PG BOS

Annexure-I

Chaudhary Bansi Lal University, Bhiwani

STUDY AND EVALUATION OF SCHEME OF

Dual Degree B.Sc. (Honors) - M.Sc. in Physics

SUMMARY

PROGRAMME	: Dual Degree B.Sc. (Honors)-M.Sc. Physics
DURATION	: 3+2YEARS
MEDIUM	: ENGLISH
Minimum Required Attendance	: 75%
Total Credits (9^{th} & 10^{th} semester)	: 40

Assessment/Evaluation:

	Internal Marks	Major Test (End Semester Exam)	Total
Theory	20	80	100
Practical	20	80	100

Internal Evaluation:

Theory			
Minor Test	Attendance	Assignment	Total
10	05	05	20

Break up of internal assessment marks (practical paper)	
Internal Viva-voce	Attendance (>75% 5 marks and >85% 10 marks)
10	10

Duration of Examinations:

Major Test (End Semester Examination	Internal (Minor Test)
3 hours	1 hours

To qualify the course, a student is required to secure a minimum of 40% marks in aggregate including the Major Test (End Semester Examination) and internal evaluation. A candidate who secures less than 40% of marks in a course shall be deemed to have failed in that course. The student should have obtained atleast 40% marks in aggregate to qualify the semester.

Note: The students should be involved in extracurricular activities through Hobbies Clubs (CGPA) such as Poetry, Science Club and Drama etc. and will be awarded a letter grade at the completion of Dual Degree B.Sc. (Honors) - M.Sc. The marks or CGPA (01 credit per semester) above said the course will be included in the scheme as per the guidelines of the university from time to time.

QUESTIONPAPERSTRUCTURE

There shall be nine questions in all by covering the entire syllabus. Students will have to attempt five questions. Question No.1 shall be compulsory, consisting of ten short answer type questions covering the entire syllabus with an option to attempt any eight questions. Each question shall carry equal marks.

(Abbreviation: P=Physics; PL = Physics Laboratory; GL=General Laboratory; GC- General Course)

Chaudhary Bansi Lal University, Bhiwani

Syllabus

For

Dual Degree B.Sc. (Honors)-M.Sc. Physics

(implemented from Academic year 2022-2023)

(Abbreviation: P = Physics; PL = Physics Laboratory; C = Chemistry; GL = General Laboratory; GC- General Course)

NOTE: This syllabus will be implemented for the batch admitted from 2022-2023 Academic Year

FIFTH YEAR
SEMESTER –IX

Total credits for semester-IX=24

Subject Code	Subject	Nature of Course	Contact Hours per week	Credits	Examination Scheme			
					Internal	Theory Exam	Practical /Project	Total
22P-901	Project[@]			24			600	600
Total credits for Semester-IX				24				600

[@]The project will be evaluated by the external expert

SEMESTER –X

Total credits for Semester-X=16

Subject Code	Subject	Nature of Course	Contact Hours per week	Credits	Examination Scheme			
					Internal	Theory Exam	Practical /Project	Total
22P-1001	Elective III	Discipline Subject Elective (DSE)	4	4	20	80		100
22P-1002	Elective IV	Discipline Subject Elective (DSE)	4	4	20	80		100
22P-1003	Elective V	Discipline Subject Elective (DSE)	4	4	20	80		100
22P-1004	Project			4	100			100
Total credits for Semester-X				16				400

Students are required to choose an elective course from the list of elective courses offered by the Department of Physics for the Batch 2022–2027 onwards.

