RANI CHANNAMMA UNIVERSITY, BELAGAVI

PROGRAM /COURSE STRUCTURE AND SYLLABUS

Of

PHYSICS

as per the Choice Based Credit System (CBCS) designed in accordance with
Learning Outcomes-Based Curriculum Framework (LOCF) of National Education Policy (NEP) 2020
for

Bachelor of Science (Physics)

V and VI Semester

(Two major system)

w.e.f.

Academic Year 2023-24 and onwards

ROGRAM STRUCTURE

Curricular and Credits Structure of Physics as one of the two majors for the V and VI semester Physics B.Sc. Undergraduate Programme with effect from 2023-24.

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC5	21BSC5C5PHY1L	Classical Mechanics-I and Quantum Mechanics-I	40	60	100	4	-	-	4	2
	21BSC5C5PHY1P	Classical Mechanics-I and Quantum Mechanics-I Practical	25	25	50	-	-	4	2	3
DSC6	21BSC5C5PHY2L	Elements of Atomic, Molecular and Laser Physics	40	60	100	4	-	-	4	2
	21BSC5C5PHY2P	Elements of Atomic, Molecular and Laser Physics Practical	25	25	50	-	-	4	2	3
DSC7	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
DSC8	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
SEC3	21BSC5SEC3	Employability Skills: Electrical Circuits and Network Skills	25	25	50	2	-	2	3	-
Total Marks					**650**	**Semester Credits**			**27**	

SEMESTER-VI

Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
			IA	SEE	Total	L	T	P		
Physics as Major Discipline										
DSC9	21BSC6C6PHY1L	Elements of Condensed Matter & Nuclear Physics	40	60	100	4	-	-	4	2
	21BSC6C6PHY1P	Elements of Condensed Matter & Nuclear Physics Practical	25	25	50	-	-	4	2	3
DSC10	21BSC6C6PHY2L	Electronic Instrumentation & Sensors	40	60	100	4	-	-	4	2
	21BSC6C6PHY2P	Electronic Instrumentation & Sensors Practical	25	25	50	-	-	4	2	3
DSC11	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
DSC12	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
INT	21BSC6IN1PHYIN	Internship / Mini Research Project	-	-	50	3 to 4 weeks			2	Report & Presentation
					Total Marks	**650**	**Semester Credits**		**26**	

SEMESTER - V

Program Name	BSc in Physics	**Semester**	V
Course Title	Classical Mechanics and Quantum Mechanics- I **(Theory)**		
Course Code	21BSC5C5PHY1L	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	02 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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.
- Understand the concept of tunnelling.

Contents	**60 Hrs**
UNIT I **Introduction to Newtonian Mechanics**: Frames of references, Newton's laws of motion, inertial and non-inertial frames. Mechanics of a particle, Conservation of linear momentum, Angular momentum and torque, conservation of angular momentum, 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. **12 Hours** **Activities:** **03 Hours**	15
UNIT II **Relativity:** Newtonian principle of relativity. Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. . **12Hours** **Activities:** **03 Hours**	15

UNIT III **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. Compton scattering: Expression for Compton shift (With derivation). 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, 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? Two-slit experiment with photons and electrons. Linear superposition principle as a consequence. **12 Hours** **Activities: 03 Hours**	15
UNIT IV Foundation of Quantum Mechanics Probabilistic interpretation of the wave function - 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, Postulates of Quantum mechanics: States as normalized wavefunctions. Applications of Schrodinger's equation – for free particle, particle in one dimensional box-derivation of Eigen values and Eigen function for infinite and finite potential well. Tunnelling. Transmission across a potential barrier, the tunnelling effect. Scanning tunnelling microscope (STM). Development of Schrodinger's equation for One dimensional Linear harmonic oscillator. Concept of zero - point energy **12 Hours** **Activities: 03 Hours**	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

References	
1	Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 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, Takwale and 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-Hill Co., 2008.
8	Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, McGraw Hill, 2003.
9	P M 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. Arora and P. S. Hemne, 1st edition, S. Chand & Company Pvt. Ltd., 2014.

