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| **Course Code** | **14NT3019** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO MOLECULAR SIMULATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Give an overview of molecular simulation and thereby mention the salient features of molecular dynamics simulation method with necessary examples. | CO1 | Remember | 20 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Monte Carlo is one of the well-known methods among other molecular simulation techniques. With a simple program explain the important features of Monte Carlo simulation. | CO1 | Apply | 10 |
| b. | Discuss the factors that should be considered in order to obtain a better algorithm which is necessary to integrate the Newton’s equations of motion. | CO1 | Understood | 10 |
|  |  |  |  |  |  |
| 3. |  | Explain in detail the interaction potentials involved in a system of atoms. Calculate the potential energy using the concept of Lennard-Jones for a pair of atoms in liquid argon. | CO2 | Apply | 20 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Define a constraint. Explain how they are treated using algorithms in simulation. | CO2 | Remember | 10 |
| b. | Describe how the distribution of velocities from all the atoms is determined at equilibrium using Maxwell’s velocity distribution in molecular dynamics. | CO2 | Apply | 10 |
|  |  |  |  |  |  |
| 5. |  | Mention the need for algorithms in simulation. Give a detailed account on the algorithms that are involved in MD simulation. | CO3 | Understood | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Verlet algorithm is the most commonly used method of integrating the equations of motion and it gives the direct solution to the second order equations. Validate the sentence. | CO3 | Analyze | 10 |
| b. | State the advantage of using metropolis algorithm in molecular dynamics simulation by explaining it in detail. | CO3 | Remember | 10 |
|  |  |  |  |  |  |
| 7. |  | Discuss briefly about ensemble especially based on the thermodynamic condition and statistical mechanics concept. | CO3 | Apply | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | To simulate a system at constant pressure in molecular dynamics the volume is considered as a dynamic variable that changes during simulation. Explain the concept in detail. | CO3 | Analyze | 10 |
| b. | Discuss the Nose-Hoover thermostat as an illustration of an extended-Lagrangian formulation in molecular dynamics. | CO3 | Understood | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Give an overview of Monte Carlo simulation and explain its formulation and Structural characterization. | CO3 | Understood | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Students will have the knowledge of basic and applied concepts of molecular interaction, structure properties relations associated thermodynamical concepts. |
| CO2 | Students will have expertise on Molecular simulations, Molecular Dynamics and Monte Carlo simulations techniques. |
| CO3 | Students will have applied knowledge of using molecular simulation techniques in nanotechnology related problems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | 10 | 10 |  |  |  | 40 |
| CO2 | 10 |  | 30 |  |  |  | 40 |
| CO3 | 10 | 50 | 20 | 20 |  |  | 100 |
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| **Course Code** | **16NT2002/17NT2002** | **Duration** | **3hrs** |
| **Course Name** | **SYNTHESIS OF NANOMATERIALS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain the synthesis of zero-dimensional nanostructures involving homogenous nucleation. | CO1 | Understand | 10 |
|  | b. | Discuss the synthesis of metallic and semiconducting nanoparticles. | CO1 | Create | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Describe the synthesis of nanoparticles through heterogeneous nucleation. | CO1 | Understand | 10 |
|  | b. | Differentiate electrospinning and electrospraying techniques. | CO1 | Analyze | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain in detail the different types of CNTs. | CO2 | Understand | 10 |
|  | b. | Explain the arc discharge method and laser ablation method of synthesizing CNTs. | CO2 | Understand | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | How are chemical reduction methods like sol-gel and co-precipitation techniques used in synthesizing nanomaterials? | CO3 | Remember | 10 |
|  | b. | Describe the growth of nanorods by template process. | CO3 | Understand | 10 |
|  |  |  |  |  |  |
| 5. | a. | Explain the physical vapor deposition method. | CO5 | Understand | 10 |
|  | b. | Discuss in detail the chemical vapor deposition method. | CO5 | Create | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain the synthesis route for nanotubes made up of metal (silver) and metal nitride (SiN). | CO4 | Understand | 10 |
|  | b. | Discuss the Atomic layer deposition method. | CO4 | Create | 10 |
|  |  |  |  |  |  |
| 7. | a. | Discuss the microlithographic method – photolithography. | CO5 | Create | 10 |
|  | b. | Discuss the microlithographic method – soft lithography. | CO5 | Create | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | How can mechanical grinding methods of high-energy ball milling attrition ball mill be used for nanoparticle synthesis? | CO6 | Remember | 10 |
|  | b. | Explain the vibration ball mill & tumbling ball mill. | CO6 | Understand | 10 |
| **PART – B (10 X 5 = 50 MARKS)**  **(Answer any 10 from the following)** | | | | | |
| 9. | a. | Explain the effect of temperature in getting the required grain size for materials. | CO6 | Understand | 10 |
