



Bangalore University
Department of Physics
Jnana Bharathi Campus
Bengaluru-560056

Syllabus for 5th and 6th Semester Physics
Under-Graduate (UG) Program

Framed according to the State Education Policy (SEP- 2025)

(Effective from the Academic Year 2026-27)



Board of Studies in Physics (UG) Members

1.	Prof. B. Eraiah	Chairperson	Department of Physics, Bangalore University, Bengaluru-56
2	Dr. K Y Madhavi	Member (External)	Professor, GCW Chintamani, Chikkaballapura Dist
3.	Dr. Wajeeha Sultana	Member (External)	Professor, Maharani Cluster University, Bengaluru
4	Dr. Satish L A	Member (External)	Professor, Nrupatunga University, Bengaluru
5	Sri. Giridhar B G	Member	Associate Professor, GFGC Nelamangala, Bengaluru Rural
6	Dr. Seeta Vasudevrao	Member	Associate Professor, GFGC Kengeri, Bengaluru
7	Dr. Shivaprakash Y	Member	Associate Professor, GFGC Magadi, Ramanagara Dist
8	Sri.T N Ashoka	Member	Associate Professor,GFGC Vijayanagara, Bengaluru
9	Dr. N. Ragini	Member (Invited)	Professor, GFGC HSR Layout, Bengaluru

Date: 27.03.2026

Bengaluru

Proceedings of the BOS Physics (UG) meeting of Bangalore City University,
Bangalore, held on 26th March 2026 and 27thMarch 2026

The Chairman welcomed all the BOS members and presented the following agenda for discussion.

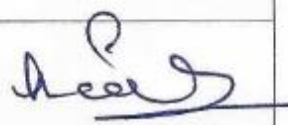
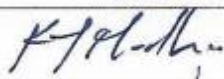
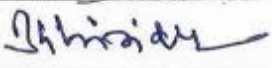
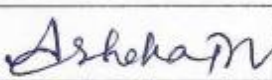
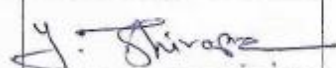
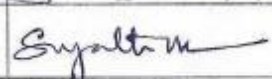
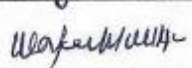
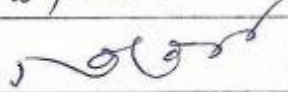
Agenda:

- (i) To finalize the Panel of Examiners (UG) for the 2025-26
- (ii) To approve the V and VI semester BSc Physics Syllabus (prepared in accordance with the State Education Policy (SEP))

After elaborate discussions, the members approved

1. Syllabus for V and VI Semester B.Sc. Physics Course (UG) to be implemented from the academic year 2026-27, following SEP guidelines.
2. The UG Panel of examiners has been updated by including teachers from all the affiliated colleges. The BOS unanimously approves the panel of examiners for UG for the academic year 2026-27.

Members of the BOS (UG) Physics

Sl. No	Names	Members	Signature
01	Dr. B. Eraiah, Professor and Chairman, Department of Physics, Bangalore University, Bengaluru-560056.	Chairman	
02	Dr. K. Y. Madhavi Government First Grade College, Channapatna	Member	
03	Dr. Seeta Vasudevan Government First Grade College, Kengeri	Member	
04	Mr. B. G. Giridhar Government First Grade College Nelamangala	Member	
05	Mr. T.N. Ashoka Government First Grade College Vijayanagara	Member	
06	Sri. Balakrishna M.T Government First Grade College, Kanakapura	Member	Absent
07	Dr. Shivaprakash. Y. Government First Grade College, Magadi	Member	
08	Dr. Sujatha. R Government First Grade College, HSR layout	Member	
09	Dr. Wajeeha Sultana Maharani Cluster University Bengaluru -01	Member	
10	Dr. Sathish L. A. Nrupathunga University, Bengaluru -01	Member	

11. Dr. N. Ragini
GFGC HSR Layout
Bengaluru - 560102

Invited
Member Ragini


Chairman,
Department of Physics
Bangalore University
Bangalore-56

Preamble of BSc Physics (V & VI) semester

V semester paper V

The study of statistical physics

1. Statistical physics acts as a bridge from atoms to the bulk properties.
2. Explains the temperature, pressure, and entropy as averages over 10^{23} particles.
3. Study the quantitative tools-partition functions, Boltzmann factors, and simple ensembles so that they can predict heat capacities and other physical quantities.
4. Study the three important distribution functions: Maxwell-Boltzmann statistics, Bose-Einstein statistics, and Fermi-Dirac statistics.

Basic quantum mechanics equips students with

1. Inadequacy of classical mechanics in explaining certain fundamental concepts such as blackbody radiation, Stability of atoms, atomic spectra, Photoelectric effect, Compton effect, Specific heat of solids, etc.
2. Enables the students to visualize a new picture of matter-wave function, quantization, and uncertainty relations to explain atoms, spectra, and chemical bonding that classical physics cannot.

The study of atomic and molecular physics explains

1. The spectra-selection rules, fine structure, and rotational/vibrational levels, classification of what shows up in emission spectra and absorption spectra.
2. Builds chemistry links-orbital hybridization, bond order, and molecular term symbols, ground organic/physical chemistry symbols

Nuclear and particle physics explain

1. Energy and forces at the atomic and sub-atomic level, constituents of the nucleus, binding energy, radioactivity, and decay laws.
2. Classification of elementary particles, fundamental interactions in nature, conservation laws, and the quark model

In the V semester paper VI

The study of solid-state physics gives BSc students a concrete arena for quantum ideas

1. Material insight-band structure, semiconductors, and phonons explain resistivity, Hall effect, and thermal conductivity, they measure in laboratories
2. Device literacy-diodes, transistors, and optical properties become intuitive, linking directly to electronics and photonics coursework.

The study of semiconductor physics turns abstract bounds into working devices for BSc students

1. P-N junctions, carrier doping, and Fermi level control explain diodes, LEDs, and solar cells they build or tested in labs
2. Quantitative edge-drift-diffusion, continuity equations, and simple I-V derivations connect directly to lab plots and data fitting.

The study of operational amplifiers equips BSc students with

1. Design speed – ideal-op-amp rules (virtual short, infinite gain) let students sketch amplifiers, filters, and sensor interfaces in minutes, then refine with real-world limits.
2. Conceptual bridge – feedback analysis learned here applies directly to control theory, stability, and even digital PLLs later on.
3. Lab reliability – mastering bias currents, slew rate, and noise helps troubleshoot instrumentation, reducing wasted bench time.
4. Employability – industry labs from biotech to aerospace still prototype measurement front-ends with op-amps, so fluency is a durable job skill.

The study of Digital electronics pushes BSc students into

Binary logic and timing, logic foundation-gates, flip-flops, and Boolean minimization give a hands-on route to microcontrollers and data acquisition, which they use in modern laboratories.