PRACTICAL

Course Title	Classical Mechanics and Quantum Mechanics- I **(Practical)**	**Practical Credits**	02
Course Code	21BSC5C5PHY1P	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Contents

Lab experiments: (at least 4 experiments from 1-6 and 4 experiments from 7-16)

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 displacement of about 10° find out, in each case, the time period of the pendulum, using bobs of different 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 (say 70°) 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.

5) Study the conservation of energy and momentum using projectile motion.

6) Verification of the Principle of Conservation of Linear Momentum

7) Determination of Planck constant and work function of the material of the cathode using Photo-electric cell.

8) To study the spectral characteristics of a photo-voltaic cell (Solar cell).

9) Determination of electron charge 'e' by Millikan's Oil drop experiment.

10) To study the characteristics of solar cell.

11) To find the value of e/m for an electron by Thomson's method using bar magnets.

12) To determine the value of e/m for an electron by magnetron method.

13) To study the tunnelling in Tunnel Diode using I-V characteristics.

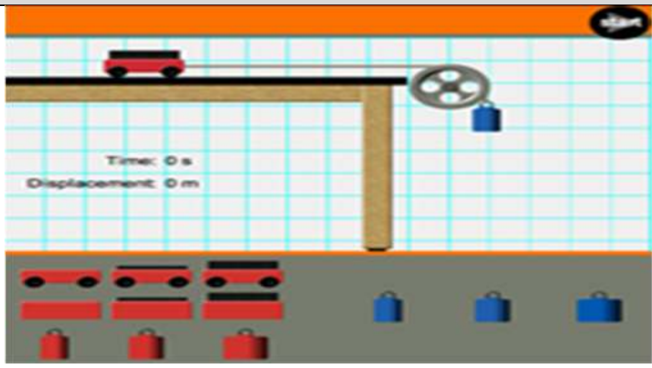
14) Determination of quantum efficiency of Photodiode.

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

	References
1	B.Sc Practical Physics by C.L Arora.
2	B.Sc Practical Physics by Harnam Singh and P.S Hemne.
3	Practical Physics by G.S Squires.
4	Scilab Manual for CC-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 B L and Flint H T.

Activities

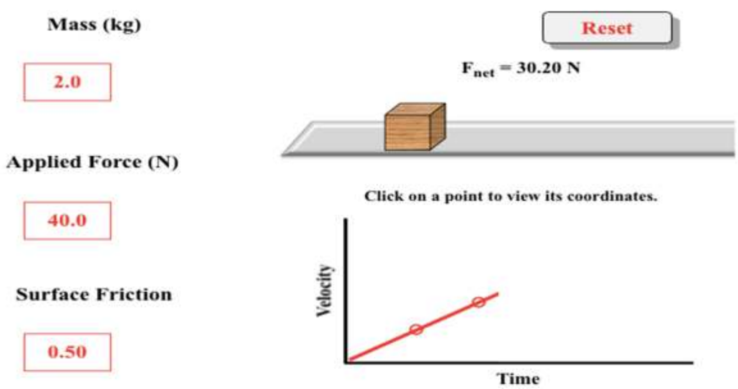
1



Atwood's Machine

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 modified Atwood's machine can be created and studies. Change the amount of mass on either 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 affect the acceleration of a box pushed across a surface, The amount of applied force, the mass, and the friction can be altered. A plot of velocity as a function of time can be used to determine the acceleration.