|  | b. | Explain the process of annealing in detail. | CO6 | Understand | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate knowledge on various types of nanomaterials. |
| CO2 | Choose the different physical methods in preparing nanomaterials. |
| CO3 | Utilize the different chemical methods in preparing nanomaterials. |
| CO4 | Select the suitable methods for synthesis of different nanomaterials. |
| CO5 | Experiment the different technique for nano material coatings. |
| CO6 | Appraise the advanced techniques like lithography. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | 20 | - | 10 | - | 10 | 40 |
| CO2 | - | 20 | - | - | - | - | 20 |
| CO3 | 10 | 10 | - | - | - | - | 20 |
| CO4 | - | 10 | - | - | - | 10 | 20 |
| CO5 | - | 10 | - | - | - | 30 | 40 |
| CO6 | 10 | 30 | - | - | - | - | 40 |
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| **Course Code** | **16NT2003/17NT2003** | **Duration** | **3hrs** |
| **Course Name** | **PROPERTIES OF NANOMATERIALS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Distinguish the size-dependent properties of bulk and nanoscale systems. | CO1 | Analyze | 10 |
|  | b. | Discuss Quantum confinement and Bohr Exciton Radius. | CO1 | Create | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Write short notes on Quantum well & quantum wire. | CO1 | Remember | 10 |
|  | b. | Explain Quantum dots - metal clusters and semiconductors. | CO1 | Understand | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain the following physical properties of nanomaterials:   1. Surface-to-volume ratio. 2. Melting point of nano materials. 3. Surface energy. | CO2 | Understand | 10 |
|  | b. | Discuss how the surface property depends on the size of the materials and Gibb’s equation. | CO2 | Create | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain the mechanical properties of nanomaterials - Hardness testing. | CO2 | Understand | 10 |
|  | b. | Explain the optical properties of nanodevices. | CO2 | Understand | 10 |
|  |  |  |  |  |  |
| 5. | a. | How does the color change occur with respect to size in CdSe quantum dots? Explain. | CO3 | Remember | 10 |
|  | b. | What is surface plasmon resonance? Explain with examples. | CO3 | Remember | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | With a neat diagram explain the density of states. | CO4 | Understand | 10 |
|  | b. | What is the Step potential and coulomb blockade effect? | CO4 | Understand | 10 |
|  |  |  |  |  |  |
| 7. | a. | Discuss the electrical conductivity of gold nanoclusters. | CO5 | Create | 10 |
|  | b. | Explain Quantum mechanical tunneling. | CO5 | Understand | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Give elaborated classification of CNTs. | CO6 | Understand | 10 |
|  | b. | Discuss the electrical properties of CNTs. | CO6 | Create | 10 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain in detail the nanomagnetic materials. | CO6 | Understand | 10 |
|  | b. | What is superparamagnetism? Write a short note on Giant magneto resistance. | CO6 | Understand | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the size-dependent properties of nanomaterial |
| CO2 | Interpret the electrical properties of nanostructured materials. |
| CO3 | Illustrate the optical properties of nanostructured materials. |
| CO4 | Analyze the mechanical properties of nanostructured materials |
| CO5 | Identify the microstructure of nanostructured materials |
| CO6 | Distinguish the ferroelectric and dielectric properties of nanostructured materials |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 10 | 10 |  | 10 |  | 10 | 40 |
| CO2 |  | 30 |  |  |  | 10 | 40 |
| CO3 | 20 |  |  |  |  |  | 20 |
| CO4 |  | 20 |  |  |  |  | 20 |
| CO5 |  | 10 |  |  |  | 10 | 20 |
| CO6 |  | 30 |  |  |  | 10 | 40 |
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| **Course Code** | **16NT3002/17NT3002** | **Duration** | **3hrs** |
| **Course Name** | **NANOELECTRONICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Design and discuss the various electrical parameters of a transistor by considering it as a black box. | CO1 | C | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Analyze the various short channel effects in detail with band diagram. | CO1 | An | 20 |
|  |  |  |  |  |  |
| 3. |  | Discuss the Silicon on Insulator technology with neat diagram. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain the working of Single Electron Transistor with neat diagram and with the help of Coulomb blockade. | CO5 | An | 20 |
|  |  |  |  |  |  |
| 5. |  | Compare the various scaling methods followed for the design of short channel transistor. | CO2 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the tunnelling element technology (Tunnel Diode) and describe about Resonant Tunnelling diode with its I-V characteristics. | CO5 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | Illustrate the working principle of Nanotubes based sensorswith its neat diagram. | CO4 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the High Electron Mobility Transistor with its schematic diagram. | CO5 | A | 20 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the Quantum cellular automate with various configuration includes wire, inverter and other logical gates. | CO6 | An | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Relate the transistor scaling and its limits. |
| CO2 | Infer about the short channel transistors and its limits. |
| CO3 | Analyze the various split gate transistor structures. |
| CO4 | Model the CMOS transistors for the various circuits. |
