KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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'A' Grade 2014

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No. KU/Aca(S&T)/JS/MGJ(Gen)/2023-24/59 Date: 04/09/2023

ಅಧಿಸೂಚನೆ

ವಿಷಯ: 2023–24ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕ ಪದವಿಗಳಿಗೆ 5 ಮತ್ತು 6ನೇ ಸೆಮೆಸ್ಟರ್ NEP-2020 ಪಠ್ಯಕ್ರಮವನ್ನು ಅಳವಡಿಸಿರುವ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ಸರ್ಕಾರದ ಅಧೀನ ಕಾರ್ಯದರ್ಶಿಗಳು(ವಿಶ್ವವಿದ್ಯಾಲಯ 1) ಉನ್ನತ ಶಿಕ್ಷಣ ಇಲಾಖೆ ಇವರ ಆದೇಶ ಸಂಖ್ಯೆ: ಇಡಿ 104 ಯುಎನ್‌ಇ 2023, ದಿ: 20.07.2023.
2. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 7, ದಿ: 31.08.2023.
3. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಆದೇಶ ದಿನಾಂಕ: 04/09/2023

ಮೇಲ್ಕಾಣಿಸಿದ ವಿಷಯ ಹಾಗೂ ಉಲ್ಲೇಖಗಳನ್ವಯ ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಆದೇಶದ ಮೇರೆಗೆ, 2023–24ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಎಲ್ಲ B.A./ BPA (Music) /BVA / BTTM / BSW/ B.Sc./B.Sc. Pulp & Paper Science/ B.Sc. (H.M)/ BCA/ B.A.S.L.P./ B.Com/ B.Com (CS) / BBA & BA ILRD ಸ್ನಾತಕ ಪದವಿಗಳ 5 ಮತ್ತು 6ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ NEP-2020ರ ಮುಂದುವರೆದ ಭಾಗವಾಗಿ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೊದಿತ ಕೋರ್ಸಿನ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದೆ. ಸದರ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲದಿಂದ ಡೌನಲೋಡ ಮಾಡಿಕೊಳ್ಳಲು ಸೂಚಿಸುತ್ತ ವಿದ್ಯಾರ್ಥಿಗಳ ಹಾಗೂ ಸಂಬಂಧಿಸಿದ ಎಲ್ಲ ಬೋಧಕರ ಗಮನಕ್ಕೆ ತಂದು ಅದರಂತೆ ಕಾರ್ಯಪ್ರವೃತ್ತರಾಗಲು ಕವಿವಿ ಅಧೀನದ/ಸಂಲಗ್ನ ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ ಸೂಚಿಸಲಾಗಿದೆ.

04/9/23
ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,
ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ವ್ಯಾಪ್ತಿಯಲ್ಲಿ ಬರುವ ಎಲ್ಲ ಅಧೀನ ಹಾಗೂ ಸಂಲಗ್ನ ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ. (ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ ಹಾಗೂ ಮಿಂಚಂಚೆ ಮೂಲಕ ಬಿತ್ತರಿಸಲಾಗುವುದು)

ಪ್ರತಿ:
1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ, ಸಂಬಂಧಿಸಿದ ಕೋರ್ಸುಗಳ ವಿಭಾಗಗಳು ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

KARNATAK UNIVERSITY, DHARWAD

B.Sc. in PHYSICS

Syllabus for V & VI Semester

SEMESTER - V

Discipline Specific Core Course (DSCC)

DSCC – 09: Theory (Code: 035 PHY 011)

DSCC – 10: Practical (Code: 035 PHY 012)

DSCC – 11: Theory (Code: 035 PHY013)

DSCC – 12: Practical (Code: 035 PHY 014)

SEC 03 – Practical (Code: 035 PHY 061)

SEMESTER - VI

Discipline Specific Core Course (DSCC)

DSCC – 13: Theory (Code: 036 PHY 011)

DSCC – 14: Practical (Code: 036 PHY 012)

DSCC – 15: Theory (Code: 036 PHY013)

DSCC – 16: Practical (Code: 036 PHY 014)

Internship-01 (Code: 036 PHY 091)

AS PER NEP-2020

With Effect from 2023-24

Karnatak University, Dharwad

B.Sc. in PHYSICS

Effective from 2023-24

Sem	Type of Course	Theory/ Practical	Course Code	Course Title	Instruction hour/ week	Total hours / sem	Duration of Exam	Marks			Credits
								Formative	Summative	Total	
V	DSCC-09	Theory	**035 PHY 011**	Classical Mechanics and Quantum Mechanics	04 hrs	56	02 hrs	40	60	100	04
	DSCC-10	Practical	**035 PHY 012**	Classical Mechanics and Quantum Mechanics	04 hrs	56	03 hrs	25	25	50	02
	DSCC-11	Theory	**035 PHY 013**	Elements of Atomic, Molecular and Laser Physics	04 hrs	56	02 hrs	40	60	100	04
	DSCC-12	Practical	**035 PHY 014**	Elements of Atomic, Molecular and Laser Physics	04 hrs	56	03 hrs	25	25	50	02
	Other subject										04
	Other subject										04
	Other subject										04
	SEC-3	Practical	**035PHY061**		04hrs	56	03 hrs	25	25	50	02
	Total										**26**
VI	DSCC-13	Theory	**036PHY011**	Elements of Condensed Matter & Nuclear Physics	04 hrs	56	02 hrs	40	60	100	04
	DSCC-14	Practical	**036PHY012**	Elements of Condensed Matter & Nuclear Physics	04 hrs	56	03 hrs	25	25	50	02
	DSCC-15	Theory	**036PHY013**	Electronic Instrumentation & Sensors	04 hrs	56	02 hrs	40	60	100	04
	DSCC-16	Practical	**036PHY014**	Electronic Instrumentation & Sensors	04 hrs	56	03 hrs	25	25	50	02
	Other subject										04
	Other subject										04
	Other subject										04
	Internship/ Mini Project		**036PHY091**	Projects in Physics at UG level				50	0	50	02
										Total	**26**

B.Sc. Semester – V

Discipline Specific Core Course (DSCC)-09

Course Title: Classical Mechanics and Quantum Mechanics

Course Code: 035PHY011

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-9	**Theory**	**04**	**04**	**56 hrs.**	**2hrs.**	**40**	**60**	**100**

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

CO1**:** Identify the failure of classical physics at the microscopic level.