In the Balloon 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. Guidance is provided for talking specifically about the third law of motion. *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 Build a 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 uses recycled 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 straightforward discussion of how each law of motion can be identified in the balloon car activity. (For a related 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 Skydive Into Forces , students make parachutes and then investigate 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 speed of a falling object. *Questions*: What forces help slow down the speed of a falling object? How does a parachute help slow 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 **photodetectors** and **sensor pixels. Prepare a report on 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 a slit 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 $\frac{1}{\Delta p_x}$ against Δx and find its slope. How this exercise is related to Heisenberg Uncertainty principle. Make a report of the observations.
4	Virtual lab to demonstrate Photoelectric 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 Photoelectric effect for an EM radiation, 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 a report of the calculations.
5	Visualization of wave packets using Physlet@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 eigen states in an infinite one - dimensional potential well using QuVis (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 a an infinite one - dimensional potential well using Physlet@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 shown are normalized. Shown are ψ and the results of the integrals that give $<x>$ and $<x^2>$ and $<p>$ and $<p^2>$. Vary n from 1 to 10. 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. What do you notice considering $\hbar = 1$? 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 a report of the calculations.
9	Calculate uncertainties of position and momentum for a particle in a box using Physlet@Quantum Physics: 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 $<p^2>$. You may vary n from 1 to 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@Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob8_1.cfm These animations show the real (blue) and imaginary (pink) parts of three time-dependent energy eigenfunctions. Assume *x* is measured in cm and time is measured in seconds. a. Write an expression for each of the three time-dependent energy eigenfunctions 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 it on a solid-state drive (SSD), Make a detailed report on the role of quantum tunnelling in these devices.

SEMESTER - V

Program Name	BSc in Physics	**Semester**	V
Course Title	Elements of Atomic, Molecular & Laser Physics (Theory)		
Course Code	21BSC5C5PHY2L	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	02 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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. • Learn the importance of Statistical mechanics and different distribution functions.	
Contents	**60 Hours**
UNIT I **Basic Atomic models** Thomson's atomic model; Rutherford atomic model – Model, Theory of alpha particle scattering, Rutherford scattering formula; Bohr atomic model – postulates, Derivation of expression for radius, total energy of electron; Origin of the spectral lines; Spectral series of hydrogen atom; Effect of nuclear motion on atomic spectra - derivation; Ritz combination principle; Correspondence principle; Critical potentials – critical potential, excitation potential and ionisation potential; Atomic excitation and its types, Franck-Hertz experiment; Sommerfeld's atomic model – model, Derivation of condition for allowed elliptical orbits. **12 Hours** **Activities: 03 Hours** 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 ionisation 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
UNIT II **Vector atomic model and optical spectra** Vector atom model – model fundamentals, spatial quantization, spinning electron; Quantum numbers associated with vector atomic model; Optical spectra – spectral terms, spectral notations, selection rules. Spin-orbit coupling/Spin-Orbit Interaction (qualitative). 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; Stern-Gerlach experiment –	15

Experimental arrangement and Principle; Fine structure of spectral lines with examples. Zeeman effect: Experimental study, Types: normal and anomalous Zeeman effect, Quantum theory of normal Zeeman effect. Energy level diagram for Sodium-D lines. Paschen back effect and Stark effect (qualitative). Lande g-factor and its calculation for different states **12 Hours** **Activities: 03 Hours** 1. Students to couple a p-state and s-state electron via L-S and j-j coupling schemes for a system with two electrons and construct vector diagrams for each resultant. 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 moment versus total orbital angular momentum "J'. Analyze the nature of the graph and draw the inferences.	
UNIT III **Molecular Physics** Types of molecules based on their moment of inertia; Types of molecular motions: Rotational and Vibrational motions and energies. Microwave Spectra: Theory of rigid rotator – energy levels and spectrum. Infra-Red Spectra: Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum. Raman effect – Stoke's and anti-Stoke's lines, characteristics of Raman spectra, classical and quantum theory of Raman effect. Experimental set up of Raman Effect. Applications of Raman effect. **Laser Physics** Interaction of radiation with matter: Induced absorption, spontaneous emission and stimulated emission. Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density; Condition for amplification of light; Population inversion; Methods of pumping; Requisites of laser – energy source, active medium and laser cavity; Three level energy diagram. Construction and Working principle of Ruby Laser. Characteristics of laser light and its applications. **12 Hours** **Activities: 03 Hours** 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. 3. Students to search different lasers used in medical field (ex: eye 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. 4. 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

UNIT IV **Statistical Mechanics** Concepts of thermodynamic ensembles (micro-canonical, canonical and grand canonical ensembles). Phase Space- Micro state & Macro state. Thermodynamic probabilities. Maxwell- Boltzmann Statistics. Derivation for Maxwell- Boltzmann distribution function. Limitations of Maxwell- Boltzmann Statistics. Concepts of Bosons and fermions. Bose-Einstein Statistics. Derivation for Bose-Einstein distribution function. Fermi-Dirac Statistics. Derivation for Fermi-Dirac distribution function. Comparison of Maxwell- Boltzmann Statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics.	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