| CO5 | Utilize the Tunneling devices for high frequency applications. |
| CO6 | Design of computing model of Nanostructured Devices. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | - | - | 20 | - | 20 | 40 |
| CO2 | - | - | - | 20 | - | - | 20 |
| CO3 | - | 20 | - |  | - | - | 20 |
| CO4 | - | - | - | 20 | - | - | 20 |
| CO5 | - | - | 40 | 20 | - | - | 60 |
| CO6 | - | - | - | 20 | - | - | 20 |
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| **Course Code** | **16NT3004/17NT3004** | **Duration** | **3hrs** |
| **Course Name** | **MAGNETIC NANOMATERIALS AND NANO FLUIDS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | List out the SI units of the properties: permittivity of free space, magnetic volume susceptibility, mass magnetization, and magnetic field strength. | CO1 | Remember | 10 |
|  | b. | Which phenomenon makes materials strong in their magnetic behavior? Rationalize the role of exchange interaction in ferromagnetic materials. | CO2 | Analyze | 10 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Explain the materials showing typical M-H plots like the following: | CO2 | Analyze | 20 |
|  |  |  |  |  |  |
| 3. |  | Discuss the phenomena of magneto crystalline and shape anisotropies. How do they affect the magnetization curve shapes? | CO2 | Understand | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Describe magnetic domains, domain walls, and domain wall width. | CO3 | Understand | 20 |
|  |  |  |  |  |  |
| 5. | a. | Explain the influence of geometry and surface on the magnetism of nanoparticles. | CO3 | Understand | 10 |
|  | b. | Give an account of the size dependence of magnetic domain formation. | CO3 | Analyze | 10 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Discuss the magnetism of free nanoparticles and nanoparticles on surfaces. | CO4 | Apply | 20 |
|  |  |  |  |  |  |
| 7. |  | Explain with a neat diagram the working of the vibrating sample magnetometer. | CO4 | Remember | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Discuss in detail permanent magnets and their applications. | CO5 | Apply | 20 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | How can magnetic nanoparticles be applied in the diagnosis and treatment of cancer? Explain with suitable examples. | CO6 | Apply | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate nanomagnetism in materials. |
| CO2 | Explain the origin of microscopic interactions in nanomaterials. |
| CO3 | Interpret nanomagnetism in spintronic devices. |
| CO4 | Choose the right magnetic nanomaterials for different applications. |
| CO5 | Apply nanofluids for heat transfer applications. |
| CO6 | Apply magnetic nanoparticles and their synthesis method to prepare new materials. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 10 | - | - | - | - | - | 10 |
| CO2 | - | 20 | - | 30 | - | - | 50 |
| CO3 | - | 30 | - | 10 | - | - | 40 |
| CO4 | 20 | - | 20 | - | - | - | 40 |
| CO5 | - | - | 20 | - | - | - | 20 |
| CO6 | - | - | 20 | - | - | - | 20 |
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| **Course Code** | **16NT3007/17NT3007** | **Duration** | **3hrs** |
| **Course Name** | **BIOMEDICAL NANOSTRUCTURES AND NANOMEDICINE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | What is the relevance of micromachining in the design of smart materials? Provide an illustrated account of micro/nanomachining of soft and hard polymeric biomaterials. | CO1 | Analyze | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | When applied to biomedical materials, how are blood-contacting materials essential? Explain their applications. | CO2 | Understand | 20 |
|  |  |  |  |  |  |
| 3. |  | With relevance to biomedical applications, give a description of the following: (i) core-shell structured materials(ii) bio conjugated hydrogels | CO3 | Understand | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | What are biocompatible polymers? Explain the role of polymeric nanomaterials in drug delivery. Which one of the polymers is your choice? Justify your answer. | CO3 | Remember | 20 |
|  |  |  |  |  |  |
| 5. |  | Describe stimuli-sensitive polymers and their applications. Give an account of microgels and nanogels. | CO2 | Apply | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | From your viewpoint explain the criteria necessary for a nanodrug delivery system to be effective. | CO4 | Analyze | 20 |
|  |  |  |  |  |  |
| 7. |  | Give an account of viral vectors and virus-like particles. | CO4 | Remember | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Give a detailed account of drug nanocrystals, their characteristics, synthesis, and applications. | CO5 | Understand | 20 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | With neat illustrations, explain the applications of nanomaterials in tissue engineering. Explain if there are any drawbacks in the methods used. | CO6 | Apply | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Explain the properties of biomedical nanostructures. |
| CO2 | Explain the applications of biomedical nanomaterials in nanomedicine. |
| CO3 | Utilize nanomaterials in the biomedical field. |
| CO4 | Justify the suitability of various nanostructures. |
| CO5 | Demonstrate the nanofiber synthesis for medical fabrics. |
| CO6 | Predict any possible downsides of each nanomaterial. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | - | - | 20 | - | - | 20 |
| CO2 | - | 20 | 20 | - | - | - | 40 |
| CO3 | 20 | 20 | - | - | - | - | 40 |
| CO4 | 20 | - | - | 20 | - | - | 40 |
| CO5 | - | 20 | - | - | - | - | 20 |
| CO6 | - | - | 20 | - | - | - | 20 |
