Name of the Department: Physics

Semester-VI

DSC 7: Elements of Condensed Matter & Nuclear Physics (Theory)

Course Title: Elements of Condensed Matter & Nuclear Physics (Theory)	**Course code: :** 21BSC6C13PHL
Total Contact Hours: 60 hours	**Course Credits: 4**
Internal Assessment Marks: 40 marks	**Duration of SEE: 02 hours**
Semester End Examination Marks: 60 marks	

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

- Explain the basic properties of nucleus and get the idea of its inner information.
- Understand the concepts of binding energy and binding energy per nucleon v/s mass number graph.
- Describe the processes of alpha, beta and gamma decays based on well-established theories.
- Explain the basic aspects of interaction of gamma radiation with matter by photoelectric effect,Compton scattering and pair production.
- Explain the different nuclear radiation detectors such as ionization chamber, Geiger-Mueller counter etc.
- Explain the basic concept of scintillation detectors, photo-multiplier tube and semiconductor detectors.

DSC 6: Elements of Atomic, Molecular & Laser Physics (Theory)

Unit	Description	Hours
1	**Crystal systems and X-rays:** Crystal structure**:** Space Lattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells.. Seven crystal system, Coordination numbers, Miller Indices, Expression for inter planner spacing. **X Rays**: Production and properties of X rays, Coolidge tube, Continuous and characteristic X-ray spectra; Moseley's law. **X-Ray diffraction**, Scattering of X-rays, Bragg's law. **Crystal diffraction:** Bragg's X-ray spectrometer-powder diffraction method, Intensity vs 2θ plot (qualitative). **Free electron theory of metals:** Classical free electron model (Drude-Lorentz model), expression for electrical and thermal conductivity, Weidman-Franz law, Failure of classical freeelectron theory; Quantum free electron theory, Fermi level and Fermi energy, Fermi-Dirac distribution function (expression for probability distribution F(E), statement only); Fermi Dirac distribution at T=0 and $E<E_f$, at $T\neq 0$ and $E>E_f$, F(E) vs E plot at T = 0 and $T\neq 0$. Density of states for free electrons (statement only, no derivation). Qualitative discussion of lattice vibration and concept of Phonons.; Specific heats of solids: Classical theory, Einstein's and Debye's theory ofspecific heats. Hall Effect in metals.	**15**
2	**Magnetic Properties of Matter, Dielectrics and Superconductivity Magnetic Properties of Matter** Review of basic formulae: Magnetic intensity, magnetic induction, permeability,	**15**

	magnetic susceptibility, magnetization (M), Classification of Dia, Para, and ferro magnetic materials; Langevin Classical Theory of dia – and Paramagnetism. Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of B-H Curve. Hysteresis and Energy Loss, Hardand Soft magnetic materials **Dielectrics**: Static dielectric constant, polarizability (electronic, ionic and orientation), calculation of Lorentz field (derivation), Clausius-Mosotti equation (derivation), dielectric loss.Piezo electric effect, cause, examples and applications. **Superconductivity:** Definition, Experimental results – Zero resistivity and Critical temperature– The critical magnetic field – Meissner effect, Type I and type II superconductors.	
3	**General Properties of Nuclei**: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, main features of binding energy versus mass number curve, angular momentum, parity, magnetic moment, electric moments **Radioactivity decay:** Radioactivity: definition of radioactivity, half-life, mean life, radioactivity equilibrium **(**a) Alpha decay: basics of α-decay processes, theory of α emission (brief), Gamow factor, Geiger-Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays' emission & kinematics,internal conversion (Definition).	**15**
4	**Interaction of Nuclear Radiation with matter**: Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, Energy loss due to ionization (quantitative description of Bethe Block formula), energy loss of electrons, introduction of Cerenkov radiation **Detector for Nuclear Radiations**: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility) qualitative only, Accelerators: Cyclotrons and Synchrotrons.	**15**

Reference Books:

1. Solid State Physics-R. K. Puri and V.K. Babber., S.Chand publications,1st Edition(2004).
2. Fundamentals of Solid State Physics-B.S.Saxena,P.N. Saxena,Pragati prakashan Meerut(2017).
3. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
4. Nuclear Physics, Irving Kaplan, Narosa Publishing House
5. Introduction to solid State Physics, ***Charles Kittel***, VII edition, (**1996**)
6. Solid State Physics- **A J Dekker**, MacMillan India Ltd, (**2000**)
7. Essential of crystallography**, M A Wahab**, Narosa Publications (**2009)**
8. Solid State Physics-**S O Pillai**-New Age Int. Publishers (**2001**).
9. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
10. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
11. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
12. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP)Publishing, 2004).
13. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
14. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).