In the VI semester paper VII

The study of Quantum mechanics-II gives BSc students

1. A core toolkit, such as the Schrodinger equation, operators, and spin, to tackle semiconductors, lasers, and MRI in later courses
2. It provides a conceptual shift, probability amplitudes, and superposition, training the flexible thinking useful across physics, chemistry, and emerging quantum technologies.
3. Directly predicts discrete energy levels and selection rules they see in spectroscopy experiments, making the theory feel concrete

The study of Astrophysics lets BSc students test core physics on a cosmic scale

1. Unified problem solving-orbital dynamics, black body radiation, and hydrostatic equilibrium reuse mechanics, thermal physics, and quantum mechanics tools in one setting
2. Data practice: Interpreting stellar spectra, light curves, and HR diagrams sharpens graphing, fitting, and error analysis skills relevant to any laboratory

The study of Atmospheric physics lets BSc students observe fluid, thermal, and radiative processes that they can observe daily

1. Applied fundamentals – hydrostatic balance, lapse rate, and black-body budgeting, reuse mechanics/thermos equations for weather, convection, and climate loops.
2. Quantitative habits – analyzing radiosonde profiles, scattering data, or spectra builds error-propagation and modelling routines useful in any experimental work.
3. Interdisciplinary bridge – links spectroscopy, aerosol optics, and fluid turbulence to chemistry and environmental science, widening project options.
4. Real-world relevance – from UV absorption to greenhouse reasoning, students see how well-posed physics informs current debates and sensor-design tasks.

The study of Nano materials enables BSc students

1. Quantum-classical crossover – quantum confinement, surface-to-volume ratios, and size-dependent Plasmon resonances show how boundary conditions rewrite familiar conductivity and optics.
2. Lab relevance – synthesis routes (sol-gel, CVD) and characterization (AFM, DLS) extend microscopy and statistical skills from earlier modules.
3. Design mindset – tuning band gaps or catalytic activity links theory to real tasks like sensors and coatings, useful in project work.
4. Current fluency – exposure to graphene, quantum dots, and safety protocols primes them for interdisciplinary internships in industry or academic labs.

The study of materials science teaches BSc students to read structure-property maps:

1. Microstructure thinking – crystallography, defects, and phase diagrams explain hardness, conductivity, and corrosion, they measure in labs.
2. Experimental breadth – XRD, SEM, and tensile tests reinforce data-analysis skills and instrument literacy.
3. Design angle – linking bonding models to elasticity or band gaps readies them for device work, composites, or nanomaterials projects.
4. Career crossover – vocabulary of alloys, polymers, and characterization is common in industry, geophysics, and even biophysics contexts.

Medical physics maps core BSc concepts onto healthcare contexts:

1. Direct application– attenuation, decay kinetics, and dosimetry give concrete meaning to nuclear and quantum basics while reinforcing error budgeting.
2. Instrumentation fluency – ultrasound, MRI, and detector geometry train students in signal chains, shielding, and safety protocols found in advanced labs.
3. Quantitative care – dose calculations and image reconstruction, sharpen integration, statistics, and inverse-problem skills.
4. Pathway diversity– opens internships in hospital physics, radiological protection, or biomedical device testing, broadening job options after the degree.

Programme Outcomes (POs)

By the end of the program, the student will be able to:

PO1	Disciplinary Knowledge	Acquire and apply the subject knowledge of physics in solving day to day and their complexed real-world problems.
PO2	Communication skills	Communicates effectively on physical activities with scientific community and with the society at large scale, and write effective reports on science events and design documentation, makes effective communication skills.
PO3	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning	Ability to think in unique manner unlike in conventional methods, giving scientific reasoning for all daily actions and generate solutions using critical thinking.
PO4	Problem solving	Acquire knowledge to solve any complex problems using simply methods
PO5	Research related skills	Use research-based knowledge and research methods to provide valid and precise results.
PO6	Co-operation/Team work/Leadership qualities	Rendering co-operation and willing to work in team, leading the team with high expectations.
PO7	Information/Digital Literacy/Modern tool usage	Utilize the techniques and modern tools for solving complex problems with an understanding of limitations.
PO8	Environment and Sustainability	Understand the impact of environmental conditions on the development of subject and demonstrate the knowledge and need of the sustainable development
PO9	Multicultural competence	Applying the basics of physics in multicultural fields with excellent competence.
PO10	Multi-disciplinary	Function effectively, as an individual, as a member or leader in divorce teams in multi-disciplinary fields.
PO11	Moral and ethical Awareness/Reasoning	Apply ethical principles and commit to professional ethics and responsibilities and norms of scientific practices.
PO12	Lifelong Learning/Self-directed learning	Recognize the need for and have the preparations and ability to engage in independent and lifelong learning of physical studies.

5th Semester
B.Sc.
Physics Syllabus
Paper V & VI

Program Name	B.Sc. (Physics)	Semester	V
Course Title	Statistical Physics, Quantum Mechanics-I, Atomic and Molecular Physics, Nuclear and Particle Physics		
Course Code	BU-PHY UG- DSC T5	No. of Credits	03
Contact Hours	56 hours/ 4 hours per week	Duration of Theory Exam	3 hours
Formative Assessment Marks	20	Summative Assessment Marks	80

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1- Explain and differentiate between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac Statistics
CO2- Justify atomic stability, atomic spectra, theory of blackbody radiation, photoelectric effect, Compton effect, and theory of specific heat of solids based on Quantum mechanics
CO3- Describe atomic term symbols, LS coupling, and Zeeman splitting and predict spectral line patterns
CO4- Use binding energy systematics, decay kinetics to model radioactivity
CO5- Classify the elementary particles based on their spin and fundamental interactions

Contents	56 Hrs
UNIT 1 Statistical Physics Introduction: Specification of state of the system- Macro state, Micro State; Phase Space, Phase Cell, Sterling's Approximation, Thermodynamic Probability and its calculation (Description of each with an example); Entropy and Thermodynamic probability ($S=k\ln\Omega$). Basic postulates of Statistical Physics. Maxwell-Boltzmann (MB) Statistics: MB Distribution function (Derivation), Energy distribution function $f(E_i)$, MB law of velocity distribution (mention- most probable velocity, average velocity, rms velocity) Limitations of MB statistics. Bose-Einstein (BE) Statistics: BE distribution function (Derivation), Energy distribution function $f(E_i)$, BE Condensation, properties of liquid He (qualitative) [Mention of expression of Bose Temperature – T_B], Variation of number of particles in zero energy state (N_0) and number of particles in non-zero energy state (N_e) with temperature. Radiation as a photon gas, Bose's derivation of Planck's law, Rayleigh-Jeans law, Wein's law; Specific Heat capacity of metals: Einstein's theory of Specific Heat Capacity of solids and its equation (Derivation). Fermi-Dirac (FD) Statistics: FD distribution function (Derivation); Energy distribution function $f(E_i)$, Fermi sphere and Fermi energy (Derivation), Fermi gas; Electronic Specific Heat Capacity in metals (Mention of the contribution to Specific Heat Capacity from free electrons). Comparison of MB, BE and FD distribution functions.	2 3 6 3