CO2**:** Alternate approach towards the study of classical mechanics by Lagrangian, Variational and Hamiltonian formulations.

CO3: Find the relationship between the normalization of a wave function and the ability to calculate expectation values or probability densities.

CO4: Explain the minimum uncertainty of measuring both observables on any quantum state.

CO5: Describe the time-dependent and time-independent Schrödinger equation for simple potentials like for instance one-dimensional potential well and Harmonic oscillator.

CO6: Apply Hermitian operators, their eigen values and eigen vectors to find various commutation anduncertainty relations.

Unit	**Title: Classical Mechanics and Quantum Mechanics**	**56 hrs/ sem**
Unit I	**Lagrangian Formulation:** Mechanics of single Particle and System of Particles (In both cases): Conservation theorems for linear momentum, angular momentum and energy. Constraints: Holonomic constraints, non-holonomic constraints with suitable examples, Scleronomic and Rheonomic constraints with suitable examples. Configuration space, Degrees of freedom, Generalized coordinates, Generalized displacement, Velocity, Acceleration, Force, Potential, Virtual displacement, Principle of virtual work. D'Alembert's principle (derivation), Lagrange equations for conservative system and non-conservative system (derivation). Applications of Lagrangian formulation (1) Newton's equation of motion for single Particle in one dimension in Cartesian coordinates and polar coordinates (2) simple pendulum expression for acceleration (3) Atwood's machine expression for common acceleration (4) linear harmonic oscillator (derivation in each case). Advantages of Lagrangian formulation.	14Hrs
Unit II	**Variational Principle:** Hamilton's principle, Deduction of Hamilton's principle, Lagrange's equation of motion from Hamilton's principle (with derivation). Hamilton's principle for non-holonomic systems using Lagrange multiplier method(with derivation). **Hamiltonian Mechanics:** The Hamiltonian of a system, Hamilton's equations of motion, Hamilton's equations from variational principle (with derivation), Integrals	14Hrs

	of Hamilton's equations: energy integrals, Canonical Transformations (qualitative discussion with mention of four different forms), Poisson Brackets: fundamental properties of Poisson brackets and equations of motion in Poisson Brackets form.	
Unit III	**Introduction to Quantum Mechanics:** Brief explanation on failure of classical physics: black body radiation, Photoelectric effect, Compton effect, stability of atoms and spectra of atoms, variation of specific heat of solids with temperature. Planck's quantum theory: a brief discussion. Compton scattering: Expression for Compton shift (With derivation). Mention of expression for scattered photon energy and K.E. of recoil electron. **Matter Waves**: de Broglie hypothesis of matter waves, Wave description of particles by wave packets, Group and Phase velocities and relation between them, Experimental evidence for existence of matter waves: G.P Thomson's experiment and its significance. **Heisenberg Uncertainty Principle:** Statement and elementary proof of Heisenberg's relation between momentum and position and mention of uncertainty principle for energy & time, and angular momentum & angular position, illustration of uncertainty principle by Diffraction of electrons through single slit experiment. Explain why electron cannot exist inside the nucleus based on uncertainty principle.	14Hrs
Unit IV	**Foundation of Quantum Mechanics:** Probabilistic interpretation of the wave function - normalization and orthogonally of wave functions, Admissibility conditions on a wave function, setting up of time independent Schrödinger equation for matter wave, mention of Schrodinger wave equation for a free particle in one and three-dimension, mention of time-dependent Schrödinger equation in one dimension. Probability current density, equation of continuity and its physical significance, 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. Ehrenfest theorem statement with example. **Applications of Wave Mechanics**: Particle in a one-dimensional infinite potential well (derivation for energy Eigen value and Eigen function), degeneracy in three-dimensional case, particle in a finite potential well (qualitative), Transmission across a potential barrier: discussion with mention of expression for Transmission & Reflection coefficients, the tunnel effect (qualitative). One-dimensional simple harmonic oscillator (qualitative) - concept of zero - point energy.	14Hrs

Pedagogy: Lecture/ PPT/ Videos/ Animations/Predict-Observe-Explain/ Demonstration/ Activity/Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Problem Based Learning/ Group Discussion/ 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 Physics Vol. No.I (V Edition)
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. Resnick, Halliday & Krane – John Wiley & Son's Inc., New-York, Singapore, 2005.
6. Berkely Physics, Vol. No. I – ABC Publications, Bangalore & New-Delhi.
7. University Physics (XI-Edition)- Young & Freedman – Pearson Education, 2004.
8. Classical Mechanics (XVII ed)- Goldstein-Narosa Publishing New Dhli,1998.
9. Quantum Mechanics vol 1 and vol 2(I ed)- Shrivatsav-Pragati Prakashan, Meerat,1977
10. Quantum Mechanics- Gupta,Kumar & Sharma- Jayprakashnath &Co,Meerat,2004
11. Quantum Mechanics (I ed)- Powell-Oxford& IBH Publishing, New Dehli, Bombay, Kolkata,1961
12. Quantum Mechanics – Pauling & Wilson.
13. Modern physics- R. Murugeshan-- S. Chand Publication,New Dehli.
14. Introduction to modern physics- Ritchmeyer, Kennerd & Lauritser-TMH Publishing New Dehli
15. Perspective of modern physics (VI ed)- A.Baiser- Tata McGraw Hill, New Dehli.2002

Note:

1. Total teaching hours are inclusive of solving numerical problems on all the topics.
2. Preference may be given to solve maximum number of numerical problems and thought-provoking problems are to be solved wherever necessary.
3. Questions should not be framed on review of basic aspects in the semester end examination as it is revision of topics in the lower class.
4. Guide/Students are permitted to do any relevant and thought provoking activity, which gives in depth understanding of physics concepts and their application in a specific chapter.
5. Guide/students are also permitted to take up any innovative project work/field work/ problem solving activity, so that students get clear understanding of underlying principles of physics/concepts of physics in a particular topic/area of physics.
6. Teacher should encourage students to think out of the box and take up activity beyond the syllabus.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Assignment/Small Project/Activities	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per guidelines.	