Name of the Department: Physics

Semester-VI

DSC 7: Elements of Condensed Matter & Nuclear Physics (Lab)

Course Title: Elements of Condensed Matter & Nuclear Physics (Lab)	**Course code: :** 21BSC6C14 PHP
Total Contact Hours: 56	**Course Credits: 02**
Internal Assessment Marks: 25 marks	**Duration of SEE: 03 hours**
Semester End Examination Marks: 25 marks	

Course Outcomes (CO's):
At the end of the course students would able to:

- Design and execute the experiments on condensed matter.
- Understand the determination of various values of nuclear radiation using nuclear detector.

LIST OF PRACTICALS: CONDENSED MATTER PHYSICS and NUCLEAR PHYSICS

1. Hall Effect in semiconductor: determination of mobility, hall coefficient.
2. Energy gap of semiconductor (diode/transistor) by reverse saturation method
3. Thermistor energy gap
4. Fermi Energy of Copper
5. Analysis of X-ray diffraction spectra and calculation of lattice parameter.
6. Plank's constant by LED.
7. Specific Heat of Solid by Electrical Method
8. Determination of Dielectric Constant of polar liquid.
9. Determination of dipole moment of organic liquid
10. B-H Curve Using CRO.
11. Spectral Response of Photo Diode and its I-V Characteristics.
12. Determination of particle size from XRD pattern using Debye-Scherrer formula.
13. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method).
14. Measurement of susceptibility of paramagnetic solid (Gouy's Method)
15. Study the characteristics of Geiger-Mùller Tube. Determine the threshold voltage, plateau regionand operating voltage.
16. Study the absorption of beta particles in aluminium foils using GM counter. Determine mass attenuation coefficient of Aluminium foils.
17. Verification of Inverse Square law of radiation.
18. Study the absorption of beta particles in thin copper foils using G M counter and determine massattenuation coefficient.
19. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculate mass attenuation coefficient of Lead for Gamma.
20. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminum foils.
21. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source andG M counter.

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

Reference Books:
1. IGNOU : Practical Physics Manual 2. Saraf : Experiment in Physics, Vikas Publications 3. S.P. Singh : Advanced Practical Physics 4. Melissons : Experiments in Modern Physics 5. Misra and Misra, Physics Lab. Manual, South Asian publishers, (2000) 6. Gupta and Kumar, Practical physics, Pragati prakashan, (1976)

Name of the Department: Physics

Semester-VI

DSC 8: Electronic Instrumentation & Sensors (Theory)

Course Title: Electronic Instrumentation & Sensors (Theory)	**Course code: :** 21BSC6C15PHL
Total Contact Hours: 60	**Course Credits: 04**
Internal Assessment Marks: 40 marks	**Duration of SEE: 02 hours**
Semester End Examination Marks: 60 marks	

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

- Identify different types of tests and measuring instruments used in practice and understand theirbasic working principles.
- Get hands on training in wiring a circuit, soldering, making a measurement using an electronic circuitused in instrumentation.
- Have an understanding of the basic electronic components viz., resistors, capacitors, inductors,discrete and integrated circuits, colour codes, values and pin diagram, their practical use.
- Understanding of the measurement of voltage, current, resistance value, identification of theterminals of a transistor and ICs.
- Identify and understand the different types of transducers and sensors used in robust and hand-heldinstruments.
- Understand and give a mathematical treatment of the working of rectifiers, filter, data convertersand different types of transducers.
- Connect the concepts learnt in the course to their practical use in daily life.
- Develop basic hands-on skills in the usage of oscilloscopes, multimeters, rectifiers, amplifiers,oscillators and high voltage probes, generators and digital meters.
- Servicing of simple faults of domestic appliances: Iron box, immersion heater, fan, hot plate, batterycharger, emergency lamp and the like.