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| **Course Code** | **16NT3008 / +17NT3008** | **Duration** | **3hrs** |
| **Course Name** | **MEMS AND NEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain the Modeling and simulation of MEMS with suitable example. | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Evaluate the various CMOS-MEMS micromachining methods with suitable diagrams. | CO2 | E | 20 |
|  |  |  |  |  |  |
| 3. | a. | Explain the Clean room and its protocols. | CO5 | A | 10 |
|  | b. | Explain the Components of a Microsystem with block diagram. | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain in detail the various MEMS fabrication techniques with neat diagram. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 5. |  | Estimate the function of low temperature co-fired ceramic (LTCC) as non-silicon MEMS/NEMS technology with suitable diagrams. | CO5 | E | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the various polymers used in MEMS/NEMS. | CO3 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | Illustrate with suitable diagrams, the function of MEMS based Optical switching | CO6 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Illustrate with suitable diagrams, the function of MEMS based memory devices. | CO6 | An | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Determine the function of printed circuit board as non-silicon MEMS technology. | CO2 | A | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Classify the microelectronics and Microsystems. |
| CO2 | Relate the fabrication techniques of MEMS & NEMS. |
| CO3 | Analyze the various substrates materials of MEMS and NEMS. |
| CO4 | Demonstrate various tools used for design and analysis of MEMS/NEMS. |
| CO5 | Make use of clean room protocols. |
| CO6 | Design various applications of MEMS/NEMS. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | - | 10 | - | - | - | 10 |
| CO2 | - | - | 20 | - | 20 | - | 40 |
| CO3 | - | - | 20 | - | - | - | 20 |
| CO4 | - | - | 40 | - | - | - | 40 |
| CO5 | - | - | 10 | - | 20 | - | 30 |
| CO6 | - | - | - | 40 | - | - | 40 |
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| **Course Code** | **16NT3011/17NT3011** | **Duration** | **3hrs** |
| **Course Name** | **PHOTOVOLTAICS: ADVANCED MATERIALS AND DEVICES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | | |
| 1. | a. | | Describe the role of P-N junction in solar cell with a suitable sketch. | CO1 | U | 10 |
|  | b. | | Illustrate that the shunt resistance (Rsh) is the inverse of the slope of I-V curve at short circuit current (Isc). | CO2 | U | 10 |
|  |  | | **(OR)** |  | U |  |
| 2. | a. | | Describe the J-V characteristics of an ideal PV cell with an equivalent circuit and mention its equation. | CO1 | U | 10 |
|  | b. | | Distinguish Ohmic and Schottky metal semiconductor junction with suitable examples. | CO2 | U | 5 |
|  | c. | | Recall the role of TCO layer in solar cells. | CO2 | R | 5 |
|  |  | |  |  |  |  |
| 3. | a. | | Elaborate the importance of work function in metal semiconductor contact with suitable examples. | CO 3 | U | 10 |
|  | b. | | Explain the major differences between mono and polycrystalline solar cells. | CO 3 | U | 10 |
|  |  | | **(OR)** |  |  |  |
| 4. |  | | With a neat sketch describe Czochralski and float zone technique used in the manufacture of Si wafers. Discuss the advantages and disadvantages of each method. | CO3 | U | 20 |
|  |  | |  |  |  |  |
| 5. | a. | | Explain the concept of hot-carrier capture and multiple exciton generation in quantum dot solar cells. | CO4 | U | 10 |
|  | b. | | Describe the basic structure of thin film solar cell with a neat sketch. | CO 4 | U | 10 |
|  |  | | **(OR)** |  |  |  |
| 6. |  | | Describe the design and working of CdTe thin film solar cell with a neat sketch and mention its advantages and disadvantages. | CO4 | U | 20 |
|  |  | |  |  |  |  |
| 7. |  | | Describe the different thin film deposition methods used in the fabrication of Copper Indium Gallium diselenide based solar cell. | CO5 | U | 20 |
|  |  | | **(OR)** |  |  |  |
| 8. |  | | Describe the materials, design and working principle of quantum dot solar cells. | CO 5 | U | 20 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | | |
| 9. | a. | Describe the effect of ambient conditions on the efficiency of solar cell. | | CO6 | U | 15 |
|  | b. | Discuss the operation of solar pumping. | | CO6 | U | 5 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the fundamental concepts of solar cells. |
| CO2 | Choose the substrate materials for solar cells. |
| CO3 | Explain the various materials for enhancing the efficiency of solar cell. |
| CO4 | Categorize the different generations of solar cells. |
| CO5 | Design a solar cell. |
| CO6 | Estimate the factors affecting the solar cell parameters. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 20 |  |  |  |  | 20 |
| CO2 | 5 | 15 |  |  |  |  | 20 |
| CO3 |  | 40 |  |  |  |  | 40 |
| CO4 |  | 40 |  |  |  |  | 40 |
| CO5 |  | 40 |  |  |  |  | 40 |
| CO6 |  | 20 |  |  |  |  | 20 |
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| **Course Code** | **17NT2001** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTORY NANOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain the construction and working of scanning electron microscope. | CO1 | Understand | 10 |
|  | b. | Give a brief description on different methods of CNT synthesis. | CO4 | Remember | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Briefly explain the preparation of graphene oxide using modified Hummers method. | CO2 | Apply | 10 |