UNIT 2 Quantum Mechanics-I	
Introduction: Inadequacy of Classical Physics to explain - Blackbody Radiation, Stability of atoms, Atomic Spectra, Photoelectric Effect, and Compton effect. Explanation based on Quantum Mechanics.	4
Matter Waves: de Broglie hypothesis of Matter Waves, de Broglie wavelength (in different forms), Phase Velocity, Concept of Wave packets, Group Velocity, Particle Velocity, and relation between them (dispersive and non-dispersive medium). Experimental evidence for Matter Waves: The Davisson - Germer Experiment; GP Thomson's experiment. Heisenberg's Uncertainty Relations (position & momentum, energy & time, and angular momentum & angular displacement), illustration of uncertainty relation by Gamma ray microscope - thought experiment. Consequences of the Uncertainty Relations: Diffraction of electrons at a single slit and Non-existence of electrons inside the nucleus.	10

UNIT 3 Atomic and Molecular Physics	
Atomic Physics Review of Bohr's theory of hydrogen atom; Sommerfeld's modification of the Bohr atomic model – derivation of the condition for allowed elliptical orbits. Vector atom model, Spatial quantization, and Electron spin. Different quantum numbers associated with the vector atom model, Spectral terms and their notations, Selection rules, coupling schemes (<i>l</i>-s and j-j coupling in multi-electron systems), Pauli's Exclusion Principle, Expression for the maximum number of electrons in an orbit. Spectra of alkali elements (sodium D-lines), Larmor precession, Bohr magneton, Stern-Gerlach Experiment. Zeeman Effect- Experimental study, theory of normal and anomalous Zeeman effect based on quantum theory.	9
Molecular Physics: Types of molecules based on their moment of inertia, Pure rotational motion, Spectrum and selection rules; Vibrational motion, vibrational spectrum and selection rules; Rotation-Vibration spectrum; Scattering of Light- Tyndall scattering, Rayleigh scattering and Raman scattering. Experimental study of Raman effect, Quantum theory of Raman effect - Applications.	5
UNIT 4 Nuclear and Particle Physics	
General Properties of Nuclei: Constituents of nucleus, intrinsic properties of nucleus, quantitative facts about mass, radii, charge density, binding energy, binding energy versus mass number curve.	4
Radioactivity: Radioactive Decay, Law of radioactive decay, Half-Life and Mean Life (Derivation), relation between them. <i>Alpha(α) decay:</i> Basics of α-decay, Gamow's theory of α emission(qualitative), Geiger-Nuttall law. <i>Beta(β)-decay:</i> positron emission, negatron emission, orbital electron capture, Pauli's neutrino hypothesis. <i>Gamma (γ) decay:</i> Internal Conversion.	5
Elementary Particles: Classification of elementary particles, Fundamental interactions (Gravitational, Electromagnetic, Weak, strong – range, relative strength, particle interactions for each). Symmetries and Conservation Laws (momentum, energy, charge, parity, lepton number, baryon number, isospin, strangeness and charm), Quark Model (brief Introduction).	5

Course articulation matrix:- Mapping of course outcomes (COs) with Program Outcomes (POs 1-12)												
Course Outcomes (COs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3		3		1					3	2
CO2			3		2		2			2		
CO3	1	2		2				2			3	3
CO4						2			3			
CO5		2		2			3			3		

Score indicators: High = 3, Medium = 2, Low = 1

Pedagogy: interactive lectures, inquiry-based learning, blended learning, learning based on experiments

Formative Assessment Theory	
Assessment Occasion/Type	Marks
One Internal Test - C1	10 marks
Assignment/ seminar – C2	05 marks
Attendance – C2	05 Marks
Total	20
Formative Assessment, as per University Guidelines, is compulsory	

Reference Books

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. Quantum Mechanics, **B.H. Bransden and C.J. Joachain**, 2nd Edition, Pearson Education (2004)
6. Introduction to Quantum Mechanics, **David J. Griffiths**, 2nd Edition, Pearson Education, (2005)
7. Modern Quantum Mechanics, **J.J. Sakurai**, Pearson Education, (2000)
8. Principles of Quantum Mechanics, **Ghatak and Lokanathan**, Macmillan, (2004)
9. Concepts of Modern Physics, Beiser 3rd edition, Student edition, New Delhi (1981).
10. Introduction to Atomic Physics – H.E. White
11. Introduction to Modern Physics – H.S. Mani, G.K. Mehta-West Press (1989).
12. Principles of Modern Physics, A.P. French, John Wiley, London (1958).

13. Modern Physics - S.N. Ghoshal, Part 1 and 2, S. Chand and Company (1996).
14. Physics of the Atom, Wehr et. al., McGraw-Hill
15. Atomic and Nuclear Physics, S. N. Ghoshal: Vol. II. (2000).
16. Introductory Nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
17. Nuclear Physics, Irving Kaplan, Narosa Publishing House
18. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw-Hill, 1998).
19. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP) Publishing, 2004).
20. Introductory Nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
21. Nuclear Physics, D C Tayal, Himalaya Publishing House, 5th Edition
22. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw-Hill, 1998).
23. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
24. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons, 2nd revised ed (2008)
25. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).

Course Title	Statistical Physics, Quantum Mechanics-I, Atomic and Molecular Physics, Nuclear and Particle Physics		Practical Credits	02
Course Code	BU-PHYUG-DSC P5		Contact Hours /week	04
Formative Assessment - Total 10 marks	Attendance – C1	05 Marks	Summative Assessment	40
	Lab Test – C2	05 Marks		

List of Experiments

1. Monte Carlo experiment (estimation of π) and error analysis
2. Dice/Coin Tossing/Galton Board – Study of Gaussian Distribution
3. Study of statistical distribution of nuclear disintegration data: using a GM counter as a black box
4. Determination of Planck's constant using a photo cell
5. Characteristics and spectral response (selenium photocell)
6. Determination of Rydberg's constant using hydrogen spectra.
7. Determination of Sommerfeld's fine structure constant.
8. Determination of e/m of an electron by Thomson's method.
9. Study of the characteristics of the GM counter.
10. Verification of the Inverse Square Law
11. Determination of mass absorption coefficient of γ - rays using Aluminium absorbers.
12. Millikan's Oil Drop Experiment
13. Analysis of the band spectrum of the PN molecule.
14. Analysis of rotational Raman spectra of N_2 molecule.
15. Analysis of rotational vibrational spectrum of a diatomic molecule (HBr).
16. Absorption spectrum of $KMnO_4$.