DSC 7: Electronic Instrumentation & Sensors (Theory)

Unit	Description	Hours
1	**Power supply** AC power and its characteristics, Single phase and three phase, Need for DC power supply and its characteristics, line voltage and frequency, Rectifier bridge (construction and working), Filters: Capacitor and inductor filers, L-section and π-section filters, ripple factor, electronic voltage regulators, stabilization factor, voltage regulation using monolithic ICs (78XX, 79XX). **Basic electrical measuring instruments** Cathode ray oscilloscope- Block diagram, basic principle, electron beam, CRT features, signal display. Basic elements of digital storage oscilloscopes.	**15**

	Basic DC voltmeter for measuring potential difference, Extending Voltmeter range, AC voltmeterusing rectifiers Basic DC ammeter, requirement of a shunt, Extending of ammeter ranges.	
2	**Wave form generators and Filters** Basic principle of standard AF signal generator: Fixed frequency and variable frequency, AF sine and square wave generator, basic Wein-bridge network and oscillator configuration, Triangular and saw tooth wave generators, circuitry and waveforms. Passive and active filters. Fundamental theorem of filters, Proof of the theorem by considering a symmetrical T-network. Types of filters, Circuitry and Cut-off frequency and frequency response of Passive (RC) and Active (op-amp based) filters: Low pass, high pass and band pass	**15**
3	**Data Conversion and display** Digital to Analog (D/A) and Analog to Digital (A/D) converters – A/D converter with pre- amplification and filtering. D/A converter - Variable resistor network, Ladder type (R-2R) D/A converter, Op-amp based D/A converter. Digital display systems and Indicators- Classification of displays, Light Emitting Diodes (LED) and Liquid Crystal Display (LCD) – Structure and working. Data Transmission systems – Advantages and disadvantages of digital transmission over analog transmission, Pulse amplitude modulation (PAM), Pulse time modulation (PTM) and Pulse width modulation (PWM)- General principles. Principle of Phase Sensitive Detection (PSD).	
4	**Transducers and sensors** Definition and types of transducers. Basic characteristics of an electrical transducer, factors governing the selection of a transducer, Resistive transducer-potentiometer, Strain gauge and types (general description), Resistance thermometer-platinum resistance thermometer. Thermistor. Inductive Transducer-general principles, Linear Variable Differential Transducer (LDVT)- principle and construction, Capacitive Transducer, Piezo-electric transducer, Photoelectric transducer, Photovoltaic cell, photo diode and phototransistor – principle and working.	**15**

Reference Books:

1. Physics for Degree students (Third Year) – C.L. Arora and P.S. Hemne, S, Chand and Co. Pvt. Ltd. 2014(For Unit-1, Power supplies)
2. Electronic Instrumentation, 3rd Edition, H.S. Kalsi, McGraw Hill Education India Pvt. Ltd. 2011 (For restof the syllabus)
3. Instrumentation – Devices and Systems (2nd Edition)– C.S. Rangan, G.R. Sarma, V.S.V. Mani, TataMcGraw Hill Education Pvt. Ltd. (Especially for circuitry and analysis of signal generators and filters)

Name of the Department: Physics

Semester-VI

DSC 8: Electronic Instrumentation & Sensors (Lab)

Course Title: Electronic Instrumentation & Sensors (Lab)	**Course code: :** 21BSC6C16PHP
Total Contact Hours: 56	**Course Credits: 02**
Internal Assessment Marks: 25 marks	**Duration of SEE: 03 hours**
Semester End Examination Marks 25 marks	

Course Outcomes (CO's):

At the end of the course:

- The students would gain the knowledge of Basic Electronics circuits.
- They would know about common solid-state devices: Semiconductor diodes and transistors. The topics also include the Rectifiers, Filters and their applications.
- They would know about the applications of Op-Amp.
- They would know about the applications of Transducers.

LIST OF EXPERIMENTS

1. Construct a DC power supply using a bridge rectifier and a capacitor filter. Use a Zener diode or a 3- pin voltage regulator and study the load and line regulation characteristics. Measure ripple factor with and without filter and compare with theoretical values.
2. Construction of simple multimeter.
3. Calibration of a low range voltmeter using a potentiometer
4. Calibration of an ammeter using a potentiometer
5. Design and construct a Wien bridge oscillator (sine wave oscillator) using μA 741 op-amp. Choose thevalues of R and C for a sine wave frequency of 1 KHz. Vary the value of R and C to change the oscillation frequency.
6. Design and construct a square wave generator using μA 741 op-amp. Determine its frequency and compare with the theoretical value. Also measure the slew rate of the op-amp. If the 741 is replace by LM318, study how does the waveform compare with the previous one.
7. Study the frequency response of a first order op-amp low pass filter
8. Study the frequency response of a second order op-amp low pass filter.
9. Study the illumination intensity of a solar cell using a standard photo detector (e.g., lux meter).
10. Study the characteristics of a LED (variation of intensity of emitted light).
11. Study the characteristics of a thermistor (temperature coefficient of resistance).
12. Study the characteristics of a photo-diode.
13. Low-pass and High-pass RC filters, Determination of cutoff frequency.
14. Determine the coupling coefficient of a piezo-electric crystal.

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

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