References	
1	Modern Physics, R. Murugeshan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
2	Atomic & Molecular spectra: Laser, Raj Kumar, Revised Edition, 2008, Kedar Nath Ram Nath Publishers, Meerut.
3	Atomic Physics, S.N. Ghoshal, Revised Edition, 2013, S. Chand & Company Ltd.
4	Concepts of Atomic Physics, S.P. Kuila, First Edition, 2018, New Central Book Agency (P) Ltd.
5	Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
6	Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Fourth Edition, 2008, Tata McGraw-Hill Publishers.
7	Elements of Spectroscopy – Atomic, Molecular and Laser Physics, Gupta, Kumar and Sharma, 2016, Pragati Publications.
8	1) Statistical Mechanics, An Introduction, **Evelyn Guha**, Narosa (**2008**) 2) Statistical Mechanics, ***R.K.Pathria***, 2nd edition, Pergamon Press (**1972**) 3) Statistical and Thermal physics, ***F.Reif***, McGraw Hill International(**1985**) 4) Statistical Mechanics, ***K.Huang***, Wiley Eastern Limited, New Delhi (**1975**). 5) Fundamentals of Statistical Mechanics: B. B. Laud, New Age International Publishers, 2nd Edn.

PRACTICAL

Course Title	Elements of Atomic, Molecular & Laser Physics (Practical)	**Practical Credits**	02
Course Code	21BSC5C5PHY2P	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Practical Content

LIST OF EXPERIMENTS

1. To determine Planck's constant using Photocell.
2. To determine Planck's constant using LED.
3. Photoconductive cell characteristics
4. Photovoltaic Cell characteristics
5. To determine wavelength of spectral lines of mercury source using spectrometer.
6. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
7. To determine the wavelength of H-alpha emission line of Hydrogen atom.
8. To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.
9. To determine the value of e/m by Magnetic focusing or Bar magnet.
10. To determine the ionization potential of mercury.
11. To setup the Millikan oil drop apparatus and determine the charge of an electron.
12. To determine the absorption lines in the rotational spectrum of Iodine vapour.
13. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
14. Characteristics of Laser Diode
15. To determine the wavelength of laser using diffraction by single slit/double slits.
16. To determine wavelength of He-Ne laser using plane diffraction grating.
17. To determine angular spread of He-Ne laser using plane diffraction grating.
18. To determine angular spread of He-Ne laser using plane diffraction
19. Study of Raman scattering by CCl_4 using laser and spectrometer/CDS.

NOTE: Students have to perform at-least EIGHT Experiments from the above list.

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

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.

Employability skills

Program Name	BSc in Physics		**Semester**	VI
Course Title	Electrical Circuits and Network Skills (Theory)			
Course Code:	21BSC5SEC3		**No. of Credits**	03
Contact Hours	45 Hours		**Duration of SEA/Exam**	2 Hours
Formative Assessment Marks		25	**Summative Assessment Marks**	25

Course Outcomes (COs): After the successful completion of the course, the student will be able to: • Understand the fundamental concepts of electrical circuits and networks. • Analyze the behavior of a simple electrical circuit. • Design a circuit to meet a specific set of requirements. • Apply the principles of electrical circuits and networks to solve real-world problems. • Troubleshoot an electrical circuit that is not working properly. • Analyze the behavior of an electrical network. • Communicate effectively about electrical circuits and networks to both technical and non-technical audiences.

Contents	**45 Hours**
Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **Understanding Electrical Circuits**: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **Electrical Drawing and Symbols**: Rules for electrical drawing. Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **Generators and Transformers**: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Transformers: Step-up and step-down transformer: principle, design and fabrication. **Electric Motors**: Single phase and three phase AC motor, DC motors, BLDC motor, Capacitor Coupling, AC regulator, Interfacing DC or AC sources to control motors. RPM and Power Consumption of AC motors..	