References

1. Physics through experiments, B Saraf etc, Vikas Publications 1987.
2. Advanced practical physics, Chauhan & Singh, Pragathi Publications 1ed
3. Practical Physics, D Chattopadhyay et al, Central Publications.
4. An Advanced Course in Practical Physics, D Chattopadhyay, PC Rakshit, B Saha, New Central Book Agency (P) Limited, Kolkata, Sixth Revised Edition, 2002.
5. Practical Physics, D C Tayal 2002.

QUESTION PAPER PATTERN (INDICATIVE TEMPLATE)

**V and VI Semester B.Sc. Examination, 2026-27
SEP – 2024 Onwards (1st Batch)**

Subject: Physics

**Paper: BU-PHYUG-DSC T5: Statistical Physics, Quantum Mechanics-I, Atomic and
Molecular Physics, Nuclear and Particle Physics**

&

**Paper: BU-PHYUG-DSC T6: Quantum Mechanics-I , Astrophysics, Atmospheric
physics and Nanomaterials**

Time: 3hours

Max. Marks: 80

Summative Assessment for Theory (For 80 Marks)

Part – A

(10X2=20)

Question Number 1to 12 (12 Questions, Answer any 10 Questions)

Part – B

(4X5=20)

Question Number 13 to 18 (6 Questions, Answer any 4 Questions)

Part – C

(4X10=40)

Question Number 19 to 24 (6 Questions, Answer any 4 Questions)

5th & 6th Semester B.Sc. Practical Examination

Distribution of Marks for the Practical Examination Paper: BU-PHYUG-DSC P5 & BU-PHYUG-DSC P6		
Sl No	Particulars	Marks
01	Writing Principle/Statement/Formulae with symbols.	05
02	Drawing illustrative diagrams and expected graphs.	03
03	Setting up the experiment & taking readings	12
04	Calculations and graphs were drawn based on experimental data.	05
05	Accuracy of results with units.	05
06	Valuation of Practical Record.	05
07	Viva voce	05
	Total Marks	40

Program Name	B.Sc. (Physics)	Semester	I
Course Title	Solid State Physics, Semiconductor Physics, Electronics I and II		
Course Code	BU-PHY UG –T6	No. of Credits	03
Contact Hours	56 hours/4 hours per week	Duration of Theory Exam	3 hours
Formative Assessment Marks	20	Summative Assessment marks	80

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1- Explain the fundamental structural properties of crystals, the behavior of free electrons in metals using classical and quantum theories, and the core principles of superconductivity.
CO2- Analyze the properties of intrinsic and extrinsic semiconductors using energy band theory, and evaluate the operational characteristics and applications of p-n junctions, special diodes, and transistors.
CO3- Evaluate the AC/DC characteristics of ideal and practical Operational Amplifiers (Op-Amps) and analyze the impact of different negative feedback topologies on circuit performance.
CO4- Design and analyze practical linear Op-Amp applications, including active filters, mathematical operation circuits (adders, integrators, differentiators), and basic oscillator circuits.
CO5- Apply the principles of digital logic, number systems, and Boolean algebra to simplify logic expressions and design basic combinational circuits such as half and full adders/ subtractors

Contents	56 Hours
UNIT-I Solid State Physics Crystal structure: Space Lattice, Bravais Lattices, Crystal systems, Miller indices. Expression for inter planar spacing in terms of Miller Indices X-rays: Production, Properties, Continuous and characteristic X-rays, Moseley's law, Scattering of X-rays, Bragg's law (Derivation).	5
Free electron theory of metals: Classical Free electron theory (Drude-Lorentz model); Expression for Electrical conductivity and Thermal conductivity, Weidman - Franz's law, Failure of classical electron theory, Quantum free electron theory, Density of states (1-D, derivation), Fermi-Dirac distribution function and Fermi energy, Expression for Fermi energy at absolute zero.	6
Superconductivity: Introduction, Experimental facts, zero resistivity, critical field, critical temperature, Meissner effect, Type I & Type II superconductors, BCS Theory (qualitative); Applications – Magnetic levitation, SQUIDS.	3

UNIT-II Semiconductor Physics Semiconductors: Distinction between metals, semiconductors, and insulators based on band theory. Intrinsic semiconductors - concept of holes – effective mass - expression for carrier concentration (derivation for electrons/holes) and electrical conductivity – Extrinsic semiconductors – mention of expressions for carrier concentrations and conductivity – impurity states in energy band diagram and Fermi level. Formation of P-N junction, depletion region, Forward and reverse biased P-N junction, Variation of the width of the depletion region, drift and diffusion current, mention the expression for diode current.	6
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Special Diodes: Zener diode – characteristics and its use as a voltage regulator. Photo diodes, Solar cells and LED (principle, working, and applications).	4
Transistors: Transistor action, Characteristics (CE mode), α and β of a transistor, DC Biasing, Load line analysis, Transistor as an amplifier (CE mode); transistor gain, h-parameters	4

UNIT III Electronics – 1 OPERATIONAL AMPLIFIERS	
Operational amplifiers and their applications Block Diagram of an OP-AMP. Introduction to the concept of Virtual Ground and Virtual Short, Characteristics of an Ideal Operational Amplifier versus a Practical Operational Amplifier (with a specific focus on IC 741). Open-loop configuration and its severe limitations. Common-Mode Rejection Ratio (CMRR) and Slew Rate. Dynamic characteristics: Gain Bandwidth Product (GBP) and the overall Frequency Response of an Op-Amp.	4
Feedback Concepts and Basic Configurations Introduction to Feedback Concepts. Advantages of negative feedback. Expression for Gain. The OP-AMP as a feedback amplifier: Non-Inverting and Inverting amplifiers. Modification of input and output impedances with negative feedback. The Voltage follower (buffer) circuit and its applications.	4
Linear Applications and Active Filters <i>Mathematical operation circuits:</i> Operation and analysis of an OP-AMP as an Adder, Difference amplifier, differentiator, and Integrator. Introduction to active filters and their advantages over passive filters. Circuit design and an expression for the frequency response of first-order low-pass and high-pass filters.	4
OP-AMP Oscillators Positive Feedback concept – Barkhausen Criterion, Phase shift oscillator, and Wien bridge oscillator.	2

UNIT IV Electronics – 2 DIGITAL ELECTRONICS Number Systems and Binary Arithmetic Introduction to Digital vs Analog. Number Systems: Binary, Octal, and Hexadecimal. Base conversions (e.g., Decimal to Any Base and vice versa). Number Codes: BCD (Binary Coded Decimal) and Gray Code. Techniques for converting Gray to Binary and Binary to Gray. Signed Numbers: Representation using Sign-Magnitude, 1's Complement, and 2's Complement. Binary Arithmetic: Addition and Subtraction using 1's and 2's complement. Understanding overflow and underflow conditions.		4
Logic Gates and Truth Tables Basic Logic Gates: OR, AND, and NOT (Inverter). Discussion of logic symbols, algebraic expressions, and Truth Tables. Universal Gates: NAND and NOR. The Power of Universality—why these gates are preferred in manufacturing. Exclusive Gates: XOR and XNOR. Applications in parity checking and controlled inverters.		3
Boolean Laws and Theorems: Commutative, Associative, Distributive, and De Morgan's Theorems. SOP (Sum of Products) equations. Simplifying Boolean expressions using algebraic manipulation. Problem-solving: converting standard logic diagrams to universal gate diagrams.		4
Half Adder and Full Adder: Circuit design, Truth Tables, and derivation of Sum and Carry expressions. Half Subtractor: Circuit design, Truth Tables, and derivation of Difference and Borrow expressions.		3