B.Sc. Semester – V

Discipline Specific Course (DSC)-10

Course Title: Classical Mechanics and Quantum Mechanics

Course Code: 035PHY012

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-10	**Practical**	**02**	**04**	**56 hrs.**	**3hrs.**	**25**	**25**	**50**

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

CO 1**:** To determine 'g', the acceleration due to gravity, at a given place, from the L – T ^{2} graph, for a simple pendulum.

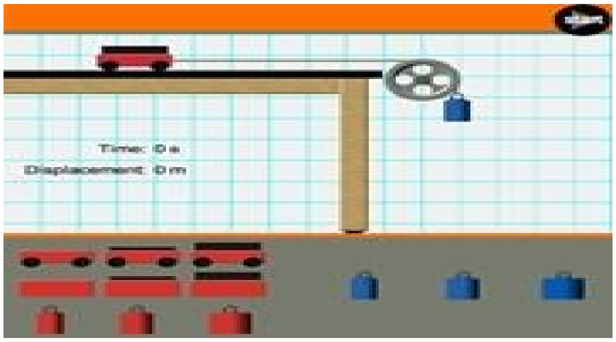
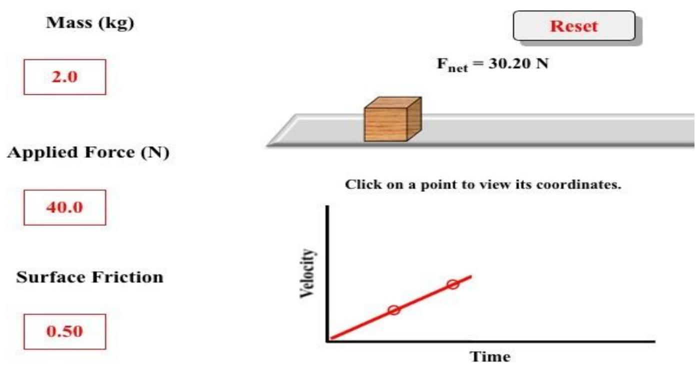
CO 2**:** Study the effect of amplitude oscillation on time period of simple pendulum.

CO 3: Determine energy Eigen value of particle electron/proton in a finite potential well.

CO 4: Determine Lagrangian for RL/RC/LC/RLC circuit using analogy with the classical mechanics concept.

Expt. No.	Title: Course Title: Classical Mechanics and QuantumMechanics	56 hrs/ sem
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 theorder 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 ofthe 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 using Atwood's machine.	
5	Study the conservation of energy and momentum using projectile motion.	
6	To study the spectral characteristics of a photo-voltaic cell (Solar cell) using different filters.	
7	To study I- V characteristics of solar cell and determine its fill factor.	
8	To study the tunneling in Tunnel Diode using I-V characteristics.	
9	Determination of quantum efficiency of Photodiode.	
10	Determine energy Eigen value of particle electron/proton in a finite potential well	
11	Study Tunnel diode as an oscillator.	
12	Determine Lagrangian for RL/RC/LC/RLC circuit using analogy with the Classical mechanics concept.	
13	Study of op amp as an Integrator.	
14	Study of op amp as an Differentiator	
15	FET as common source amplifier.	
16	FET as a DC voltmeter.	

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 craftmaterials 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 effectfor an EM radiation, when incident on a zinc metal surface. 2. Determine the target material if the threshold frequency of EM radiation is5.5×10^{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 3×10^{15}Hz. **4.** What should be the stopping potential for photoelectrons if the target Material used is Platinum and incident frequency is 2×10^{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 thislink https://www.compadre.org/PQP/quantum-need/section5_9.cfm Students can take up the exercises using the link which is as followshttps://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 $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$. You may vary n from 1 to 10. a) What do you notice about the values of $\langle x \rangle$ and $\langle x^2 \rangle$ as you vary n? b) What do you think $\langle x^2 \rangle$ should become in the limit of $n \to \infty$? Why? c) What do you notice about the values of $\langle p \rangle$ and $\langle p^2 \rangle$ 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 $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$. Vary n from 1 to 10. a) What do you notice about how $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$ 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 boxusing 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 $\langle x \rangle$ and $\langle x^2 \rangle$, and $\langle p \rangle$ and $\langle p^2 \rangle$. 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.

General instructions:

1. Minimum of eight experiments to be performed.
2. Practical Records/Journal of the candidate should be certified by the concerned teacher/HOD only after ascertaining successful completion of practical course/experiments by the candidate
3. Any new experiment may be added to the list with the prior approval from the BOS.

Scheme of Practical Examination (distribution of marks):
25 marks for Semester end examination

1. Basic formula, Units & Nature of graph, Circuit Diagram/Ray Diagram/Schematic diagram.	**05 Marks**
2. Tabular column with quantities and unit mentioned experimental skills.	**05 Marks**
3. Recording of observations, calculations and drawing graph, and accuracy of the result.	**10 Marks**
4. Viva-Voce.	**2 Marks**
5. Completed & Certified Journal.	**3 Marks**
Total	**25 Marks**

Note: The same shall be used for internal examination as well as for semester end examination from I Sem to VI Sem from the academic year 2023-24.

B.Sc. Semester – V

Discipline Specific Course (DSC)-11

Course Title: Elements of Atomic, Molecular & Laser Physics)

Course Code: 035 PHY 013

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-11	**Theory**	**04**	**04**	**56 hrs.**	**2hrs.**	**40**	**60**	**100**

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

CO1: Learn origin of spectral lines and spectral series of hydrogen like atom.

CO2: Interpret vector atomic model optical spectra.

CO3: Interpretation of molecular Spectra of compounds using basics of molecular physics.

CO4: Explain laser systems and their applications in various fields.

