**	**2Hours**
Formative Assessment Marks	**40**	**Summative Assessment Marks**	**60**

Course Pre-requisite(s):

Course Outcomes(COs): After the successful completion of the course, the student will be able to:

- Identify different types of tests and measuring instruments used in practice and understand their basic working principles.
- Get hands on training in wiring a circuit, soldering, making a measurement using an electronic circuit used in instrumentation.
- Have an understanding of the basic electronic components viz., resistors, capacitors, inductors, discrete and integrated circuits, color codes, value sand pin diagram, their practical use.
- Understanding of the measurement of voltage, current, resistance value, identification of the terminals of a transistor and ICs.
- Identify and understand the different types of transducers and sensors used in robust and hand-held instruments.
- Understand and give a mathematical treatment of the working of rectifiers, filter, data converters and different types of transducers.
- Connect the concepts learn tin the course to their practical use in daily life.
- Develop basic hands-on skills in the usage of oscilloscopes, multi meters, rectifiers, amplifiers, oscillators and high voltage probes, generators and digital meters.
- Servicing of simple faults of domestic appliances: Iron box, immersion heater, fan, hot plate, battery charger, emergency lamp and the like.

Contents	**60Hours**
Power supply Properties of AC, AC power and its characteristics, Single phase and three phase systems, Configurations of three phase systems, Need for DC power supply and its characteristics, the line voltage and frequency of AC power, Rectifier bridge, Filters: Capacitor and inductor filers, L-section and π-section filters, ripple factor, electronic voltage regulators: different types, Zener controlled transistor voltage regulator, voltage stabilization factor, voltage regulation using ICs , types of IC voltage regulators, working principle , key components and applications of IC voltage regulators. **Basic electrical measuring instruments** Cathode ray oscilloscope- Block diagram, basic principle, electron beam, CRT features, display of signal waveform on CRO, deflection sensitivity of CRT, various controls of CRO, mention of applications of CRO. Basic elements of digital storage oscilloscopes. Basic DC voltmeter for measuring potential difference, Extending Voltmeter range, AC voltmeter using rectifiers, Basic DC ammeter, requirement of a shunt, Extending of ammeter ranges. Numerical Problems. **Topics for self-study:** Average value and RMS value of current, Ripple factor, Average AC input power and DC output power, efficiency of a DC power supply. Multi range voltmeter and ammeter. **12 Hours**	15

ACTIVITIES: **03Hours** Design and wire your own DC regulated power supply. Power output :5V,10V,±5V. Components required: A step down transformer, semiconductor diodes (BY126/127), Inductor, Capacitor, Zener diode or 3-pin voltage regulator or IC. Measure the ripple factor and efficiency at each stage. Tabulate the result. 1. Extend the range of measurement of voltage of a voltmeter (analog or digital) using external component and circuitry. Design your own circuit and report. 2. Measure the characteristics of the signal waveform using a CRO and function generator. Tabulate the frequency and time period. Learn the function of Trigger input in an CRO. 3. Learn to use a Storage Oscilloscope for measuring the characteristics of a repetitive input signal. Convince yourself how signal averaging using Storage CRO improves S/N ratio.	
Wave form generators and Filters Basic principle of standard AF signal generator: Fixed frequency and variable frequency, AF sine and square wave generator, basic Wein-bridge network and oscillator configuration, Triangular and saw tooth wave generators, circuitry and waveforms, Study of Function Generator. Passive and active filters. Types of filters, Circuitry and Cut-off frequency and frequency response of Passive (RC) and Active (op-amp based) filters: Low pass, high pass and band pass, Reject and all pass. Solving of Function Generator. Numerical Problems. **12Hours** **ACTIVITIES:** **03Hours** 1. Measure the amplitude and frequency of the different waveforms and tabulate the results. Required instruments: A10MHz oscilloscope, Function generators (sine wave and square wave). 2. Explore where signal filtering network is used in real life. Visit an ear by telephone Exchange and discuss with the Engineers and technicians. Prepare are port. 3. Explore op-amp which works from a single supply biasing voltage (+15V). Construct an inverting/non- inverting amplifier powered by a single supply voltage instead of dual or bipolar supply voltage. 4. Op-amp is a linear (analog) IC. Can it be used to function as logic gates? Explore, construct and implement AND, OR NAND and NOR gate functions using op- amps. Verify the truth table. Hint: LM3900 op-amp may be used. The status of the output may be checked by LED.	15