Course articulation matrix:- Mapping of course outcomes (COs) with Program Outcomes (POs 1-12)												
Course Outcomes (COs) Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3		3		1					3	2
CO2			3		2		2			2		
CO3	1	2		2				2			3	3
CO4						2			3			
CO5		2		2			3			3		

Score indicators: High = 3, Medium = 2, Low = 1

Pedagogy: interactive lectures, inquiry-based learning, Blended learning, Learning based on Experiments

Formative Assessment Theory	
Assessment Occasion/Type	Marks
One Internal Test - C1	10 marks
Assignment/ seminar – C2	05 marks
Attendance – C2	05 Marks
Total	20
Formative Assessment, as per University Guidelines, is compulsory	

References:

1. Introduction to Solid State Physics, **Charles Kittel**, VII edition, (1996)
2. Solid State Physics- **A J Dekker**, MacMillan India Ltd, (2000)
3. Elementary Solid-State Physics, **J P Srivastava**, PHI, (2008)
4. Essentials of Crystallography, **M A Wahab**, Narosa Publications (2009)
5. Solid State Physics-**F W Ashcroft and A D Mermin**-Saunders College (1976)
6. Solid State Physics-**S O Pillai**-New Age Int. Publishers (2001)
7. OPAMPS and Linear Integrated Circuits, **Ramakant A Gayakwad**, PHI Learning Private Limited, 4th Edition
8. Operational Amplifiers with Linear Integrated Circuits, **William D Stanley**, Pearson, 4th Edition
9. Electronic Devices and Circuit Theory, **Robert Boylestead and Louis Nashelsky**,
10. PHI Learning Private Limited, 10th Edition
11. Digital Principles and Applications, **Leach and Malvino**, McGraw–Hill, 5th Edition

Course Title	Statistical Physics, Quantum Mechanics-I, Atomic and Molecular Physics, Nuclear and Particle Physics		Practical Credits	02
Course Code	BU-PHYUG-DSC P5		Contact Hours /week	04
Formative Assessment - Total 10 marks	Attendance – C1	05 Marks	Summative Assessment	40
	Lab Test – C2	05 Marks		

List Of Experiments
(A minimum of 8 experiments to be performed)

1. Experiments on a semiconductor as a temperature sensor.
2. Determination of the temperature coefficient of resistance and energy gap of a thermistor.
3. Study of ZENER diode characteristics and determination of V_z in reverse bias.
4. Study of LDR characteristics – dark resistance – saturation current.
5. Study of SOLAR CELL characteristics and to find the Open circuit voltage, short circuit current, efficiency and fill factor.
6. Study of I – V characteristics of a PHOTO diode with distance and different intensity
7. Analysis of X-ray diffraction pattern to determine lattice parameters of a crystal.
8. Determination of particle size from XRD pattern using Debye-Scherrer formula.
9. Determination of Fermi energy of a metal.
10. Design the circuit of Transistor as a switch and determine the gain in active region
11. Study of frequency response of high pass filter using OP-AMP
12. Study of frequency response of low pass filter using OP-AMP
13. Study of working of OP-AMP as non-inverting and inverting amplifier
14. Study of working of OP-AMP as differentiator and integrator
15. Design and verification of AND, OR, NOT and XOR gates using NAND gates
16. Study of Digital Half-adder & Full-adder using IC circuits.
17. Half Subtractor & Full Subtractor, using logic gate ICs
18. Design and Construct the Wein bridge oscillator circuit using OP-AMP
19. Design and Construct the Phase Shift oscillator circuit using OP-AMP

References

1. IGNOU : Practical Physics Manual IGNOU publications
2. Saraf : Experiment in Physics Vikas publicatios
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)
7. Ramalingom & Raghuopalan : A Lab. Course in Electronics
8. Bharagav et al : Electronics, TTI tata MacGraw Hill 33rd Reprint (2002)

6th Semester
B.Sc.
Physics Syllabus
Paper VII, Elective
Papers & Skill-Based
Practicals

Program Name	B.Sc. (Physics)	Semester	VI
Course Title	Quantum Mechanics-II, Astrophysics, Atmospheric Physics, and Nanomaterials		
Course Code	BU-PHY UG- DSC T7	No. of Credits	03
Contact Hours	56 hours/ 4 hours per week	Duration of Theory Exam	3 hours
Formative Assessment Marks	20	Summative Assessment Marks	80

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1-Solve Schrödinger's equation for standard potentials and interpret wavefunction probability densities and expectation values.
CO2- Apply operators, eigenvalues, and spin formalism to predict measurement outcomes and selection rules.
CO3-Model stellar structure and evolution using hydrostatic equilibrium and nuclear-burning timescales to explain HR-diagram trends.
CO4-Diagnose atmospheric stability and convection by calculating lapse rates, buoyancy, and potential temperature from sounding data..
CO5- Correlate microstructural features from heat treatment to measured hardness/ductility and justify process choices for a given application.

Contents	48
Unit 1 Quantum Mechanics-II The concept of wave function, the physical significance of a wave function, and the development of time-independent and time-dependent Schrödinger wave equations(derivations). Max Born's interpretation of a wave function, admissibility conditions to be satisfied by a wave function, Normalisation and expectation values, observables, Quantum Mechanical operators, Eigen values and Eigen functions. Applications of the Schrodinger equation for (i) a particle in a one-dimensional box (potential well) – derivation. Extension to a three-dimensional box (Quantitative). Eigen functions and probability densities of a particle. (ii) Schrodinger equation for a free particle, (iii) Development of Schrodinger equation for one-dimensional linear harmonic oscillator (Derivation), Development of the Schrodinger equation for the rigid rotator and the hydrogen atom (Qualitative), mention the eigenvalues and eigenfunctions for the ground state	14
Unit-2 Astrophysics Astronomical distances: Parallax and distance, Heliocentric parallax, definition of Astronomical unit (AU), parsec (Pc), Light year (Ly), and their relations. 2 Luminosity of stars: - Apparent brightness, apparent magnitude, Hipparchus scale, Absolute magnitude, relation between Absolute magnitude, Apparent magnitude, and distance (Derivation), Visual magnitude, Bolometric magnitude and Bolometric correction, Radius of a star using Stefan's law. 2 Stellar Classification: - Pickering classification (Harvard Classification), Yerkes' luminosity classification, H-R diagram (Quantitative), Evolutionary stages of stars based on H-R diagram. Main-sequence stars and their general characteristics. 2 Core properties of Stars: - Gravitational potential Energy or self-Energy of a star based on the linear density model, Statement and explanation of Virial theorem-(Derivation). Surface or effective temperature and colour of a star, Wien's displacement law(Qualitative), concept of Hydrostatic equilibrium, Expression for average and core temperature of a star based on the linear density model of a star, concept of internal pressure of a star, Expression for core pressure of a star based on the linear density model of a star, Photon diffusion-time (Qualitative), Relation between mass and luminosity of a star, expression for life time of a star ($T_{\text{life}} \propto 1/m^2$). 5 Evolution of stars: - Different stages of formation, Giant molecular cloud (GNC), protostar, T-Tauri stage. Main sequence evolution, white dwarfs, pulsars, Neutron stars, Black holes, Variable stars, supernova, and types of Supernovae, Electron degeneracy in white dwarfs, Chandrasekhar's mass limit, concept of event horizon, singularity, Schwarzschild's radius 3	
Unit-3 Atmospheric Physics Introduction to Atmosphere: - Atmosphere: - definition and importance, Composition of atmosphere, fixed and variable gases. Different layers of atmosphere: vertical profile of atmosphere. 2 Solar radiation and energy balance: - Solar radiation (insolation), Earth's energy budget, Albedo and greenhouse effect, and Global warming. Heat transfer: - conduction, convection, and radiation. 2	

