जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया – सूचानी (बागला), जिला सांबा – 181143, जम्मू (जम्मू एवं कश्मीर)
Rahya - Suchani (Bagla), District: Samba – 181143, Jammu (J&K)

संख्या: CUJ/ Acad/4-X/2023/378 04.06.2024

Notification /अधिसूचना संख्या82 /2024

Sub: Course Scheme and Syllabus Notification as per NEP-2020 of 5th and 6th Semesters of Integrated B.Sc. (Hons) – M.Sc. in Physics w.e.f. Academic Session 2022-23 – Reg.

विभागाध्यक्ष, भौतिकी और खगोल विज्ञान विभाग; अधिष्ठाता, आधारिक एवम अनुप्रयुक्त विज्ञान विद्यालय, 15.03.2024 को भौतिकी और खगोल विज्ञान विभाग की आयोजित 10वीं बोर्ड ऑफ स्टडीज (बीओएस) की सिफारिश पर और अगली स्कूल बोर्ड एवं अकादमिक परिषद की प्रत्याशा में सक्षम प्राधिकारी ने भौतिकी में एकीकृत B.Sc (ऑनर्स) – M.Sc के 5वें और 6वें सेमेस्टर के एनईपी-2020 के अनुसार शैक्षणिक सत्र 2022-23 से पाठ्यक्रम योजना और पाठ्यक्रम अधिसूचना को मंजूरी दे दी है जोकि इस प्रकार है :

On the recommendation of Head, Department of Physics and Astronomical Sciences, Dean, School of Basic and Applied Sciences, 10th Board of Studies (BoS) held on 15.03.2024 in the Department of Physics and Astronomical Sciences and School Board of Basic and Applied Sciences and in anticipation of next Academic Council the Competent Authority has approved, the Course Scheme and Syllabus Notification as per NEP-2020 of 5th and 6th Semesters of Integrated B.Sc. (Hons) – M.Sc. in Physics w.e.f. Academic Session 2022-23 as detailed below:

SEMESTER V

Course Code	Course Title	Credit		L	T	P
		L	P			
CORE COURSES						
IPHY3C001T	Elementary Quantum Mechanics	3	0	3	0	0
		0	1	0	0	2
IPHY3C002T	Solid State Physics	3	0	3	0	0
		0	1	0	0	2
OPEN ELECTIVE COURSES(SEC/VAC/AEC/OEC) or on SWAYAM Platform –MOOC Courses						
#	Open Elective Courses	12	-	-	-	-
	Total	**20**	-	-	-	-

The student has to earn minimum of **20 credits** during the Semester-V. Apart from two core courses of **4 credits** (3 of Lecture and 1 of Practical) **each**, the candidate has to earn **12 more credits** (minimum **04 credits** from **AEC**) among the **Open Elective** basket offered by the Department or other Departments or on SWAYAM Platform – MOOC Courses etc.

SEMESTER VI

Course Code	Course Title	Credit L	Credit P	L	T	P
CORE COURSES						
IPHY3C003T	Introduction to Nuclear Physics	3	0	3	0	0
		0	1	0	0	2
IPHY3C004T	Statistical Mechanics	3	0	3	0	0
		0	1	0	0	2
OPEN ELECTIVE COURSES(SEC/VAC/AEC/OEC) or on SWAYAM Platform –MOOC Courses						
±	Open Elective Courses	12	-	-	-	-
	Total	**20**	-	-	-	-

The student has to earn minimum of **20 credits** during the Semester-VI. Apart from two core courses of **4 credits** (3 of Lecture and 1 of Practical) **each**, the candidate has to earn **12 more credits** among the **Open Elective** basket offered by the Department or other Departments or SWAYAM Platform – MOOC Courses etc.

Open elective Courses Offered by Department of Physics:

Course Code	Course Name	Course	Credit	L	T	P
UPHY0O011T	Plasma Physics	OEC	4	4	0	0
UPHY0O012T	Electromagnetic Theory	OEC	4	4	0	0
UPHY0O013T	Special Theory of Relativity	OEC	4	4	0	0
UPHY0O014T	Atomic and Molecular Physics	OEC	4	4	0	0
UPHY0O015T	Nanomaterials and its applications	OEC	4	4	0	0
UPHY0O016T	Energy conversion and Storage System	OEC	4	4	0	0

04/06/2

कुलसचिव (I/c)
ईमेल: registrar@cujammu.ac.in
दूरभाष: 80821-97957

8

विभागाध्यक्ष /Head
भौतिकी एवं खगोल विज्ञान विभाग/ Department of Physics and Astronomical Sciences
प्रतिलिपि/ Copy to:
परीक्षा नियंत्रक / Controller of Examinations