Data Conversion and display Digital to Analog converters-D/A converter - Variable resistor network, Ladder type (R-2R) D/A converter, Analog to Digital converters - counter comparator ADC, successive approximation type ADC Digital display systems and Indicators - Light Emitting Diodes (LED) and Liquid Crystal Display (LCD) – Structure and working. Elements of TV transmission, scanning types, composite video signal and its components. TV standards. Elements of TV reception - Block diagram (Monochrome). Basics of color television. Numerical Problems. **12Hours** Topic for self-study: Lock-in amplifier and its application, phase locked loop. **ACTIVITIES:** **03Hours** **Activities** 1. Explore where modulation and demodulation technique is employed in real life. Visit a Radio broadcasting station. (Aakashavani or Private). Prepare a report on different AM and FM stations. 2. Exploreandfindoutthedifferencebetweenastandardop-ampandaninstrumentation op-amp. Compare the two and prep area report.	15
Transducers and sensors Definition and types of transducers. Basic characteristics of an electrical transducer, factors governing the selection of a transducer, Resistive transducer-potentiometer, Strain gauge and types (general description), Resistance thermometer-platinum resistance thermometer. Thermistor. Inductive Transducer-general principles, Linear Variable Differential Transducer (LDVT)- principle and construction, Capacitive Transducer- Advantage and Disadvantages), Piezoelectric Transducer-Applications, Photoelectric transducer, Photovoltaic Cell-Principle and working, photo diode Principle and working and phototransistor Principle and working. Numerical problems. **12Hours** **ACTIVITIES:** **03Hours** **Activities** 1. Construct your own thermocouple for the measurement of temperature with copper and constantan wires. Use the thermocouple and a Digital multi meter (DMM). Record the emf (voltage induced) by maintaining one of the junctions at a constant temperature (say at 0^oC, melting ice) and another junction at variable temperature bath. Tabulate the voltages induced and temperatures read out using standard chart (Chart can be downloaded from the internet). Observe a solar water heater. Some solar water heaters are fitted with an anode rod (alloy of aluminium). Study why it is required. Describe the principle behind solar water heater. **Pedagogy:** Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict- Observe-Explain/ Demonstration/Conceptmapping/CaseStudiesexamples/Tutorial/Activity/FlippedClas sro om/Jigsaw/Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/GameBasedLearning/GroupDiscussion/CollaborativeLearning/Experiential Learning /Self Directed Learning etc.	15

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Total	**40Marks**
Formative Assessment as per UNIVERSITY guide lines are compulsory	

References

1. Physics for Degree students (Third Year) C.L.AroraandP.S.Hemne, S. Chand and Co. Pvt. Ltd. 2014 (ForUnit-1, Power supplies)
2. Electronic Instrumentation, 3rd Edition, H.S. Kalsi, McGraw Hill Education India Pvt. Ltd. 2011 (For rest of the syllabus)
3. Physics for Degree students (ThirdYear)–C.L.AroraandP.S.Hemne, S. Chand and Co. Pvt. Ltd. 2014 (ForUnit-1,Power supplies)
4. Instrumentation – Devices and Systems (2nd Edition)– C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill Education Pvt. Ltd. (Especially for circuitry and analysis of signal generators and filters)

Course Title	**Electronic Instrumentation & Sensors (Practical)**	**Practical Credits**	**02**
Course Code	**PHYC17 –P**	**Contact Hours**	**04 Hours**
Formative Assessment	**25 Marks**	**Summative Assessment**	**25 Marks**

Practical Content

List of experiments (At least 8 experiments to be performed)

1. Bridge rectifier with and without filter
2. Phase measurement in LCR circuit using CRO
3. Study of Zener diode as a voltage regulator.
4. RC low pass and high pass filters.
5. Calibration of a low range voltmeter using a potentiometer
6. Calibration of an ammeter using a potentiometer
7. Study of Wien bridge oscillator
8. Study the frequency response of a first order op-amp low pass filter
9. Study the frequency response of a first order op-amp high pass filter
10. Study of LDR Characteristics.
11. Study the characteristics of *pn*-junction of a solar cell and determine its efficiency.
12. Study the illumination intensity of a solar cell using a standard photo detector (e.g., lux meter).
13. Determine the coupling coefficient of a piezo- electric crystal.
14. Study the amplitude modulation using a transistor.
15. Performance analysis of A/D and D/A converter using resistor ladder network and op-amp.

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/Conceptmapping/CaseStudiesexamples/Tutorial/Activity/FlippedClassroom/Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ ProblemBasedLearning/GameBasedLearning/GroupDiscussion/CollaborativeLearning/Experiential Learning /Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
Total	**25Marks**
Formative Assessment as per University guide lines are compulsory	

References
1. Advanced Practical Physics for students,B.L.FlintandH.T.Worsnop,1971,AsiaPublishi ng House. 2. B.Sc. Practical Physics, C.L.Arora (Revised Edition),S.Chand and Co.Ltd. 2007 3. PracticalPhysics,D.C.Tayal,FirstMillenniumEdition,HimalayaPublishingHouse, 2000

Employ ability and skill development

The whole syllabus is prepared with a focus on employability.

Skill development achieved: Fundamental understanding of the working of test and measuring instruments. Operating and using them for measurements. Servicing of laboratory equipment for simple cable faults, loose contacts and discontinuity.

Job opportunities: Lab Assistant/Scientific Assistant in hospitals, R and D institutions, educational in situatio

NEP 2020 From the Academic Year 2023 – 2024 onwards

SUBJECT – PHYSICS

BLUE PRINT

For Semester V ,VI

Time – 02 hours 30min **Max. Marks – 60**

Part - A

Answer any SIX questions **6X2=12 Marks**

1.	Concept / understanding / application based short answer questions to be set	Total eight questions to be set with two questions from each unit.	2 marks
2.			2 marks
3.			2 marks
4.			2 marks
5.			2 marks
6.			2 marks
7.			2 marks
8.			2 marks

Part - B

Answer any THREE questions **3 X 12=36 Marks**

9.	Theory, short or long derivations to be set.	Total four questions to be set with one question from each unit of the syllabus. Each question in this part shall contain sub divisions a,b,c or a & b	12 marks
10.			12 marks
11.			12 mark
12.			12 marks

Part - C

Answer any THREE questions **3 X 4=12 Marks**

13.	Numerical problems/ application oriented questions to be set.	Total four questions to be set with one question from each unit of the syllabus.	4 marks
14.			4 marks
15.			4 marks
16.			4 marks