Electrical Protection: Grounding and isolation, Phase reversal, Surge protection, Fuses and disconnect switches, Circuit breakers, Overload Devices. Relay, Timer relay, Voltage controller, Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **Solid-State Devices**: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **Electrical Wiring**: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **Reference Books:** 1. A text book in Electrical Technology - B L Theraja - S Chand & Co. 2. A text book of Electrical Technology - A K Theraja 3. Performance and design of AC machines - M G Say ELBS Edn.	
Practicals: **1**. Verification of Ohms law. 2. Verification of Millman's theorem. 3. IV characteristics of a solid-state relay. 4. Capacitor coupled power supply. 5. Load regulation and line regulation of an SMPS Power Supply. 6. TE model characterization using Peltier Cooler 7. Voltage controller using a 3 pin IC 8. IV characteristics of a buck boost converter 9. Monostable multivibrator using IC 555 10. LDR characteristics	

Note: It is the discretion of teacher to combine theory and practical in 45 hrs**.** Some topics can be covered by inviting experts in the field, e.g., electricians and motor winding experts.

SEMESTER - VI

Program Name	BSc in Physics	**Semester**	VI
Course Title	Elements of Condensed Matter & Nuclear Physics (Theory)		
Course Code	21BSC6C6PHY1L	**No. of Credits**	4
Contact Hours	60 Hours	**Duration of SEA/Exam**	3 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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

- Explain the basic properties of nucleus and get the idea of its inner information.
- 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
UNIT I **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 vs 2θ plot (qualitative). **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); Fermi Dirac distribution at T=0 and $E<E_f$, at $T\neq 0$ and $E>E_f$, F(E) vs E plot at T = 0 and $T\neq 0$. Density of states for free electrons (statement only, no derivation). Qualitative discussion of lattice vibration and concept of Phonons.; Specific heats of solids: Classical theory, Einstein's and Debye's theory of specific heats. Hall Effect in metals. **12 HOURS** **ACTIVITIES: 03 HOURS**	15
UNIT II **Magnetic Properties of Matter** Magnetic susceptibility (χ), magnetization (M), Classification of Dia, Para, and ferro magnetic materials; Langevin theory of diamagnetism. Langevin Classical and Quantum Theory of Paramagnetism. Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of M-H Curve. Hysteresis and Energy Loss, Hard and Soft magnetic materials.	15

Dielectric Materials: Static dielectric constant, Types of polarization (electronic, ionic and orientation), calculation of Lorentz field (derivation), Clausius-Mosotti equation (derivation), dielectric loss. Piezo electric effect, cause, examples and applications. **Superconductivity:** Definition, Experimental results – Zero resistivity and Critical temperature– The critical magnetic field – Meissner effect, Type I and type II superconductors. **Thermoelectricity:** Thermoelectric effect: Peltier and Seebeck effects. Principle of thermocouple. **12 Hours** **ACTIVITIES:** **03 Hours**	
UNIT III **General Properties of Nuclei**: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, main features of binding energy versus mass number curve, angular momentum, parity, magnetic moment, electric moments **Radioactivity decay:** Radioactivity: definition of radioactivity, half-life, mean life, radioactivity equilibrium **(**a) Alpha decay: basics of α-decay processes, theory of α decay (Gamow theory). Geiger-Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays' emission & kinematics, internal conversion (Definition). **12 Hours** **ACTIVITIES:** **03 Hours**	15
UNIT IV **Interaction of Nuclear Radiation with matter**: Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production (qualitative). **Nuclear models:** liquid drop model: explanation of semiempirical formula. Explanation of nuclear fission on the basis of liquid drop model. **Nuclear power reactors:** Controlled chain reaction. Nuclear reactor and brief explanation of its components, types of reactors: fast breeder reactor, heavy water reactor and research reactor. **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). **Accelerators:** Linear accelerators and Cyclotrons. Elementary particles: Classification of elementary particles. Concept of Quark model. **12 Hours** **ACTIVITIES:** **03 Hours**	15
Suggested Activities:	
1) Students to construct seven crystal systems with bamboo sticks and rubber bands. Use foam ball as atoms and study the BCC and FCC systems. 2)Students to search the characteristic X ray wavelength of different atoms/elements and plot characteristic wavelength vs 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 ferrofluids and see how it behaves in the presence of magnetic field. https://nationalmaglab.org/magnet-academy/try-this-at-home/making-ferrofluids/

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 photocathode 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/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

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,Pragati prakashan 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- **A J Dekker**, MacMillan India Ltd, (**2000**)
6. Essential of crystallography**, M A Wahab**, Narosa Publications (**2009)**
7. Solid State Physics-**S O Pillai**-New Age Int. Publishers (**2001**).
8. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw 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 Naeem Ahmed (Academic Press, Elsevier, 2007).