Unit	Title: Elements of Atomic, Molecular & Laser Physics	56hrs/ sem
Unit I	**Basic Atomic models:** Review of Thomson's and Rutherford atomic models and their failure. Theory of e/m of electron by J. J. Thomson method (with derivation). Determination of Charge of an electron by Millikan's oil drop experiment. Bohr atomic model–postulates, energy of electron in nth orbit of Hydrogen like atom (derivation). Origin of the spectral lines, spectral series of hydrogen atom. Effect of finite mass of nucleus on atomic spectra (with derivation). Ritz combination principle: explanation with verification using Paschen and Balmer lines. Bohr's correspondence principle. Explanation of potentials: critical potential, excitation potential, ionization potential , atomic excitation and its types. Franck-Hertz experiment to determine critical potentials. Sommerfeld's atomic model: Derivation of condition for allowed elliptical orbits.	14Hrs
Unit II	**Vector Atomic Model and Optical Spectra:** Vector atom model – model fundamentals, space quantisation of angular momentum, 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, Bohr magneton, Larmor precession. Magnetic dipole moment due to spin motion of electron, moment, total magnetic dipole moment. Lande g-factor and its calculation for different states. Stern-Gerlach experiment – experimental arrangement, principle and result. Fine structure of spectral lines with examples, spin-orbit coupling (qualitative). Optical spectra: spectral terms, spectral notations, selection rules, intensity rules. Fine structure of the sodium D-line. **Zeeman effect**: normal and anomalous Zeeman effect, experimental study and classical theory of normal Zeeman effect and Zeeman shift expression, theory of anomalous Zeeman effect (derivation), examples for anomalous Zeeman effect: Magnetic splitting of Sodium D1 and D2 lines.	14Hrs

Unit III	**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 – 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. Electronic spectra of molecules – fluorescence and phosphorescence. Raman effect – Stoke's and anti-Stoke's lines, characteristics of Raman spectra, classical and quantum theory, Experimental study of Raman effect, applications of Raman effect.	14Hrs
Unit IV	**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. Difference between three level and four level lasers with examples. 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.	14Hrs

Pedagogy: Lecture/ PPT/ Videos/ Animations/Predict-Observe-Explain/ Demonstration/ Activity/Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Problem Based Learning/ Group Discussion/ 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.

Note:

1. Total teaching hours are inclusive of solving numerical problems on all the topics.
2. Preference may be given to solve maximum number of numerical problems and thought-provoking problems are to be solved wherever necessary.
3. Questions should not be framed on review of basic aspects in the semester end examination as it is revision of topics in the lower class.
4. Guide/Students are permitted to do any relevant and thought provoking activity, which gives in depth understanding of physics concepts and their application in a specific chapter.
5. Guide/students are also permitted to take up any innovative project work/field work/ problem solving activity, so that students get clear understanding of underlying principles of physics/concepts of physics in a particular topic/area of physics.
6. Teacher should encourage students to think out of the box and take up activity beyond the syllabus.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Assignment/Small Project/Activities	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per guidelines.	

B.Sc. Semester – V

Discipline Specific Course (DSC)-12

Course Title: Elements of Atomic, Molecular & Laser Physics

Course Code: 035 PHY 014

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-12	**Practical**	**02**	**04**	**56 hrs.**	**3hrs.**	**25**	**25**	**50**

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

CO1**:** Determine the value of Rydberg's constant using diffraction grating/prism and hydrogen discharge tube.

CO2: Determine fine structure constant using fine structure separation of sodium D-lines using a plane Diffraction grating.

CO3: Verify Bhor's Correspondence Principle when principal quantum number tends to infinity.

CO4: Analysis of Rotational spectra of diatomic molecule and hence determine rotational constant, bond length and moment of inertia.

Expt. No.	Title: Elements of Atomic, Molecular & Laser Physics	56 hrs/ sem
1	To determine the value of Rydberg's constant using diffraction grating/prism and hydrogen discharge tube.	
2	To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.	
3	To find the value of e/m for an electron by Thomson's method using barmagnets.	
4	To determine the ionization potential of mercury/Xenon	
5	To setup the Millikan oil drop apparatus and determine the charge of an electron.	
6	To determine the absorption lines in the rotational spectrum of Iodine vapors/study of Zeeman effect.	
7	To verify Bhor's Correspondence Principle when principal quantum number tends to infinity.	
8	Analysis of Raman spectrum for diatomic molecule O2, HCL, N2 or any other diatomic molecule.	
9	Verification of Ritz combination Principle for all spectral series hydrogen atom/hydrogen like atoms using available data from literature.	
10	Analysis of Rotational spectra of diatomic molecule and hence determine rotational constant, bond length and moment of inertia.	
11	To determine wavelength/angular spread of He-Ne laser using diffraction grating.	
12	Study the frequency response of first order low pass/high pass filter using Op-Amp	
13	Study of Raman scattering by CCl_4 using laser and spectrometer/CDS.	
14	Design and construct the crystal oscillator and hence determine its frequency	
15	Determination of Plank's constant by Photo Cell/LED.	
16	LDR characteristics.	

Activities:

Activities 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.
- Students to search critical, excitation and ionization potentials of different elements and plot the graph of critical /excitation / ionization potentials versus atomic number/mass number/neutron number of element. Analyze the nature of the graph and draw the inferences.

Activities: II:

- Students to couple a p-state and s-state electron via L-S and j-j coupling schemes for asystem with two electrons and construct vector diagrams for each resultant. Analyze the coupling results and draw the inferences.
- Students to estimate magnetic dipole moment due to orbital motion of electron for different states $^2P1/2$, $^2P3/2$, $^2P5/2$, $^2P7/2$, $^2P9/2$ and $^2P11/2$ and plot the graph of dipole moment versus total orbital angular momentum “J’. Analyze the nature of the graph and draw the inferences.

Activities: III

- Students to estimate energy of rigid diatomic molecules CO, HCl and plot the graph of rotational energy versus rotational quantum number ‘J’. Analyze the nature of the graph and draw the inferences. Also students study the effect of isotopes on rotational energies.
- Students to estimate energy of harmonic vibrating molecules CO, HCl and plot the graph of vibrational energy versus vibrational quantum number ‘v’. Analyze the nature of the graph and draw the inferences.