|  | b. | Explain the sol gel technique. | CO1 | Understand | 10 |
|  |  |  |  |  |  |
| 3. | a. | Briefly explain the properties of graphene. | CO5 | Evaluate | 10 |
|  | b. | What are the medical applications of fullerenes? | CO4 | Remember | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Give a brief description on Atomic force microscopy technique. | CO6 | Understand | 10 |
|  | b. | Explain the sonochemical method for the synthesis of nanomaterials. | CO3 | Apply | 10 |
|  |  |  |  |  |  |
| 5. | a. | What are the contributions of Feynman and Eric Drexler in the field of nanotechnology? | CO4 | Analyse | 10 |
|  | b. | “There is plenty of room at the bottom”. Whose famous statement is this? Justify the statement. | CO3 | Apply | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | What is high energy ball milling method? | CO6 | Remember | 10 |
|  | b. | Differentiate between top down and bottom up approaches in nanotechnology. | CO2 | Understand | 10 |
|  |  |  |  |  |  |
| 7. | a. | Describe the electronic properties of nanomaterials as a function of size. | CO5 | Analyse | 10 |
|  | b. | Mention about the ethical challenges and dangers faced in the field of nanotechnology. | CO3 | Apply | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain the different types of Carbon NanoTube. | CO3 | Remember | 10 |
|  | b. | Explain in detail the synthesis and purification of fullerene. | CO4 | Understand | 10 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Write in detail the history of nanotechnology. | CO2 | Remember | 10 |
|  | b. | Explain few applications of nanotechnology. | CO3 | Apply | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the various nanoparticles process methods. |
| CO2 | Relate the various nanoscale processing techniques. |
| CO3 | Identify 0D,1D,2D and 3D nanomaterials. |
| CO4 | Infer the optical and mechanical properties. |
| CO5 | Interpret the magnetic and electrical properties. |
| CO6 | Illustrate the use of nanomaterials for different applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 20 |  |  |  |  |  |
| CO2 | 10 | 10 | 10 |  |  |  |  |
| CO3 | 10 |  | 40 |  |  |  |  |
| CO4 | 20 | 10 |  | 10 |  |  |  |
| CO5 |  |  |  | 10 | 10 |  |  |
| CO6 | 10 | 10 |  |  |  |  |  |
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| **Course Code** | **17NT2007** | **Duration** | **3hrs** |
| **Course Name** | **NANOTECHNOLOGY IN TEXTILES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | What are carbon nanotubes? Explain the structure and properties of carbon nanotubes. | CO2 | U | 10 |
|  | b. | Explain in detail the production of nanofibers. How is electrospinning used for nanofiber production? | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | How do you control the morphologies of electrospun nanofibers? | CO1 | An | 10 |
|  | b. | Illustrate polypropylene. How do you modify polypropylene using copolymerization method? | CO3 | R | 10 |
| 3. | a. | What is the role of nanofinish in textiles? Explain few nanofinishing treatments used and the future of this process. | CO4 | U | 10 |
|  | b. | Elaborate the different industrial applications of polymer nanocomposites. | CO3 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Describe the electrostatic self-assembly of nanofilms on cotton fibers. | CO5 | E | 10 |
|  | b. | What is dyeable propylene? What is the application of dyeable propylene in nanotechnology? | CO4 | A | 10 |
| 5. | a. | Elaborate the nanofabrication of thin polymer films. | CO1 | R | 10 |
|  | b. | Explain how nanotechnology is used in coating and structuring of textiles. | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | How does cyclodextrins help in nanostructuring of polymers? | CO2 | A | 10 |
|  | b. | What are clay nanocomposites? | CO3 | R | 10 |
| 7. | a. | Detail the production of nylon 6 nanocomposites from polymerization. | CO5 | A | 10 |
|  | b. | Explain polyolefins. | CO6 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | How can we improve polymer functionality? Explain in detail with required diagrams. | CO4 | A | 10 |
|  | b. | Explain the different tools used in nanotechnology in the field of textiles. | CO1 | An | 10 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Describe nanofibers in tissue engineering. | CO2 | An | 10 |
|  | b. | Explain carbon nanocomposites. How is it used for industrial applications? | CO4 | A | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the fabrication and processing of nanofibers. |
| CO2 | Categorize the different types of nanofibers based on carbon materials. |
| CO3 | Interpret the functionalization of nanofibers with composites and dyes. |
| CO4 | Demonstrate the surface modification of nanofibers with nanomaterials. |
| CO5 | Demonstrate the drug loaded medical fabric preparation. |
| CO6 | Apply the nanocoatings and fibers in textiles and self-cleaning fabrics. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 10 |  | 10 | 20 |  |  |  |
| CO2 |  | 20 | 10 | 10 |  |  |  |
| CO3 | 30 |  |  |  |  |  |  |
| CO4 |  | 10 | 30 |  |  |  |  |
| CO5 |  |  | 10 |  | 10 |  |  |
| CO6 |  | 10 |  |  |  |  |  |
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| **Course Code** | **17NT3003** | **Duration** | **3hrs** |
| **Course Name** | **NANO-LITHOGRAPHY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain contact, proximity and projection printing technique with a suitable diagram. | CO1 | E | 10 |
|  | b. | Discuss the photolithographic process by positive and negative photo resist with a neat diagram. | CO2 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Design N type MOSFET by photolithography process. | CO3 | C | 10 |