Elective	Thin Film coatings for Advanced Technologies
	Thin Film Science and basic components: Definition and importance of thin films; classification of thin films; nucleation and growth processes; Film growth modes; Surface energy, adhesion, and wettability; Bottom-up approach vs Top-down approach; vacuum chambers; valves; seals: o-rings, metal seals; substrate: purpose, selection, preparation; Mask: purpose, selection, preparation; thickness measurements. **Vacuum science, pumping systems, and gauges:** Definition and importance of vacuum in science and industry, gas laws and kinetic theory; Vacuum pumps: rotary vane pump, diffusion pump, turbo-molecular pumps, ion pump, Cryopump – their operating principles and design; vacuum measurement and gauges: pirani gauge (thermal conductivity gauge), thermocouple gauge, ionization gauge (penning gauge). **Thin Film Deposition Techniques:** Physical Deposition Techniques: Thermal evaporation, Flash evaporation, Electron beam evaporation, Sputtering (DC and RF), Molecular beam epitaxy (MBE), Pulsed laser deposition; Chemical Deposition Techniques: Chemical vapor deposition (CVD), Plasma-enhanced CVD, Atomic layer deposition (ALD), Sol-gel, Spray pyrolysis, Dip Coatings, Spin Coatings. **Emerging Trends and Applications of Thin films:** Overview of emerging trends and applications of thin films as Optical coatings: Antireflection coatings, High-reflectivity coatings, Optical filters; Thin Films for Energy Applications: Thin-film photovoltaics, Perovskite solar cells, Transparent conducting oxides, Thin film thermoelectric devices, Thin Film Energy storage devices; Thin Films in Optoelectronics: Flat Panel Displays, LEDs, Photodetectors; Flexible and wearable thin Film; Thin Film Sensors: Gas sensors, Humidity sensors, temperature sensors; Protective coatings: Corrosion-resistant coatings; Wear-resistant coatings; Thermal barrier coatings; Hydrophobic and Self-Cleaning Coatings. **Suggested Readings** 1. Thin Film Technology Handbook by Elshabini-Riad, A. A. R. and Barlow III, F. D. 2. Thin-Film Deposition: Principles and Practice by Smith, D. L. 3. Handbook of Deposition Technologies for Films and Coatings by Bunshah, R. F. (Ed.) 4. Thin Films and Coatings by Zhang, S. 5. The World of Thin Film Coatings by Basu, A. 6. Vacuum Technology by Roth, A. 7. Thin Film Phenomena by Chopra, K. L. 8. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Cao, G. 9. Optical Processes in Semiconductors by Pankove, J. I. 10. Handbook of Modern Sensors: Physics, Designs, and Applications by Fraden, J. 11. Sensors and Transducers by Patranabis, D. 12. Handbook of Deposition Technologies for Films and Coatings by Bunshah, R. F. (Ed.) 13. Materials Science of Thin Films: Deposition and Structure by Ohring, M. 14. Thin-Film Deposition: Principles and Practice by Smith, D. L. 15. Thin Film Processes II by Hoffmann, A. and Singh, M.

	16. Handbook of Physical Vapor Deposition (PVD) Processing by Mattox, D. M. 17. Principles of Electronic Materials and Devices by Kasap, S. O. 18. Handbook of Thin Film Technology by Maissel, L. I. and Glang, R. (Eds.) 19. Solid State Electronic Devices by Streetman, B. G. and Banerjee, S. K. 20. Thin Film Processes by Vossen, J. L. and Kern, W. (Eds.)

Elective	Radiation Physics
	Radioactivity and Sources of Radiations: Radioactive decay, Half life time, Radioactive growth and decay, Radioactive equilibrium, Radioactive series, Radioactive branching, Radioactive dating, Artificial radioactivity, and Uses of radio-isotopes, X-rays: Characteristic X-rays, Bremsstrahlung radiations, synchrotron radiation, Cherenkov radiation, Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI). **Interaction of radiation (basic):** Active Vs Passive detector, Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Solid State Nuclear Track Detector (SSNTD), Semiconductor Detectors (Junction type detector, Lithium drift Germanium detector, and HPGe), Thermo – Luminescent Dosimeters (TLD), Chemical detectors (Photographic Emulsions Films). Neutron sources, Neutron collimators, Properties of neutrons, Classification of neutrons according to energy, Neutron detectors: Slow neutron detectors (Boron trifluride proportional counter), Medium and fast neutron detectors (basic idea). **Biological Effects of Ionizing Radiation:** Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect) **Principles of Radiological Protection:** Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students; Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds, Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Disposal of radioactive wastes, Sources of radioactive waste, Classification of radioactive wastes. **Suggested Readings** 1. Radiation Detection and Measurement by Glenn F. Knoll. 2. Concepts of Modern Physics by Arthur Beiser, S Mahajan, and S Rai Choudhury. 3. Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005. 4. Practical knowledge for Handling Radioactive Sources by Dr. Claus Grupen. 5. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx 6. Radiation Biology: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2010.

	7. Student Solutions Manual to accompany Radiation Detection and Measurement by Glenn F. Knoll. 8. Nuclear and Particle Physics by S. L. Kakani and ShubhraKakani.