Activities: IV

- Students to search different lasers used in medical field (ex: eye surgery, endoscopy, dentistry etc.), list their parameters and analyze the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study.
- Students to search different lasers used in defense field (ex: range finding, laser weapon, etc.), list their parameters and analyses the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study.

General instructions:

1. Minimum of eight experiments to be performed.
2. Practical Records/Journal of the candidate should be certified by the concerned teacher/HOD only after ascertaining successful completion of practical course/experiments by the candidate
3. Any new experiment may be added to the list with the prior approval from the BOS.

Scheme of Practical Examination (distribution of marks):

25 marks for Semester end examination

1.	**Basic formula, Units & Nature of graph, Circuit Diagram / Ray Diagram / Schematic diagram.**	**05 Marks**
2.	**Tabular column with quantities and unit mentioned experimental skills.**	**05 Marks**
3.	**Recording of observations, calculations and drawing graph, and accuracy of the result.**	**10 Marks**
4.	**Viva-Voce.**	**2 Marks**
5.	**Completed & Certified Journal.**	**3 Marks**
	Total	**25 Marks**

Note: The same shall be used for internal examination as well as for semester end examination from I Sem to VI Sem from the academic year 2023-24.

B.Sc. Semester – V

Skill Enhancement Course: SEC-3

Course Title: Applied Physics

Course Code: 035PHY061

Type of Course	Theory / Practical	Credits	Instruction hour/ week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
SEC-3	**Practical**	**02**	**04**	**56 hrs.**	**3hrs.**	**25**	**25**	**50**

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

CO1: Correct of Hypermetropia (long sightedness).

CO2: Study loading effect of voltmeter in case of very high resistive network.

CO3: Construct of constant current source using Op-Amp/power Transistor/ MOSFET.

CO4: Study DC load line analysis for BJT using different biasing techniques.

Expt. No	**Title: Applied Physics**	**56 hrs/ sem**
1	Correction of Hypermetropia (long sightedness)/myopia (short sightedness)	
2	Star to delta conversion using resistive and capacitive network	
3	Study of AM detector using PIN diode.	
4	Determine the energy gap of thermistor.	
5	Study UJT as a relaxation oscillator.	
6	Study SCR as power control device.	
7	Emitter follower.	
8	Loading effect of voltmeter in case of very high resistive network.	
9	Application of LDR: Using BJT as switch.	
10	Design and construct multi range capacitance meter using Op-amp and micro ammeter.	
11	Astable Multivibrator using BJT	
12	Clipping/ Clamping circuit	
13	Application of RTD (PT100) sensor using bridge to measure temperature.	
14	Verification of Thevenin's and Norton's theorem for ladder network using multiple sources (minimum one voltage source and one current source must beused)	
15	DC load line analysis for BJT using different biasing techniques.	
16	Voltage multiplier using diodes and capacitors.	

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. Advanced Practical Physics for Students by Worsnop B L and Flint H T.

7. Computational Quantum Mechanics using Scilab, BIT Mesra.

General instructions:

1. Minimum of eight experiments to be performed.
2. Practical Records/Journal of the candidate should be certified by the concerned teacher/HOD only after ascertaining successful completion of practical course/experiments by the candidate
3. Any new experiment may be added to the list with the prior approval from the BOS.

Scheme of Practical Examination (distribution of marks):

25 marks for Semester end examination

1. Basic formula, Units & Nature of graph, Circuit Diagram / Ray Diagram / Schematic diagram.	**05 Marks**
2. Tabular column with quantities and unit mentioned experimental skills.	**05 Marks**
3. Recording of observations, calculations and drawing graph, and accuracy of the result.	**10 Marks**
4. Viva-Voce.	**2 Marks**
5. Completed & Certified Journal.	**3 Marks**
Total	**25 Marks**

Note: The same shall be used for internal examination as well as for semester end examination from I Sem to VI Sem from the academic year 2023-24.

UG Program: 2023-24

GENERAL PATTERN OF THEORY QUESTION COURSE FOR DSCC

(60 marks for Semester end Examination with 2 hrs. duration)

Part-A

1. Question number 01-06 carries 2 Marks each. Answer any 05 questions : 10 marks

Part-B

2. Question number 07- 11 carries 05 Marks each. Answer any 04 questions : 20 marks

Part-C

3. Question number 12-15 carries 10 Marks each. Answer any 03 questions : 30 marks
   (Minimum 1 question from each unit and 10 marks question may have
   Sub-questions for 8+2, or 7+3 or 6+4 or 5+5 if necessary)

Total: 60 Marks

Note: Proportionate weightage shall be given to each unit based on number of hours prescribed

B.Sc. Semester – VI

Discipline Specific Course (DSC)-13

Course Title: Elements of Condensed Matter & Nuclear Physics

Course Code: 036PHY011

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-13	**Theory**	**04**	**04**	**56 hrs.**	**2hrs.**	**40**	**60**	**100**

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

CO 1**:** Study crystal systems and X-ray spectra and Braggs X-ray spectrometer.

CO 2: Understand the concepts of free electron theory of metals, specific heat of solids, semiconductors and magnetic properties of matter.

CO 3: Understand the theory and applications of Hall Effect.

CO 4**:** Describe the processes of alpha, beta and gamma decays based on well-establishedtheories.

CO 5: Explain the basic aspects of interaction of gamma radiation with matter byphotoelectric effect, Compton scattering and pair production.

CO 6**:** Explain the different nuclear radiation detectors such as ionization chamber, Geiger-Muellercounter etc.

CO 7: Explain the basic concept of scintillation detectors, photo-multiplier tube and semiconductor detectors.