|  | b. | Elaborate the photolithographic process with a flow chart. | CO1 | R |  |
| 3. | a. | Detail stereo lithography. | CO4 | U | 10 |
|  | b. | Explain the merits and demerits of X-ray lithography and its schematic diagram. | CO3 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain nanoscratching. How is it different from nanoindentation? | CO5 | E | 10 |
|  | b. | Elaborate the different tools used for nanolithography. | CO4 | A | 10 |
| 5. | a. | Briefly explain the different types of microscopy used in nanotechnology for analysis and characterization. | CO3 | An | 10 |
|  | b. | Describe focused ion beam lithography and its applications. | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | How do you clean the substrate used in lithography? Name two substrates normally used. | CO1 | A | 10 |
|  | b. | Explain in detail nanosphere lithography with required diagrams. | CO3 | R | 10 |
| 7. | a. | How can molecular manipulation be done using AFM? | CO5 | A | 10 |
|  | b. | Explain the fabrication of CMOS FET using p-well and n-well process. | CO6 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Detail the lithography steps. Explain each with suitable diagram. | CO4 | R | 10 |
|  | b. | How does optical lithography work? | CO1 | An | 10 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain in detail nano-imprint lithography with required diagrams. | CO6 | R | 10 |
|  | b. | Discuss dip pen lithography with its applications. | CO4 | A | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate photolithography process. |
| CO2 | Experiment the mask preparation. |
| CO3 | Apply lithographic technique to construct a device. |
| CO4 | Appraise the different lithographic techniques. |
| CO5 | Illustrate the fabrication of nanoelectronic devices and sensors. |
| CO6 | Design nanoscale devices. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 10 |  | 10 | 10 | 10 |  |  |
| CO2 |  | 10 |  | 10 |  |  |  |
| CO3 | 20 |  |  | 10 |  | 10 |  |
| CO4 | 10 | 10 | 20 |  |  |  |  |
| CO5 |  |  | 10 |  | 10 |  |  |
| CO6 | 10 | 10 |  |  |  |  |  |
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| **Course Code** | **17NT3005** | **Duration** | **3hrs** |
| **Course Name** | **FUNCTIONALIZATION OF NANOSTRUCTURES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | | | **Bloom’s Level** | **Marks** | |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | | | | |
| 1. | a. | Describe the methods of functionalization of fullerenes. | | CO1 | | U | | 10 |
|  | b. | Explain the functionalization methods of CNTs. | | CO1 | | U | | 10 |
|  |  | **(OR)** | |  | |  | |  |
| 2. |  | What are the ligands and stabilizers for the synthesize of gold nanoparticles? Explain with examples. | | CO2 | | R | | 20 |
|  |  |  | |  | |  | |  |
| 3. |  | Explain Diels-Alder and Bingel reactions in the functionalization of graphene oxides. | | CO2 | | R | | 20 |
|  |  | **(OR)** | |  | |  | |  |
| 4. |  | Explain the methods of surface modification of magnetic nanoparticles. | | CO3 | | R | | 20 |
| 5. |  | Describe the stability of magnetic nanoparticles and ligand modification of them. | | CO3 | | An | | 10 |
|  |  | **(OR)** | |  | |  | |  |
| 6. |  | How are silica nanoparticles synthesized? Explain their properties. | | CO4 | | A | | 20 |
| 7. |  | Give a detailed account on the applications of functionalized graphene oxides in various fields. | | CO4 | | An | | 20 |
|  |  | **(OR)** | |  | |  | |  |
| 8. |  | Explain the applications of quantum dots in biology and medicine. | | CO5 | | A | | 20 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | | | | |
| 9. |  | Describe the functionalization methods and properties of quantum dots. | | | CO6 | U | | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the mechanism of functionalization. |
| CO2 | Infer the metal oxide, organic functionalization in carbon nanomaterials. |
| CO3 | To solve problems on functionalization methods. |
| CO4 | To choose reagents for deriving functional groups on nanomaterials. |
| CO5 | To envisage the tailoring of properties of nanomaterials based on functionalization. |
| CO6 | To understand recent newer developments in functionalized nanomaterials for plausible new devices. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | 20 | - | - | - | - | 20 |
| CO2 | 40 | - | - | - | - | - | 40 |
| CO3 | 20 | - | - | 10 | - | - | 30 |
| CO4 | - | - | 20 | 20 | - | - | 40 |
| CO5 | - | - | 20 | - | - | - | 20 |
| CO6 | 20 | - | - | - | - | - | 20 |
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| **Course Code** | **16NT3006 / 17NT3006** | **Duration** | **3hrs** |
| **Course Name** | **NANO SAFETY AND ENVIRONMENTAL ISSUES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | List four areas of application of nanomaterials. | CO1 | R | 4 |
|  | b. | Highlight the areas in which research is needed in order to respond the challenges posed by nanoparticles. | CO1 | U | 16 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Analyse the characteristics of nanoparticles which are responsible for health effects. | CO1 | An | 10 |
|  | b. | Illustrate the various methods of process and waste control by which risk is reduced. | CO1 | A | 10 |
|  |  |  |  |  |  |
| 3. | a. | Analyse the various aspects associated with risk assessment of ENMs. | CO2 | An | 15 |
|  | b. | Write the salient features of the DuPont’s nanorisk framework. | CO2 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | In predicting hazard what are the considerations on nanomaterial towards hazard assessment? | CO2 | R | 8 |