Elective	**Fundamentals of Energy Systems and Clean Power**
	Fundamentals of Energy and Energy Resources: Energy and power: concepts and units, Global energy demand and sustainability, Energy conversion and efficiency, Exergy and energy quality, Environmental impact of energy utilization, Conventional Energy Sources: Fossil fuels and thermal power plants, Nuclear energy and nuclear reactors, Environmental issues and carbon emissions, Renewable Energy Sources: Solar energy, Wind energy, Hydropower, Biomass energy, Geothermal and ocean energy Energy Storage Technologies: Electrochemical Batteries, Fundamentals of electrochemical energy storage, Cell voltage and thermodynamics, Electrode-electrolyte interfaces, Primary and secondary batteries, Lead-acid batteries, Nickel-Cadmium and Nickel-Metal Hydride batteries, Lithium-ion batteries, Lithium-polymer batteries, Solid-state batteries, Battery charging and discharging characteristics, Battery management systems (BMS), Safety issues and thermal runaway Supercapacitors: Fundamentals of capacitors and energy storage, Electric double-layer capacitors (EDLCs), Pseudocapacitors, Hybrid supercapacitors, Materials for supercapacitors, Activated carbon, Graphene, Carbon nanotubes, Metal oxides, Energy density and power density, Ragone plots. Applications in electric vehicles and grid storage, Hybrid Storage Systems. Fuel Cells and Energy Harvesting Technologies: Fuel Cells, Fundamentals of fuel cells, Electrochemical principles, Thermodynamics and efficiency, Hydrogen economy, Types of Fuel Cells: Proton Exchange Membrane Fuel Cell (PEMFC), Alkaline Fuel Cell (AFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cell (SOFC), Fuel Cell Components: Electrodes, Electrolytes, Catalysts, Bipolar plates, Fuel Cell Applications: Transportation, Portable electronics, Distributed power generation **Suggested Readings** 1. Renewable Energy Resources by John Twidell and Tony Weir. 2. Energy Harvesting Technologies by Shashank Priya and Daniel J. Inman (Eds.). 3. Energy Storage by Robert A. Huggins. 4. Fuel Cell Fundamentals by Ryan O'Hayre et al. 5. Physics of Solar Cells by Peter Würfel. 6. Non-Conventional Energy Sources by G. D. Rai. 7. Renewable Energy Sources and Emerging Technologies by D. P. Kothari, K. C. Singal and Rakesh Ranjan. 8. Solar Energy: Fundamentals, Design, Modelling and Applications by G. N. Tiwari. 9. Renewable Energy Engineering and Technology by V. V. N. Kishore. 10. Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications by B. E. Conway.

Elective	**Introduction to Density Functional Theory and Electronic Structure of Solids**
	Introduction to many-particle quantum systems. Schrödinger equation for many-electron atoms and molecules. Difficulties in solving many-body problems. Independent particle approximation. Hartree theory and self-consistent field concept. Identical particles and spin. Pauli exclusion principle. Hartree–Fock theory, antisymmetric wave functions, Slater determinants, and exchange interaction. Introduction to Koopmans' theorem and its applications. Electron density as a fundamental quantity. Concept of functionals and functional derivatives. Thomas–Fermi model and its limitations. Hohenberg–Kohn theorems and their significance. Exchange-correlation energy and its physical meaning. Introduction to exchange-correlation approximations: Local Density Approximation (LDA), Local Spin Density Approximation (LSDA), Generalized Gradient Approximation (GGA), and Hybrid Functionals. Kohn–Sham approach to Density Functional Theory. Kohn–Sham equations and effective potential. Plane waves and pseudopotentials. Self-consistent field (SCF) method. Janak's theorem and ionization potential theorem (qualitative treatment). Introduction to electronic structure calculations using DFT. Advantages and limitations of DFT. Free electron model and its applications. Energy bands in solids. Tight-binding approximation (elementary treatment). Conductors, semiconductors, and insulators. Band structure and density of states. Fermi energy and Fermi surface. Interpretation of Kohn–Sham eigenvalues. Concept of band gap and its significance in materials. **Learning Activities:** Demonstrations using open-source DFT software, modelling, and guided exercise, Brainstorming, computational demonstrations, and interpretation of band structure plots. **Suggested Readings** 1. D. Sholl and J. A. Steckel, *Density Functional Theory: A Practical Introduction*, Wiley. 2. R. M. Martin, *Electronic Structure: Basic Theory and Practical Methods*, Cambridge University Press. 3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Cengage Learning. 4. C. Kittel, *Introduction to Solid State Physics*, Wiley. 5. R. G. Parr and W. Yang, *Density Functional Theory of Atoms and Molecules*, Oxford University Press.