Unit	Title: Elements of Condensed Matter & Nuclear Physics	56 hrs/ sem
Unit I	**Crystal Systems:** Crystal structure: Space Lattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells. Seven crystal systems, 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, explain intensity variation with respect to 2ϴ (qualitative). **Free Electron Theory of Metals:** Classical free electron model (Drude-Lorentz model), expression for electrical and thermal conductivity, Wiedemann-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≠ 0. Density of states for free electrons (statement only, noderivation). Qualitative discussion of lattice vibration and concept of Phonons; **Specific heats of solids**: Classical theory, Einstein's and Debye's theory of specific heats (with derivation).	14 Hrs

Unit II	**Semiconductors:** Review of Semiconductors and its types. Expression for electrical conductivity in case of intrinsic and extrinsic semiconductors, mobility, **Hall Effect**: Statement, expression for Hall coefficient and mobility. Applications of Hall effect. **Magnetic Properties of Matter**: Review of basic formulae: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, magnetization (M). Classification of Dia, Para, and ferro magnetic materials. Langevin's classical theory of dia and Para magnetism (with derivation). Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of B-H Curve: hysteresis and energy loss, hard and soft magnetic materials. **Superconductivity:** Definition, Experimental results – Zero resistivity and Critical temperature– The critical magnetic field – Meissner effect, Isotope effect , BCS theory (qualitative)Type I and type II Superconductors.	14Hrs
Unit III	**Nuclear Physics:** Review of general properties of nuclei and radioactivity. **Nuclear Forces:** Properties of nuclear forces, Meson theory of nuclear forces. **Nuclear Models:** Liquid-drop model: Semi-empirical mass formula and explanation of the terms, nuclear fission on the basis of liquid-drop model. Shell model (qualitative), Magic numbers. **Nuclear Reactions:** Types of nuclearreactions with examples. Energy balance in Nuclear reactions and the Q-value.Brief discussions on compound nucleus formation in nuclear reactions. **AlphaDecay:** Gamow's theory of alpha decay (without derivation). Derivation of expression for alpha disintegration energy. Range of Alpha particles. Experimental determination of range of alpha particles. Geiger-Nuttal relationand its significance (qualitative). Alpha particle spectra with examples. **BetaDecay:** Types of beta decay with examples. The neutrino theory of beta decay(qualitative). Decay scheme of Tl-204.	14Hrs
Unit IV	**Interaction of Nuclear Radiation with Matter:** Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production (qualitative with mention of cross section and z dependence) Energy loss due to ionization (quantitative description of Bethe block formula), energy loss of electrons, introduction of Cerenkov radiation. Decay schemes of Cs-137, Na-22, Mn-54 and CO-57. **Detector for Nuclear Radiations:** Gas detectors: estimation of electric field, mobility of particle, for ionization chamber (construction & working) and GM counter (construction, working and characteristics). Basic principle of Scintillation detectors (with NaI(Tl) as example) and construction of photo- multiplier tube (PMT). Semiconductor Detectors (Si (Li) and Ge(Li)) for charged particle and photon detection (qualitative). **Accelerators**: Cyclotrons (construction, working and derivation of expression for final energy), synchrotron construction and working. Applications of Accelerators.	14Hrs

Pedagogy: Lecture/ PPT/ Videos/ Animations/Predict-Observe-Explain/ Demonstration/ Activity/Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Problem Based Learning/ Group Discussion/ 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.
5. Introduction to solid State Physics, ***Charles Kittel***, VII edition, (**1996**)
6. Solid State Physics- A J Dekker, MacMillan India Ltd, (**2000**)
7. Essential of crystallography, M A Wahab, Narosa Publications (**2009)**
8. Solid State Physics-S O Pillai-New Age Int. Publishers (**2001**).
9. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
10. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
11. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
12. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP) Publishing, 2004).
13. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
14. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier,2007).

Note:

1. Total teaching hours are inclusive of solving numerical problems on all the topics.
2. Preference may be given to solve maximum number of numerical problems and thought-provoking problems are to be solved wherever necessary.
3. Questions should not be framed on review of basic aspects in the semester end examination as it is revision of topics in the lower class.
4. Guide/Students are permitted to do any relevant and thought provoking activity, which gives in depth understanding of physics concepts and their application in a specific chapter.
5. Guide/students are also permitted to take up any innovative project work/field work/ problem solving activity, so that students get clear understanding of underlying principles of physics/concepts of physics in a particular topic/area of physics.
6. Teacher should encourage students to think out of the box and take up activity beyond syllabus.

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Assignment/Small Project/Activities	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per guidelines.	

B.Sc. Semester – VI

Discipline Specific Course (DSC)-14

Course Title: Elements of Condensed Matter & Nuclear Physics

Course Code: 036PHY012

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-14	**Practical**	**02**	**04**	**56 hrs.**	**3hrs.**	**25**	**25**	**50**

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

CO1**:** Study the Hall Effect in semiconductor: determination of types of charge carrier, Hall coefficient, Mobility.

CO2: Analysis of X-ray diffraction spectra and calculation of lattice parameter.

CO3: Determine of particle size from XRD pattern using Debye-Scherrer formula.

CO4: Study the characteristics of Geiger-Muller Tube and determine the threshold voltage, plateau region and operating voltage.

Expt. No.	Title: Elements of Condensed Matter & Nuclear Physics	56 hrs/ sem
1	Hall Effect in semiconductor: determination of types of charge carrier, Hall coefficient, Mobility.	
2	Energy gap of semiconductor by Four Probe Method.	
3	Analysis of X-ray diffraction spectra and calculation of lattice parameter.	
4	Energy gap of semiconductor (diode/transistor) by reverse saturation method	
5	B-H Curve.	
6	Determination of particle size from XRD pattern using Debye-Scherrer formula.	
7	Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method).	
8	Measurement of susceptibility of paramagnetic solid (Gouy’s Method)	
9	Verification of Geiger- Nuttal Law using data available in the literature for natural Radioactive series.	
10	Study the characteristics of Geiger-Muller Tube and determine the threshold voltage, plateau region and operating voltage.	
11	Study the absorption of beta particles in aluminum foils using GM counter and hence determine mass attenuation coefficient of Aluminum.	
12	Study the absorption of beta particles in thin copper foils using G M counter and determine mass attenuation coefficient.	
13	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.	
14	Determine the end point energy of Tl-204 source by studying the absorption of beta particles in Aluminum foils.	
15	To measure e/K using BJT.	
16	Determine the Fermi energy of Copper.	