|  | b. | Analyse the various factors to be considered in material characterization. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 5. | a. | Illustrate the ways by which the inhaled nanomaterial is cleared from the lungs. | CO3 | A | 10 |
|  | b. | Analyse the occurrence of inhaled solid material in the lungs through their bio-persistence. | CO3 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Critically review the systemic translocation of inhaled nanoparticles. | CO3 | U | 5 |
|  | b. | Analyse the pulmonary effects of SWCNT. | CO4 | An | 15 |
|  |  |  |  |  |  |
| 7. | a. | Review the various eco-toxicological test to ascertain the toxicity of a material. | CO4 | U | 15 |
|  | b. | Explain how the end points are classified in ecotoxicological tests. | CO4 | R | 5 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Discuss the terms and parameters frequently used in ecotoxicological tests. | CO5 | R | 10 |
|  | b. | Review the ecotoxicity measurement of polychlorinated biphenyls. | CO5 | A | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Expand FDA, EPA and OSHA and write their role on regulations on toxicity of nanomaterials. | CO6 | U | 6 |
|  | b. | Analyse the FDA regulation on nano-safety and environmental issues. | CO6 | A | 14 |

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|  | **COURSE OUTCOMES** |
| CO1 | Relate the toxic effects of nanotechnology on human health. |
| CO2 | Analyse the various issues on environmental effects. |
| CO3 | Identify suitable remedial measures. |
| CO4 | Suggest start-of-the-pipe solution for environmental issues based on nanomaterials. |
| CO5 | Workout problems on nanomaterials related to toxicity. |
| CO6 | To frame a model policy on preventing health hazards. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 16 | 10 | 10 |  |  | 40 |
| CO2 | 8 | 5 |  | 27 |  |  | 40 |
| CO3 |  | 5 | 10 | 10 |  |  | 25 |
| CO4 | 5 | 15 |  | 15 |  |  | 35 |
| CO5 | 10 |  | 10 |  |  |  | 20 |
| CO6 |  | 6 | 14 |  |  |  | 20 |
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| **Course Code** | **17NT3009** | **Duration** | **3hrs** |
| **Course Name** | **NANOTECHNOLOGY FOR CANCER DIAGNOSIS AND TREATMENT** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Some aromatic compounds failed to respond to carcinogenicity tests in vitro. Justify the statement by providing a suitable example. | CO1 | An | 5 |
|  | b. | Explain the theory of clonal evolution of cancer.What are proto-oncogenes? How did Weinberg explain those? | CO2 | U | 15 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Give an account of mutations in the development of cancer. Explain the types of mutations. | CO1 | R | 20 |
|  |  |  |  |  |  |
| 3. |  | What is meant by chemotherapy? Explain the role of hormones and biological response modifiers in chemotherapy for cancer. | CO2 | R | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Describe the role of DNA binders and topoisomerase inhibitors in the treatment of cancer. | CO3 | U | 20 |
|  |  |  |  |  |  |
| 5. |  | Discuss the concept of Magnetic Resonance Imaging and its applications in the diagnosis of cancer. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the working principle, mechanism, and advantages of SPECT in the diagnosis of cancer. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | With suitable diagrams, describe the role of nanoparticles in the diagnosis of cancer. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | List out the applications of plasmonic materials in cancer diagnosis. | CO6 | R | 20 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | How are magnetic nanoparticles applied in the targeted delivery of cancer drugs? What are the design principles employed to make nanomaterials suitable for drug transport? | CO6 | An | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the mechanism of mutation and cancer-causing cells. |
| CO2 | Identify the different cancer diagnosis techniques. |
| CO3 | To explain the pros and cons of cancer nanotechnology methods. |
| CO4 | To justify the best method from the student’s perspective. |
| CO5 | To choose methods of improvising cancer diagnosis and treatment using nanomaterials. |
| CO6 | Demonstrate the applications of nanomaterials in cancer diagnosis and treatment. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | - | - | 5 | - | - | 25 |
| CO2 | 20 | 15 | - | - | - | - | 35 |
| CO3 | - | 20 | 20 | - | - | - | 40 |
| CO4 | - | - | 20 | - | - | - | 20 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | 20 |  |  | 20 | - | - | 40 |
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| **Course Code** | **17NT3013** | **Duration** | **3hrs** |
| **Course Name** | **NANOSCALE TRANSISTORS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain the various electrical parameters of transistor by considering it as a black box. | CO1 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Evaluate the Gate Geometry and Electrostatic Integrity of the various structures of nano scale transistor. | CO2 | E | 20 |
|  |  |  |  |  |  |
| 3. |  | Explain the Multiple-Gate MOSFETs with its different gate structure diagram. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain the fabrication sequence of a Tri-gate MOSFET with suitable diagram. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 5. | a. | Explain the gate stack of Fin FET in gate patterning by poly silicon as gate. | CO4 | A | 10 |