Atmospheric thermodynamics: - Ideal gas law, pressure and temperature variation with height (Derivation), Derivation of Beer's law.	3
Winds and circulation: - Pressure gradient force, Coriolis force, Expression for Coriolis force. Consequences of Coriolis Force: Trade winds, Direction of river flow, Soil erosion	3
Moisture and weather phenomena: - Humidity (Absolute, Relative, Specific), Cloud formation, precipitation (rain, snow, hail), Formation of cyclones.	2
Climate change impacts and applications: - Causes: - Natural Vs Anthropogenic. Effects: - Sea level rise, Extreme weather, Droughts and floods, ozone depletion.	2
Unit-4 Nanomaterials Introduction to Nanomaterial: Definition of Nanoscience and Nanotechnology. Size scale (1-100nm) and importance. Difference between bulk and nanomaterials. Surface to volume ratio concept. Quantum confinement effect. Optical, electrical, and magnetic property changes at the nanoscale.	3
Classification of nanomaterials: - OD, 1D, 2D nano structures (quantum dots, wires, thin films), Metal and semiconductor nano materials. Carbon nanostructures: - Fullerenes (Bucky balls), Carbon nanotubes (CNTs). Transition from molecule to bulk materials.	3
Synthesis of Nanomaterials: - Top-down approaches: - lithography, Mechanical milling, Bottom-up approaches - Sol-gel method. Chemical vapour deposition (CVD), Physical vapour deposition (PVD)	3
Characterization Techniques: - Microscopy method: SEM, TEM, AFM	
Applications of Nanomaterials: - Nano electronics, Energy applications (solar cells, batteries), Sensors and Biosensors, Nano medicine and drug delivery, Optical and Photonic devices (Qualitative)	5

Course articulation matrix:- Mapping of course outcomes (COs) with Program Outcomes (POs 1-12)												
Course Outcomes (COs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3		3		1					3	2
CO2			3		2		2			2		
CO3	1	2		2				2			3	3
CO4						2			3			
CO5		2		2			3			3		

Score indicators: High = 3, Medium = 2, Low = 1

Pedagogy: interactive lectures, inquiry-based learning, Blended learning, Learning based on Experiments

Formative Assessment Theory	
Assessment Occasion/Type	Marks
One Internal Test - C1	10 marks
Assignment/ seminar – C2	05 marks
Attendance – C2	05 Marks
Total	20
Formative Assessment, as per University Guidelines, is compulsory	

Course Title	Quantum Mechanics-II, Astrophysics, Atmospheric Physics, and Nanomaterials		Practical Credits	02
Course Code	BU-PHYUG-DSC P7		Contact Hours /week	04
Formative Assessment - Total 10 marks	Attendance – C1	05 Marks	Summative Assessment	40
	Lab Test – C2	05 Marks		

List of Experiments

1. Determination of quantised energy levels in atoms using the experimental data of the Frank-Hertz experiment
2. Study of the I-V characteristics and the determination of the valley voltage of the tunnel diode
3. Determination of the sidereal and synodic periods by analysing the data of sunspot photographs
4. Study the given stellar spectra, determine the temperature of a star, and classify it.
5. Determination of physical properties of stars using the H-R Diagram
6. Determination of distance using the parallax method
7. Determination of the mass of binary stars by radial components of velocities
8. Determination of the Hubble constant from the given data
9. Study the variation of atmospheric pressure with altitude for the given data
10. Determination of the relative humidity of the indoor atmosphere using dry and wet bulb thermometer
11. Study the Albedo effect using the given experimental data
12. Study the Climate modelling using computer simulations
13. Determination of Particle size using given XRD data
14. A code in C/C++/Scilab to find the first seven eigenstates and eigenfunctions of the linear harmonic oscillator by solving the Schrodinger Equation
15. A code in C/C++/Scilab to plot and analyse the wave functions for a particle in an infinite potential well by solving the Schrodinger Equation
16. Measurement of solar constant

References

1. IGNOU : Practical Physics Manual IGNOU publications
2. Saraf : Experiment in Physics Vikas publicatios
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)
7. Ramalingom & Raghuopalan : A Lab. Course in Electronics
8. Bharagav et al : Electronics, TTI tata MacGraw Hill 33rd Reprint (2002)

Program Name	B.Sc. (Physics)	Semester	VI
Course Title	Medical Physics		
Course Code	BU-PHY UG- DSC E1	No. of Credits	03
Contact Hours	56 hours/ 4 hours per week	Duration of Theory Exam	3 hours
Formative Assessment Marks	20	Summative Assessment Marks	80

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1- Explain the generation and attenuation of X-rays and γ -rays and compute dose metrics for diagnostics and therapy.
CO2- Operate ultrasound and MRI concepts—acoustic impedance, spin precession, k-space encoding—and assess image quality.
CO3- Design shielding and QA tests that follow ALARA principles and regulatory limits.
CO4- Calibrate detectors (ion chamber, GM, scintillator), propagate uncertainties, and draft
CO5- Audit safety workflows for nuclear-medicine and radiotherapy contexts, flagging ethical and environmental concerns.