Activities:

- Students to construct seven crystal systems with bamboo sticks and rubber bands. Use foam ball as atoms and study the BCC and FCC systems.
- Students to search the characteristic X- ray wavelength of different atoms/elements and plot characteristic wavelength vs atomic number and analyze the result and draw the inference.
- 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.
- Study the decay scheme of selected alpha, beta & gamma radioactive sources with the helpof standard nuclear data book.
- Calculate binding energy of some selected light, medium and heavy nuclei. Plot the graphof binding energy versus mass number A.
- Study the decay scheme of standard alpha, beta and gamma sources using nuclear databook.
- 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.
- Study the Z dependence of photoelectric effect cross section. Study the Z dependence of common cross section for selected gamma energies and selected elements through theoretical calculation.
- List the materials and their properties which are used for photocathode of PMT.
- Study any two types of PMT and their advantages and disadvantages.

General instructions:

1. Minimum of eight experiments to be performed.
2. Practical Records/Journal of the candidate should be certified by the concerned teacher/HOD only after ascertaining successful completion of practical course/experiments by the candidate
3. Any new experiment may be added to the list with the prior approval from the BOS.

Scheme of Practical Examination (distribution of marks):

25 marks for Semester end examination

1. Basic formula, Units & Nature of graph, Circuit Diagram/Ray Diagram/Schematic diagram.	**05 Marks**
2. Tabular column with quantities and unit mentioned experimental skills.	**05 Marks**
3. Recording of observations, calculations and drawing graph, and accuracy of the result.	**10 Marks**
4. Viva-Voce.	**2 Marks**
5. Completed & Certified Journal.	**3 Marks**
Total	**25 Marks**

Note: The same shall be used for internal examination as well as for semester end examination from I Sem to VI Sem from the academic year 2023-24.

B.Sc. Semester – VI

Discipline Specific Course (DSC)-15

Course Title: Electronic Instrumentation & Sensors

Course Code: 036PHY013

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-15	**Theory**	**04**	**04**	**56 hrs.**	**2hrs.**	**40**	**60**	**100**

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

CO1**:** Identify different types of tests and measuring instruments used in practice and understand their basic working principles.

CO2: Get hands on training in wiring a circuit, soldering, making a measurement using an electronic circuit used in instrumentation.

CO3: 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**.**

CO4: Understanding of the measurement of voltage, current, resistance value, identification of the terminals of a transistor and ICs.

CO5: Identify and understand the different types of transducers and sensors used in robust and hand-held instruments.

CO6: Understand and give a mathematical treatment of the working of rectifiers, filter, data converters and different types of transducers.

CO7: Connect the concepts learnt in the course to their practical use in daily life.

CO8: Develop basic hands-on skills in the usage of oscilloscopes, multi meters, rectifiers, amplifiers, oscillators and high voltage probes, generators and digital meters.

CO9: Servicing of simple faults of domestic appliances: Iron box, immersion heater, fan, hot plate, battery charger, emergency lamp and the like.

Unit	Title: Electronic Instrumentation & Sensors	56 hrs/ sem
Unit I	**DC Power Supply:** Block diagram of regulated power supply, Zener diode characteristics and Zener diode as voltage regulator, Dual power Supply using 78xx and 79xx ICs. **Constant Current Source:** Construction using BJT and IC 741 and its characteristics. **Basic electrical measuring Instruments**: Cathode ray oscilloscope- block diagram, basic principle, electron beam, CRT features, signal display. 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.	14Hrs

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.	14Hrs
Unit III	**Data Conversion and Display:** Digital to Analog (D/A) and Analog to Digital (A/D) converters – A/D converter with pre- amplification and filtering. D/A converter - variable resistor network, ladder type (R-2R) D/A converter, Op-amp based D/A converter. **Digital Display Systems and Indicators:** Classification of displays, Light Emitting Diodes (LED) and Liquid Crystal Display (LCD) – structure and working. **Data Transmission Systems:** Advantages and disadvantages of digital transmission over analog transmission, Need of Modulation, Types of Modulation: Analog and digital, Analog Amplitude Modulation (AM) expression, modulation index and its importance, frequency spectrum, Amplitude modulator using BJT, Digital Pulse amplitude modulation (PAM), Pulse Position Modulation (PPM) and Pulse Width Modulation (PWM) - General principles. Principle of Phase Sensitive Detection (PSD).	14hrs
Unit IV	**Sensors:** Basics of Energy Transformation: transducers, sensors and actuators (definitions). Difference between sensor and actuators, detectable phenomenon. Need for Sensors. Classification of sensors into different types. **Selection criteria and characteristics:** Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band (definition). **Signal Transmission**: Types of signal: Electronic Signal. **Resistive Sensors:** Working Principle and applications of potentiometer, Strain Gauges, Thermistors and Photo-resistive sensor. **Inductive Sensors:** Principle of operation, construction details, characteristics and applications of LVDT, Design of Displacement measurement system using LVDT. **Capacitive transducers:** Principle of operation, construction details, characteristics of Capacitive transducers and Applications of capacitor microphone, capacitive pressure sensor. Working Principles and applications of piezoelectric sensors. **Light Sensors**: Photoelectric transducer: construction, working, application, photo-voltaic transducer-construction, working, application.	14Hrs

Pedagogy: Lecture/ PPT/ Videos/ Animations/Predict-Observe-Explain/ Demonstration/ Activity/Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Problem Based Learning/ Group Discussion/ 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)
2. Electronic Instrumentation, 3rd Edition, H.S. Kalsi, McGraw Hill Education India Pvt. Ltd. 2011 (For restof 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

Note:

1. Total teaching hours are inclusive of solving numerical problems on all the topics.
2. Preference may be given to solve maximum number of numerical problems and thought-provoking problems are to be solved wherever necessary.
3. Questions should not be framed on review of basic aspects in the semester end examination as it is revision of topics in the lower class.
4. Guide/Students are permitted to do any relevant and thought provoking activity, which gives in depth understanding of physics concepts and their application in a specific chapter.
5. Guide/students are also permitted to take up any innovative project work/field work/ problem solving activity, so that students get clear understanding of underlying principles of physics/concepts of physics in a particular topic/area of physics.
6. Teacher should encourage students to think out of the box and take up activity beyond the syllabus.