Int. B.Sc.(H)-M.Sc. Physics				
			Type:	Core
Semester :	VI			
Course Name:	Introduction to Nuclear Physics		Course Code:	
			L T P:	3-0-2
Credits:	3+1			

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand the basic properties of atomic nuclei, including nuclear size, shape, and stability.*

CO 2 *Describe the different models of the atomic nucleus, such as the liquid drop model and the shell model.*

CO 3 *Explain the processes of nuclear decay, including alpha, beta, and gamma decay, as well as nuclear reactions..*

CO 4 *Analyze experimental data related to nuclear phenomena using appropriate theoretical models..*

CO 5 *Critically evaluate the current research and advancements in the field of Nuclear Physics.*

UNIT-I

Mass, radius, angular momentum, magnetic moment, electric quadrupole moment, parity, estimation of mass, basic concepts of mass spectrographs, double focussing spectrograph, Coulomb scattering of a charged particle by a nucleus, Electron scattering by a nucleus, variation of nuclear radius with mass number A.

UNIT-II

Constituents of the nucleus. Nuclear forces and its properties, Binding energy, mass defect, variation of binding energy with mass number A, Liquid drop model, Semiempirical mass formula, origin of various terms, stable nucleus and conditions for stability

UNIT-III

Energy release in nuclear fission (using BE curve) spontaneous fission and potential barrier, liquid drop model, self-sustaining chain reaction, neutron balance in a nuclear reactor, classification of reactors, uncontrolled reaction and atomic bomb, Nuclear Fusion: Energy released in nuclear fusion in stars, carbon-nitrogen and proton-proton cycle, problems of controlled fusion.

UNIT-IV

Linear accelerator, cyclotron, synchrocyclotron, betatron, synchrotron, Electron Synchrotron, proton synchrotron, Nuclear detectors: Ionisation chamber, Proportional counter, GM counter, scintillation counters, solid state detectors, neutron detector.

UNIT-V

Properties of particles, classification into leptons, mesons and baryons, matter and antimatter, conservation laws, fundamental interactions, quark model for the structure of matter.

Text/Reference Books:

1. Nuclear physics by Irving Kaplan, Oxford & IBH Pub., 1962.
2. Introduction to experimental Nuclear Physics by R. M. Singru, Wiley Eastern Pvt. Ltd.
3. Nuclear Physics by S. N. Ghoshal, S. Chand, 2006.
4. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
5. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

List of Practicals

1. Detection of γ radiation with a scintillation counter.
2. Quantitative observation of the Compton effect.
3. Demonstrating the tracks of α particles in a Wilson cloud chamber.
4. Rutherford scattering: measuring the scattering rate as a function of the scattering angle and the atomic number.
5. Deflection of beta radiation in a magnetic field.
6. Recording and calibrating a γ spectrum.
7. Determining the energy loss of α radiation in air.
8. Study the characteristics of a G.M counter Characteristics & Determine the Pleatau Value.
9. Study the Absorption Factors using Different Thickness of Aluminium Sheets.
10. Study Half Life.
11. Inverse Law using Distribution Method.
12. To determine the endpoint energy of beta particle of a given radioactive source using gm counter
13. Study the characteristics of a G.M counter and verify the inverse square law.
14. Study of β- absorption in aluminium foil using G.M counter.
15. Study of variation of modulus of rigidity of a given specimen as a function of temperature.
16. To reproduce the Binding Energy curve for the whole mass range.
17. Semi empirical mass formula .
18. Any other experiments of the equivalent standard can be set.

Int. B.Sc.(H)-M.Sc. Physics			
		Type:	Core
Semester :	VI	Course Code:	
Course Name:	Statistical Mechanics	L T P:	3-0-2
Credits:	3+1		

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand the fundamental principles of statistical mechanics, including ensembles, probability distributions, and the concept of entropy.*

CO 2 *Describe the behavior of systems with a large number of particles using statistical methods, including the classical, quantum, and classical statistical ensembles.*

CO 3 *Explain the concept of equilibrium and the relationship between macroscopic observables and microscopic states.*

CO 4 *Discuss the principles of phase transitions and critical phenomena, including the Ising model and mean field theory.*

CO 5 *Apply statistical mechanics to various physical systems, including gases, solids, and liquids.*

UNIT-I

Classical statistical mechanics approach based on kinetic theory of particles, Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Law of Equipartition of Energy – Applications to Specific Heat and its Limitations, Negative Temperature.

UNIT II

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

UNIT III

Quantum Theory of Radiation Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan Boltzmann Law, (4) Wien's Displacement law from Planck's law.

UNIT IV

Bose-Einstein Statistics, B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

UNIT V

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals.

Reference Books

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed.,1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Fran-cis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
7. Statistical Mechanics - an elementary outline, A. Lahiri, 2008, Universities Press.

List of Practicals:

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics.