Contents	56
Unit 1 Basic Human Anatomy and Radiation Physics Review of atomic & nuclear structure: Radioactivity and decay laws (α, β, γ), Nature of radiation; ionizing and non-ionizing, Radioactivity, Decay law, Half- life and mean life. Interaction of radiation with matter: (i) Photoelectric effect, (ii) Compton scattering, (iii) Pair production. Radiation quantities: Exposure, absorbed dose, Equivalent dose. Units: Gray (Gy), Sievert (Sv) Human anatomy and physiology: Structure and functions of the skeletal system, the nervous system, the cardiovascular system, the respiratory system, the digestive system, and the circulatory system, types of cells, tissues (Brief idea)	7 3 4
Unit 2 Radiation Detection and Dosimetry Radiation detection: Gas-filled detectors, ionization chamber, GM counter, Scintillation detectors, Semiconductor detectors (Basic idea) Radiation dosimetry: Units, Exposure, REM, UNSCEAR reports, Absorbed dose, Equivalent dose Measurement techniques: Spark Counters, Solid State Nuclear Track Detectors, ALPHA Guard, TLD (Thermoluminescence dosimeter), Film badge radiation hazards and protection, shielding, and ALARA Principle	5 3 6

Unit 3 Diagnostic Medical Imaging	
X-ray imaging: X-ray tubes, Production of X-rays, X-ray spectrum, radiography, and fluoroscopy.	3
Advanced Imaging Techniques: CT scan (principle & application), colour scan (principle & application)	2
Imaging basics: Nuclear Magnetic Resonance (NMR), plane Magnetic Resonance Imaging (MRI) and contrast MRI, Spectrometric analysis, PET (Positron Emission Tomography), SPECT (Single Photon Emission CT)	6
Ultrasound Imaging: Pulse-echo technique, Doppler effect. Applications of all the above techniques.	3
Unit-4 Radiation Therapy and Nuclear Medicine	
Introduction: Nuclear Medicine, Diagnostic vs. Therapeutic Use	2
Radio pharmaceuticals: Definition and properties, Common isotopes: Technetium-99m and Iodine-131	2
Radioisotope Production (Basic idea): Reactor-produced isotopes; Cyclotron-produced isotopes	3
Detection & Imaging: Gamma camera; Scintillation detector; Basic working principle	3
Radiation Therapy: External beam therapy, Linear accelerator (LINAC), Brachytherapy, Treatment planning basics.	4

Course articulation matrix: - Mapping of course outcomes (COs) with Program Outcomes (POs 1-12)												
Course Outcomes (COs) Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3		3		1					3	2
CO2			3		2		2			2		
CO3	1	2		2				2			3	3
CO4						2			3			
CO5		2		2			3			3		

Score indicators: High = 3, Medium = 2, Low = 1

Pedagogy: interactive lectures, inquiry-based learning, Blended learning, Learning based on Experiments

Formative Assessment Theory	
Assessment Occasion/Type	Marks
One Internal Test - C1	10 marks
Assignment/ seminar – C2	05 marks
Attendance – C2	05 Marks
Total	20
Formative Assessment, as per University Guidelines, is compulsory	

Reference Books

1. Physics and Radiobiology of Nuclear Medicine – Gopal B.Saha
2. Medical physics – John R. Cameron
3. The essential physics of medical imaging – Bushburg
4. Medical physics: A beginner's guide" by Jim Thrush
5. The physics of radiation Therapy – Faiz khan
6. Physics and Radiobiology of Nuclear Medicine - Gopal B. Saha
7. Introduction to Radiological Physics and Radiation Dosimetry - Frank Herbert Attix
8. Radiation Oncology Physics: A Handbook for Teachers and Students
9. International Atomic Energy Agency

Program Name	B.Sc. (Physics)	Semester	VI
Course Title	Material Science		
Course Code	BU-PHY UG- DSC E2	No. of Credits	03
Contact Hours	56 hours/ 4 hours per week	Duration of Theory Exam	3 hours
Formative Assessment Marks	20	Summative Assessment Marks	80

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1- Relate crystal structures and defect types to mechanical, thermal, and electronic behavior.
CO2- Interpret phase diagrams and plan heat treatments for targeted microstructures.
CO3- Select characterization tools (XRD, SEM, hardness tests) and analyze output quantitatively.
CO4- Predict material degradation (corrosion, fatigue, creep) and propose mitigation strategies.
CO5- evaluate sustainability and economics when choosing materials for real-world applications.

Contents	56
Unit 1:	
Classification of Engineering Materials: Metals and Alloys, Ceramics, Glasses, Polymers, and their applications. Levels of structure- (Macrostructure, Microstructure, Substructure, Crystal structure, electronic structure, and nuclear structure).	4
Chemical Bonding in Materials: Ionization Potential, Electron Affinity and Electronegativity, Bond Energy, Bond Type and Bond Length. Ionic Bonding, Covalent Bonding, σ -Bond, π -Bond, Metallic Bonding, Secondary Bonding (H-Bonding between water molecules), Variation of Bonding Character and Properties.	7
Structure of Solids: The Crystalline and the Non-Crystalline States. Metals and Alloys. Close Packing of Spheres. The Structure of Silica and Silicates.	3
Unit-2	
Polymers: Classification of Polymers. Structure of Long Chain Polymers. Crystallinity of Long Chain Polymers.	5
Crystal Imperfections: Classification of Imperfections (Point Imperfection, Line Imperfection, Surface Imperfection, Volume Imperfection). Point Imperfection in detail. The Geometry of Dislocations. Berger Circuits for Perfect Crystals and Imperfect Crystals with Edge Dislocations. Frenkel and Schottky defects and their concentrations.	9
Unit-3	
Phase diagrams: The Phase Rule, Single Component Systems, Binary Phase diagrams (Al_2O_3 - Cr_2O_3 , Pb-Sn, and Ag-Pt Phase diagrams). Microstructural Change During Cooling. The Lever Rule and the 1-2-1 Rule and their applications.	7
Phase Transformations: Time Scale for Phase Changes. Nucleation and Growth. The Nucleation Kinetics. Transformations in Steel. Solidification and Crystallization. The Glass Transition. Recovery, Re-crystallization and Grain Growth, Laws of Re-crystallization.	7
Unit-4	
Deformation of Materials and Creep: Elastic Deformation. Plastic Deformation. Plastic Deformation by slip, Deformation by Twinning. Comparison between Slip and Twinning. The Tensile Stress-Strain Curve, The Shear Strength of Perfect and Real Crystals.	6
Creep: Mechanism of Creep-(a) Dislocation Climb (b) Vacancy Diffusion (c) Grain Boundary Sliding. Creep Resistant Materials.	3
Fracture: Ductile Fracture. Brittle Fracture. Fracture Toughness. Ductile-Brittle Transition. Fatigue Fracture.	5

Course articulation matrix:- Mapping of course outcomes (COs) with Program Outcomes (POs 1-12)												
Course Outcomes (COs) Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3		3		1					3	2
CO2			3		2		2			2		
CO3	1	2		2				2			3	3
CO4						2			3			
CO5		2		2			3			3		

Score indicators: High = 3, Medium = 2, Low = 1

Pedagogy: interactive lectures, inquiry-based learning, Blended learning, Learning based on Experiments

Formative Assessment Theory	
Assessment Occasion/Type	Marks
One Internal Test - C1	10 marks
Assignment/ seminar – C2	05 marks
Attendance – C2	05 Marks
Total	20
Formative Assessment as per University Guidelines are Compulsory	

References

1. Materials Science and Engineering - V. Raghavan (5th Ed)
2. Introduction to Physics and Chemistry - Robert J.N
3. Introductory Physics of Materials- David Barton
4. Physics of Functional Materials - Hasse Fredriksson and Ulla Akerlind, John Wiley and Sons Ltd.
5. Materials Science - S.L. Kakani and Amit Kakani, New Age Int. (P) Ltd Publishers.