PRACTICAL

Course Title	Elements of Condensed Matter & Nuclear Physics (Practical)	**Practical Credits**	02
Course Code	21BSC6C6PHY1P	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Practical Content

CONDENSED MATTER PHYSICS

1. Determination of Plank's constant by Photo Cell
2. Hall Effect in semiconductor: determination of mobility, hall coefficient.
3. Energy gap of semiconductor (diode/transistor) by reverse saturation method
4. Thermistor energy gap
5. Fermi Energy of Copper
6. Analysis of X-ray diffraction spectra and calculation of lattice parameter.
7. Plank's constant by LED
8. Specific Heat of Solid by Electrical Method
9. Determination of Dielectric Constant of polar liquid.
10. Determination of dipole moment of organic liquid
11. B-H Curve Using CRO.
12. Spectral Response of Photo Diode and its I-V Characteristics.
13. Determination of particle size from XRD pattern using Debye-Scherrer formula.
14. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method).
15. Measurement of susceptibility of paramagnetic solid (Gouy's Method)

NUCLEAR PHYSICS

1. Study the characteristics of Geiger-Mùller Tube. Determine the threshold voltage, plateau region and operating voltage.
2. Study the absorption of beta particles in aluminium foils using GM counter. Determine mass attenuation coefficient of Aluminium foils.
3. Study the absorption of beta particles in thin copper foils using G M counter and determine mass attenuation coefficient.
4. 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.
5. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminium foils.
6. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source and G M counter.

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

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, Pragati prakashan, (**1976**)

SEMESTER VI

Program Name	BSc in Physics	**Semester**	VI
Course Title	Electronic Instrumentation & Sensors (Theory)		
Course Code:	21BSC6C6PHY2L	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	2 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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, colour codes, values and 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 learnt in the course to their practical use in daily life.
- Develop basic hands-on skills in the usage of oscilloscopes, multimeters, 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.
- Learn about Fourier series and its applications.

Contents	60Hours
UNIT I **Power supply** AC power and its characteristics, Single phase and three phase, Need for DC power supply and its characteristics, line voltage and frequency, Bridge rectifier, Filters: Capacitor and inductor filers, L-section and π-section filters, ripple factor, electronic voltage regulators, stabilization factor, voltage regulation using ICs. **Basic electrical measuring instruments** Cathode ray oscilloscope- Block diagram, basic principle, electron beam, CRT features, signal display. Basic elements of digital storage oscilloscopes. Generation of Lissajous figures. Basic DC voltmeter for measuring potential difference, Extending Voltmeter range, AC voltmeter using rectifiers	15

Basic DC ammeter, requirement of a shunt, Extending of ammeter ranges. Electrical fuses: different types. Circuit breakers: types, principle and applications. *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. Multirange voltmeter and ammeter.* **12 Hours** **ACTIVITIES: 3 Hours** **Activities** Design and wire your own DC regulated power supply. Power output: 5 V, 10 V, ± 5 V. 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.	
UNIT II **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. Passive and active filters. Fundamental theorem of filters, Proof of the theorem by considering a symmetrical T-network. 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. **12 Hours** **ACTIVITIES: 03 Hours** **Activities** 1. Measure the amplitude and frequency of the different waveforms and tabulate the results. Required instruments: A 10 MHz oscilloscope, Function generators (sine wave and square wave). 2. Explore where signal filtering network is used in real life. Visit a nearby telephone exchange and discuss with the Engineers and technicians. Prepare a report. 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.	15