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
   a. Study of local number density in the equilibrium state (i) average; (ii) fluctuations
   b. Study of transient behavior of the system (approach to equilibrium)
   c. Relationship of large N and the arrow of time
   d. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
   e. Computation and study of mean molecular speed and its dependence on particle mass
   f. Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function Z (b) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:

   a. Study of how Z (b), average energy <E>, energy fluctuation DE, specific heat at constant volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.

   b. Ratios of occupation numbers of various states for the systems considered above

   c. Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T .

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

   a. Maxwell-Boltzmann distribution
   b. Fermi-Dirac distribution
   c. Bose-Einstein distribution

Note: Any other experiments of the equivalent standard can be set

Reference Books

1. Elementary Numerical Analysis, K.E.Atkinson, 3 rd Edn . 20 07 , Wiley India Edition

2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

3. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987

4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Fran-cis W. Sears and Gerhard L. Salinger, 1986, Narosa.

5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

6. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.

7. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.

8. V. Fernandez. 2014 Springer ISBN: 978-3319067896

Five years Integrated B.Sc.(H)-M.Sc. Physics			
Semester :		Type:	OEC
Course Name:	Plasma Physics	Course Code:	
Credits:	4	L T P:	3-1-0

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Define plasma and explain its key properties*

CO 2 *Describe methods for plasma production and diagnostics in laboratory settings.*

CO 3 *Explain the principles of controlled thermonuclear fusion and differentiate between open and closed systems (e.g., Tokamak).*

CO 4 *Analyze the concepts of charge neutrality, Debye length and plasma frequency.*

CO 5 *Explain fundamental plasma processes like collisions, diffusion, and basic principles governing plasma behavior (e.g., Ohm's Law).*

Unit-I

Definition and properties of plasma, plasma production in laboratory and diagnostics, microscopic description; motion of a charged particle in electric and magnetic fields-curvature, gradients and external force drift, controlled thermonuclear devices, magnetically confined open and closed systems (linear pinch, mirror machine and Tokamak); laser plasmas- inertially confined system.

Unit-II

Plasma definition and general properties of charge neutrality and collective behavior, Debye length, Plasma frequency concept of equilibrium, plasma temperature and plasma in nature; basic plasma processes: charged particle interactions in plasma, elastic and inelastic collisions, cross-section, frequencies, diffusion, mobility, Einstein relationship, Ohms law, Excitation, ionization, recombination processes, radiation from plasma.

Unit-III

Statistical description of plasmas, Bogoliubov–Born–Green–Kirkwood–Yvon (BBGKY) hierarchy of equations, Boltzmann-Vlasov equation, equivalence of particle orbit theory and the Vlasov equation, Boltzmann and landau collision integral H-theorem, B.G.K. model, Fokker-Planck term, solution of Boltzmann equation (brief outline); transport coefficient-electrical conductivity, diffusion.

Unit-IV

Source of ionization, formation of an ionized layer, the ionospheric regions, distribution of ion in the topside ionosphere, magnetic field variation and concepts of atmospheric dynamo and motor, moments in the atmospheric plasma and neutral atmospheric interaction currents in ionosphere, storm time distribution, motion in the upper atmosphere; production of irregularities in the ionosphere

Unit-V

Small amplitude plasma oscillations, oscillations in warm field-free plasma, Landau damping, Nyquist method-Penrose criterion of stability, two stream stability (linear and quasi linear theory); Vlasov theory of magnetized plasma, loss cone stability, quasilinear theory of gently bump instability, non-linear electrostatic waves.

Text Books and References:

1. F.F. Chen, Introduction to Plasma Physics, (Plenum Press).
2. N.A. Krall and Trivelpiece, Principles of Plasma Physics, (San Fransisco Press).
3. G. Schimdt, Physics of High Temperature Plasmas, (Academic Press).
4. R.D. Hazeltine & F.L. Waelbroeck, The framework of Plasma Physics, (Perseus Books).
5. R.J. Goldston and P.H. Rutherford, Introduction to Plasma Physics, (IOP).

Int. B.Sc.(H)-M.Sc. Physics		Type:	OEC
Semester :		Course Code:	
Course Name:	ATOMIC AND MOLECULAR PHYSICS	L T P:	3-1-0
Credits:	4		

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand about the atoms and atomic spectra*

CO 2 *Understand about the Zeeman's Effect*

CO 3 *explain the change in behavior of atoms in external applied electric*

CO 4 *explain rotational, vibrational, electronic and Raman spectra of molecules.*

UNIT-I

Inadequacy of Bohr atomic model, correction due to finite mass of the nucleus, Rydberg constant in terms of reduced mass, Excitation and Ionisation potentials, Franck-Hertz experiment, Bohr-Sommerfeld Model of atom, vector model of an atom, Electron spin, space quantisation, magnetic moment of an electron due to its orbital motion. Stern-Gerlach experiment and its theory, Spin-orbit interaction and Fine structure of spectral lines

UNIT-II

Quantum numbers and selection rules, Pauli's exclusion principle, Electronic configuration of atoms, Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na atom, selection rules, sodium Doublet. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ coupling schemes. Singlet Triplet separation for interaction energy of LS coupling. Lande's Interval rule, Problems.