Program Name	B.Sc. (Physics)	Semester	VI
Course Title	Nuclear and Particle Physics		
Course Code	BU-PHY UG- DSC E3	No. of Credits	03
Contact Hours	56 hours/ 4 hours per week	Duration of Theory Exam	3 hours
Formative Assessment Marks	20	Summative Assessment Marks	80

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1- Apply SEMF, shell model, and reaction kinematics to predict binding energies, decay modes, and cross-sections.
CO2- Design and calibrate radiation detectors, analyze spectra, and assess statistical and systematic uncertainties.
CO3- Compute dose metrics, plan shielding, and audit safety protocols under ALARA constraints.
CO4- Explain quark-lepton structure, mediation, and conservation rules to interpret particle processes.
CO5- Synthesize experimental data with theory in short reports that state assumptions, uncertainties, and limits.

Contents	56
UNIT 1 Basic Properties of Nucleus Nuclear Structure: Basic properties of nucleus - size, charge, mass, spin, magnetic dipole moment, and electric quadrupole moment. Binding energy of nucleus, deuteron binding energy, p-p, n-n, and n-p scattering (concepts), nuclear forces. Nuclear models- liquid drop model, shell model. Radioactivity: Radioactivity, laws of radioactivity, Half-life (derivation), Mean life (derivation). Relation between Half-life and Mean life. Alpha Decay, Gamow's theory of Alpha decay, Geiger-Nuttall law, and its significance, Beta decay, types of Beta decay, Pauli's neutrino hypothesis, Gamma Decay, selection rules, and internal conversion process	7 7
UNIT 2 Nuclear Reactions Nuclear Reactions: Basics of nuclear reactions, types of nuclear reactions with examples, Conservation laws in Nuclear reactions, Energetics of Nuclear reactions, Expression for Q value of Nuclear reactions(derivation), Exoergic and Endoergic reactions. Nuclear reaction cross-section (derivation), Relation between mean free path and Macroscopic Nuclear reaction cross-section(derivation). Theory of formation of compound nucleus and its decay, Direct and Compound Nuclear reactions, Nuclear reaction rate. Resonance reactions. Nuclear Power reactors. Peaceful use of nuclear energy	14

UNIT 3 Particle Accelerators and Detectors Particle Accelerators Van de Graff generator, Linear Accelerator, Cyclotron, Synchrocyclotron, Betatron, and Proton Synchrotron. Large Hadron Collider and its role in discovering subatomic particles (Qualitative) Particle Detectors Gas-filled Detectors: Variation of ionization current with applied voltage. Ionization chamber, Proportional counter, Geiger-Muller counter Wilson's cloud chamber, Bubble chamber, Solid state detectors, Application of Detectors in various fields	7 7
UNIT 4 Particle Physics Elementary Particles: Classification of elementary particles based on their interactions and the statistics they obey (Bose-Einstein or Fermi-Dirac statistics) and their families. Fundamental Interactions: Yukawa hypothesis, Feynman diagram for electromagnetic, weak, and strong interactions. Feynman rules. Conservation Laws and Symmetries: Conservation of energy, momentum, angular momentum, charge, baryon number, and lepton number. Symmetry groups and SU (2) Isospin analysis, Gell-Mann Nishijima formula. The Standard Model: Structure of matter, Quark model, Quark compositions of baryons and mesons, charm, bottom, and top quarks, and quantum chromodynamics	3 3 4 4

Course articulation matrix:- Mapping of course outcomes (COs) with Program Outcomes (POs 1-12)												
Course Outcomes (COs) Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3		3		1					3	2
CO2			3		2		2			2		
CO3	1	2		2				2			3	3
CO4						2			3			
CO5		2		2			3			3		

Score indicators: High = 3, Medium = 2, Low = 1

Pedagogy: interactive lectures, inquiry-based learning, blended learning, Learning based on Experiments

Formative Assessment Theory	
Assessment Occasion/Type	Marks
One Internal Test - C1	10 marks
Assignment/ seminar – C2	05 marks
Attendance – C2	05 Marks
Total	20
Formative Assessment, as per University Guidelines, is compulsory	

References

1. Concepts of Nuclear Physics- B. L. Cohen
2. Introductory Nuclear Physics-. Kenneth S. Krane
3. Introduction to Elementary Particles-..D. Griffiths
4. Nuclear and Particle Physics (concise intro).- Bernard Schaeffer & Gérard Sajot
5. Particle Astrophysics (for broader context).- Donald Perkins

Program Name	B.Sc. (Physics)	Semester	VI
Course Title	Skill Based Practicals		
Course Code	BU-PHYUG- SBP	No. of Credits	02
Contact Hours	4 hours per week	Duration of Practical Exam	3 hours
Formative Assessment Marks	10	Summative Assessment Marks	40

Course pre-requisite(s):
COs- After the successful completion of the course, the student will be able to
CO1- Build and troubleshoot apparatus systematically, logging decisions and failures.
CO2- Process real datasets with code, propagate errors, and defend statistical choices.
CO3- Translate measurements into physical insight, citing limits and systematic effects.
CO4- Present findings in written and oral formats tailored to technical audiences.
CO5- Work safely under supervision—risk-assess experiments, handle chemicals/lasers, and follow waste and electrical protocols.

SKILL-BASED EXPERIMENTS

1. Use of EXCEL AND DESMOS in plotting graphs-(2 graphs each for equations in physics (linear and exponential))
2. Python program for Projectile motion with air resistance-(2 programs with velocity variation)
3. Analysis of XRD OF NANOMATERIALS-full width at half maximum and estimation of particle size (2 XRDs)
4. Study of Lissajous figures using CRO (Frequency ratio and phase difference)
5. Error Analysis (Two Experiments-Viscosity of a liquid by the Stokes method and Young's modulus by a single Cantilever, Calculation of mean, standard deviation, and least square analysis)
6. To determine the constant of proportionality in Newton's law of cooling (Water as a liquid)
7. Monte Carlo Simulations (Study of the Gaussian distribution using six faced dice, Estimation of the value of (π))
8. Determination of acceleration due to gravity using video analysis (Tracker software)
9. Determination of Coefficient of restitution using video analysis (Tracker software)
10. Tracking Sunspots Using Real Data from SOHO

Note:

1. Error analysis is compulsory.
2. Minimum of six experiments to be performed (excluding error analysis).