Verify the truth table. Hint: LM3900 op-amp may be used. The status of the output may be checked by LED.	
UNIT III **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, Piezo-electric transducer, Photoelectric transducer, Photovoltaic cell, photo diode and phototransistor – principle and working. **12 Hours** **ACTIVITIES: 03 Hours** **Activities** 1. Construct your own thermocouple for the measurement of temperature with copper and constantan wires. Use the thermocouple and a Digital multimeter (DMM). Record the emf (voltage induced) by maintaining one of the junctions at a constant temperature (say at 0^o C, 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	15
UNIT IV **MATHEMATICAL PHYSICS** **Fourier Series**: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Application. Summing of Infinite Series. **Laplace transform:** Definition, transform of elementary functions, inverse transforms, transform of derivations, differentiation and integration of transforms. Difference between Laplace and Fourier transform.	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

References
1. Physics for Degree students (Third Year) – C.L. Arora and P.S. Hemne, S, Chand and Co. Pvt. Ltd. 2014 (For Unit-1, Power supplies)

References
2. Electronic Instrumentation, 3rd Edition, H.S. Kalsi, McGraw Hill Education India Pvt. Ltd. 2011 (For rest of the syllabus) 3. 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). 4. Mathematical Physics ---H. K. Dass and Dr. Rama Verma 5. Mathematical Methods for Physicists (4th Edition) George Arfken and Hans J. Weber Academic Press San Diego(1995). 6. Mathematical Physics - P.K. Chatopadhyay-Wiley Eastern Limited New Delhi (1990). 7. Introduction to mathematical Physics – Charlie Harper, Prentice-Hall of India Private Limited New-Delhi (1995)

PRACTICAL

Course Title	Electronic Instrumentation & Sensors (Practical)	**Practical Credits**	02
Course Code	21BSC6C6PHY2P	**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. Construct a DC power supply using a bridge rectifier and a capacitor filter. Use a Zener diode or a 3-pin voltage regulator and study the load and line regulation characteristics. Measure ripple factor with and without filter and compare with theoretical values.
2. Calibration of a low range voltmeter using a potentiometer
3. Calibration of an ammeter using a potentiometer
4. Design and construct a Wien bridge oscillator (sine wave oscillator) using μA 741 op-amp. Choose the values of R and C for a sine wave frequency of 1 KHz. Vary the value of R and C to change the oscillation frequency.
5. Design and construct a square wave generator using *μA* 741 op-amp. Determine its frequency and compare with the theoretical value. Also measure the slew rate of the op-amp. If the 741 is replace by LM318, study how does the waveform compare with the previous one.
6. Study the frequency response of a first order op-amp low pass filter
7. Study the frequency response of a first order op-amp low pass filter
8. Study the characteristics of *pn*-junction of a solar cell and determine its efficiency.
9. Study the illumination intensity of a solar cell using a standard photo detector (e.g., lux meter).
10. Study the characteristics of a LED (variation of intensity of emitted light).
11. Study the characteristics of a thermistor (temperature coefficient of resistance)
12. Study the characteristics of a photo-diode
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/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

References
1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House. 2. B.Sc. Practical Physics, C.L. Arora (Revised Edition), S. Chand and Co. Ltd. 2007 3. Practical Physics, D.C. Tayal, First Millennium Edition, Himalaya Publishing House, 2000

Employability 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 institutions.

B.Sc. Semester–VI
Internship/Mini Research Project

Course Title	Internship/Mini Research Project	**Practical Credits**	02
Course Code	21BSC6IN1PHYIN	**Contact Hours for Mini Project**	04 Hours
Report and Presentation			50 Marks

Course Outcomes (COs): At the end of the course the students will be able to

CO1: The students learn the scientific methodology in carrying out internship/project work including planning and execution of the experiment.

CO2: The students acquire experiential learning by handling instruments/devices, etc., while setting up an experiment or by reading in-depth assigned subject for theoretical analysis.

CO3: The students learn the importance of team work, mutual participation and nurture their motivation either towards theoretical or experimental internship/project work.

CO4: Internship/project helps students to get research and industrial exposure and application of knowledge.

Internship:

A course requiring students to participate in a professional activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an expert of the given external entity. A key aspect of the internship is induction into actual work situations for 2 credits. Internships involve working with local industry, local governments (such as panchayats, municipalities) or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.