UNIT-III

Early discoveries and developments, Experimental arrangement, Normal and anomalous Zeeman Effect Problems, Stark effect (Qualitative discussion), X-ray spectroscopy: Nature of X-rays, Discrete and continuous X-ray spectra, Daune and Hunt's Rule, X-ray emission spectra, Mosley's law and its applications, Auger effect , Problems

UNIT-IV

Molecular formation, the H molecular ion, H_2 – molecule. Salient features of molecular spectra. Rotation, vibration and electronic spectra of molecules, associated quantum numbers and selection rules, Theory of pure rotation and rotation- vibration spectra, Raman and IR spectra, simple applications.

UNIT-V

Classical theory of Raman Effect. Molecular polarizability, Quantum theory of Raman Effect, Experimental set up for Raman Effect, Applications of Raman spectroscopy

Books Recommended:

1. Atomic Physics (Modern Physics), S N Ghosal, (S. Chand)
2. Concepts of Modern Physics 4th edition, Arthur Baiser (McGraw Hill International edition)
3. Introduction to Atomic spectra, H. E White. (McGraw Hill International edition)
4. Introduction to Atomic and Molecular Spectroscopy , V.K.Jain, Narosa Publication.
5. Molecular Structure And Spectroscopy, 2nd Edition, G. Aruldhas (PHI Learning).
6. Physics of Atoms and Molecules, 2nd edition B H Bransden and C J Joachain, Pearson International.

Int. B.Sc.(H)-M.Sc. Physics			
Semester :			
Course Name:	NANOMATERIALS AND APPLICATIONS	Type:	OEC
		Course Code:	
Credits:	4	L T P:	3-1-0

Pre-Requisites:

Knowledge of different materials and their basic properties such as crystal structure, band diagram

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Comprehend the unique properties of nanomaterials for their applications in different fields.
CO2	Solve the Schrödinger equations for 2D, 1D and 0D quantum confined nanostructures.
CO3	Understand the principles of nanomaterial synthesis and fabrication techniques.
CO4	Comprehend different characterization methods used to analyze nanomaterials.
CO5	Analyze emerging research trends in nanomaterial applications and addressing challenges in integrating nanomaterials into various fields

UNIT-1:

Introduction to Nanostructured materials and their technological significance, Classification of Low dimensional Systems-2D, 1D, and 0D systems, Quantum dots, Nanowires, Nanorods, Surface effect and Quantum Confinement effect, Schrödinger equations for 2D, 1D and 0D systems, Density of States in bulk and low dimensional Systems- derivation and explanation.

UNIT-2:

Size dependent Properties of Nanomaterials-Physical, Chemical, Optical, Electronic, Mechanical and Magnetic Properties.

UNIT-3:

Bottom-up and top-down approaches, Physical and Chemical Techniques, Nucleation and Growth Mechanism of thin film and nanostructure formation; Thermal Evaporation and Electron beam Evaporation, Arc-discharge, Laser Ablation, Chemical Vapor Deposition, Colloidal synthesis, Self-assembly techniques, Spin coating, Dip coating, Spray pyrolysis; Nanofabrication-photolithography and Electron-beam Lithography.

UNIT-4:

X-Ray Diffraction, Electron microscope (SEM, TEM), and Scanning probe microscopes (STM, AFM); Applications of Nanomaterials in Modern Nanodevices- Biological, Optoelectronic and Sensing devices.

UNIT-5:

Carbon-based nanomaterials (graphene, carbon nanotubes) and Semiconductor nanomaterials (quantum dots, nanowires) based FETs, Applications of nanomaterials in the field of medicine and drug delivery, energy and Environmental Science.

Reference Books:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Wiley, 2006.
4. B.S. Murty, P. Shankar, Baldev Raj, B B Rath and James Murday, Textbook of nanoscience and Nanotechnology, Universities Press, 2012
5. Charles P. Poole, Frank J. Owens, Introduction to Nanotechnology, Wiley 2012
6. M.A. Shah and Tokeer Ahmad , Principles of Nanoscience and Nanotechnology, Narosa, 2011.
7. Raul J. Martin-Palma, Akhlesh Lakhtakia, Nanotechnology, SPIE Press, USA, 2010.
8. Robert Kelsall, Ian Hamley and Mark Geoghegan, Nanoscale Science and Technology, Wiley, 2005.