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Assignment/Small Project/Activities	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per guidelines.	

B.Sc. Semester – VI

Discipline Specific Course (DSC)-16

Course Title: Course Title: Electronic Instrumentation & Sensors

Course Code: 036PHY014

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSCC-16	**Practical**	**02**	**04**	**56 hrs.**	**3hrs.**	**25**	**25**	**50**

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

CO1**:** Design and construct a Wien bridge oscillator (sine wave oscillator) using O-Amp IC 741. 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.

CO2: Study of generation of voltage using piezo- electric sensor/ vibration sensor.

CO3: Design and construct D/A converter using resistor ladder network.

CO4: Study the frequency response of a RC low pass filter

Expt. No,	Title: **Course Title:** Electronic Instrumentation & Sensors	56.hrs/ sem
1	Design Zener diode as a voltage regulator and study the load and line regulation.	
2	Construction of dual power supply using IC 78xx and 79xx	
3	Calibration of a low range voltmeter using a potentiometer	
4	Calibration of an ammeter using a potentiometer	
5	Design and construct a Wien bridge oscillator (sine wave oscillator) using Op-Amp IC741. 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	
6	Generation of PAM/PPM with two different amplitudes.	
7	Construction of constant current source using Op-Amp/power Transistor/ MOSFET	
8	Generation of PWM with two different amplitudes.	
9	Study of micro phone as capacitive transducer.	
10	Study of LVDT.	
11	Study of generation of voltage using piezo- electric sensor/ vibration sensor.	
12	Generate amplitude modulated wave using BJT.	
13	Design and construct D/A converter using resistor ladder network.	
14	Design and construct two bit A/D converter using OP- Amp	
15	Study the frequency response of a RC low pass filter and CR high filter	
16	Determine Time Delay between two pulses/signals using C. R. O.	

Activities: I

- 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.
- Extend the range of measurement of voltage of a voltmeter (analog or digital) using external component and circuitry. Design your own circuit and report.
- 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 CRO.
- 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.

Activities: II

- 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).
- 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.
- 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.
- 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.

Activities: III

- 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.
- Explore and find out the difference between a standard op-amp and an instrumentation op-amp. Compare the two and prepare a report.

Activities: IV

- 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 aluminum). Study why it is required. Describe the principle behind solar water heater.

General instructions:

1. Minimum of eight experiments to be performed.
2. Practical Records/Journal of the candidate should be certified by the concerned teacher/HOD only after ascertaining successful completion of practical course/experiments by the candidate
3. Any new experiment may be added to the list with the prior approval from the BOS.

Scheme of Practical Examination (distribution of marks):

25 marks for Semester end examination

1.	**Basic formula, Units & Nature of graph, Circuit Diagram / Ray Diagram / Schematic diagram.**	**05 Marks**
2.	**Tabular column with quantities and unit mentioned experimental skills.**	**05 Marks**
3.	**Recording of observations, calculations and drawing graph, and accuracy of the result.**	**10 Marks**
4.	**Viva-Voce.**	**2 Marks**
5.	**Completed & Certified Journal.**	**3 Marks**
	Total	**25 Marks**

Note: The same shall be used for internal examination as well as for semester end examination from I Sem to VI Sem from the academic year 2023-24.

B.Sc. Semester – VI

Internship/Mini Project

Course Title: Internship/Projects in Physics at UG level

Course Code: 036PHY091

Type of Course	Theory / Practical	Credits	Instruction hour/week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
Internship/ Project	**Practical**	**02**				**50**	**0**	**50**

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 help 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 ofthe 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 Project:

- The project work may be carried out in the college.
- Project work may include the experimental works such as studying the properties of materials, designing of electronic gadgets, electrical units etc.
- The project report should be submitted by each student at the end of VI semester to become eligible for the examination.
- 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.
- During this examination, the project supervisor along with two internal examiners from the panel of BOE will be involved in the evaluation.

References:

1. An Introduction to Scientific Research: E. Bright Wilson Jr., McGraw Hill Book Co., New York (1952) (Chapters 3 & 9)
2. Research Methodology: a step-by-step guide for beginners (3rd ed.) – Ranjit Kumar, SAGE Publication, London (2011)
3. Research Methodology: an introduction (2nd ed.) – Wayne Goddard, Stuart Melville (2007)
4. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler & Timothy A. Nieman, Harcourt College Publishers, (2001)
5. Experimental measurements: precision, Error and Truth - N C Barford- Addison-Wesley Pub (1967)
6. Computer oriented numerical methods – V. Rajaraman, Prentic Hall of India Pvt. Ltd, New Delhi (2003)
7. Computational Physics - R.C. Verma, P.K.Ahluwalia & K.C. Sharma. New Age Int.(P) Ltd publishers, New Delhi (1999)

Formative Assessment for Project	
Assessment	**Distribution of Marks**
The Experimental Work	**20 Marks**
Preparation of the Report	**20 Marks**
Power Point Presentation and Viva-Voce	**10 Marks**
Total	**50 Marks**

UG Program: 2023-24

GENERAL PATTERN OF THEORY QUESTION COURSE FOR DSCC

(60 marks for Semester end Examination with 2 hrs. duration)

Part-A

4. Question number 01-06 carries 2 Marks each. Answer any 05 questions : 10 marks

Part-B

5. Question number 07- 11 carries 05 Marks each. Answer any 04 questions : 20 marks

Part-C

6. Question number 12-15 carries 10 Marks each. Answer any 03 questions : 30 marks
   (Minimum 1 question from each unit and 10 marks question may have
   Sub-questions for 8+2, or 7+3 or 6+4 or 5+5 if necessary)

Total: 60 Marks

Note: Proportionate weightage shall be given to each unit based on number of hours prescribed