Note:

1. **One credit** internship is equal to 30 hrs on field experience.
2. Internship shall be Discipline Specific of 45-60 hours (2 credits) with duration 1-2 weeks.
3. Internship may be full-time/part-time (full-time during last 1-2 weeks before closure of the semester or weekly 4 hrs. in the academic session for 13-14 weeks).
4. College shall decide the suitable method for program wise but not subject wise.
5. Internship mentor/supervisor shall avail work allotment during 6^{th} semester for a maximum of 20hrs.
6. The student should submit the final internship report (45-60 hours of Internship) to the mentor for completion of the internship.
7. Method of Evaluation: Power Point Presentations, Submission of Report and Internship Completion Certificate.

Mini Research Project:

Physics deals with various concepts and material properties. Students can get good knowledge on Physics principles after doing project work in the area of experimental and theoretical Physics.

The objective of the Project work is to provide a platform for the students to demonstrate their ability to apply their technical/theoretical knowledge and skills gained from theory lectures and practical work throughout the course.

COs: After completing the project work students will be able to

1) Understand, plan and execute a mini project with team with the help of a supervisor.
2) implement the theoretical knowledge of Physics in model building, material synthesis.
3) learn software such as LabViwew, Phyton and MATLAB and solve Physics problems.
4) Prepare a technical report on the mini project work.
5) Deliver a presentation based on the mini project work.

Mini project work is carried out in the following form:

This course will be conducted for students as an individual or in a group of three to four students under the guidance of a staff member in the college.

Course Guidelines:

1) Students should select a problem which addresses some basic home, office or other real life applications.
2) A written report of about 5 to 10 pages should be submitted individually.
3) A group of maximum four students can be permitted to work on one mini project.
4) Student should deliver presentation about the project and demonstrate its working individually.
5) The evaluation of the project carries a maximum of 50 marks. The experimental work and preparation of the report carries 40 Marks. The viva-voce examination carries a maximum of 10 marks and will be in the form of presentation by the student.

ASSESSMENT METHODS

Evaluation Scheme for Internal Assessment:

Theory:

Assessment Criteria	40 marks
1st Internal Assessment Test for 30 marks 1 hr after 8 weeks and 2nd Internal Assessment Test for 30 marks 1 hr after 15 weeks . Average of two tests should be considered.	30
Assignment	05
Activity	05
Total	**40**

Assessment Criteria	25 marks
1st Internal Assessment Test for 20 marks 1 hr after 8 weeks and 2nd Internal Assessment Test for 20 marks 1 hr after 15 weeks. Average of two tests should be considered.	20
Assignment/Activity	05
Total	**25**

Practical:

Assessment Criteria	25 marks
Internal test	15
Viva Voce / basic understanding of the concept	05
Journal/Practical Record	05
Total	**25**

Scheme of Evaluation for Practical Examination

Sl. No.	Particulars	Marks Allotted Max. 25
1.	Basic formula with description, nature of graph if any & indication of unit	05
2.	Tracing of schematic ray diagram/Circuit diagram with description and tabulation	05
4.	Experimental skill & connection	05
5.	Record of observation,	05
6.	Calculation including drawing graph	04
7.	Accuracy of result with unit	01
	Total	**25**

Question Paper Pattern:

RANI CHANNAMMA UNIVERSITY
Department of PHYSICS

V / VI Semester B.Sc.

Sub: **Code:** **Maximum Marks: 60**

Q.No.1.	**Answer any Six Questions** ***(Two question from Each Unit to be asked)*** **a.** **b.** **c.** **d,** **e.** **f.** **g.** **h.**	**6X2=12**
Q.No.2.	**(Questions from Unit-I)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.3.	**(Questions from Entire Unit-II)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.4.	**(Questions from Unit-III)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.5.	**(Questions from Unit-IV)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**

Note:

i. There should be a problem of marks from each unit and may be asked in either b or d in questions 2 to 5.

ii. If necessary, sub questions a and c from 2 to 5 may be subdivided in to i. and ii. Without exceeding maximum 08 marks.