|  | b. | Evaluate the current drive for multi-fin multigate MOSFET | CO3 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Evaluate the fabrication concept of Fully Silicided Metal Gate (FUSI) with neat diagram. | CO4 | E | 20 |
|  |  |  |  |  |  |
| 7. | a. | Explain the drain current for independently controlled Gates with I-V characteristics. | CO3 | A | 10 |
|  | b. | Illustrate the mobility and strain engineering of nanoscale transistor by Nitride Stress Liners | CO6 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Illustrate the mobility and strain engineering of nanoscale transistor by wafer bending experiment. | CO6 | An | 20 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the function of gate all around transistor with its channel and various high –K gate dielectric materials. | CO5 | An | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Define the concepts of MOSFET devices. |
| CO2 | Infer about the short channel effects. |
| CO3 | Illustrate the Multi structural Gate transistor. |
| CO4 | Analysis of fabrication of advanced FET. |
| CO5 | Determine the various materials used in GAA. |
| CO6 | Evaluate the property analysis of Nanoscale transistor. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | - | 20 | - | - | - | 20 |
| CO2 | - | - | - | - | 20 | - | 20 |
| CO3 | - | - | 30 | 10 | - | - | 40 |
| CO4 | - | - | 40 | - | 20 | - | 60 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | - | - | - | 20 | - | - | 20 |
|  | | | | | | | **180** |

Graphical user interface, application

Description automatically generated with medium confidence

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| **Course Code** | **17NT3016** | **Duration** | **3hrs** |
| **Course Name** | **NANOTECHNOLOGY IN FUEL CELLS AND ENERGY STORAGE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Describe the working principle of a fuel cell. | CO1 | U | 10 |
|  | b. | Distinguish the impregnation method and colloidal method for preparing the catalyst. | CO1 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Explain the various electrode reactions occurring at the low temperature fuel cells. | CO1 | A | 10 |
|  | b. | Discuss the various catalyst supports utilized in the low temperature fuel cells. | CO5 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Discuss the importance of dye-sensitized solar cells. | CO2 | An | 10 |
|  | b. | Explain the recombination rates in semiconductors. | CO2 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | With a clean diagram, describe the operation of dye-sensitized solar cells. | CO2 | U | 10 |
|  | b. | Using a diagram, explain the process of back transport of electrons from oxide to the absorbing semiconductor. | CO2 | An | 10 |
|  |  |  |  |  |  |
| 5. | a. | What are the porous oxides used in SSSC and compare their performance. | CO3 | An | 10 |
|  | b. | Discuss the role of hole conductor in ETA cell. Illustrate with examples. | CO3 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | How does ETA cell work? | CO3 | U | 10 |
|  | b. | Summarize the importance of three component ETA cells. | CO4 | An | 10 |
|  |  |  |  |  |  |
| 7. | a. | Categorize the various types of energy storage devices. | CO4 | An | 10 |
|  | b. | Summarize the zeolite structures and transition metal based structures used for hydrogen storage. | CO6 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | What are the units of volumetric and gravimetric energy density? Compare the volumetric and gravimetric energy densities of super capacitors, batteries and hydrogen storage systems. | CO5 | U | 10 |
|  | b. | Discuss the storage of hydrogen in various forms. | CO5 | A | 10 |
| **PART – B (1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain the various organic and carbon materials used for hydrogen storage. | CO6 | An | 10 |
|  | b. | Describe the methods used for the characterization of hydrogen storage materials. | CO6 | An | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | To appraise the working of fuel cells. |
| CO2 | To demonstrate the working of solar cells. |
| CO3 | To appraise the oxides of semiconductor materials. |
| CO4 | To demonstrate the hydrogen evaluation and storage. |
| CO5 | To apply kinetic properties in hydride systems. |
| CO6 | To apply fuel cell and solar energy for long term energy storage. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 10 | 10 | 10 |  |  | 30 |
| CO2 |  | 10 | 10 | 20 |  |  | 40 |
| CO3 |  | 10 |  | 20 |  |  | 30 |
| CO4 |  |  |  | 20 |  |  | 20 |
| CO5 |  | 20 | 10 |  |  |  | 30 |
| CO6 |  | 10 |  | 20 |  |  | 30 |
|  | | | | | | | **180** |



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| **Course Code** | **17NT3030** | **Duration** | **3hrs** |
| **Course Name** | **BIOSENSORS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Discuss the nanostructure required for the enzyme stabilizations. | CO1 | A | 10 |
|  | b. | Illustrate the protein-based nanosensors with examples. | CO1 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Describe the postulates of microporous silica nanotubes | CO1 | A | 10 |
|  | b. | Illustrate the salient features of single enzyme nanoparticles | CO1 | An | 10 |
|  |  |  |  |  |  |
| 3. | a. | Discuss the DNA biosensors with their principles and types. | CO2 | A | 10 |
|  | b. | How will you determine the heavy metals present in DNA from the water samples? | CO2 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | How will you estimate the heavy metals complexed in DNA from food samples? | CO2 | An | 10 |
|  | b. | Write short notes on the DNA zymo Biosensors. | CO2 | A | 10 |
|  |  |  |  |  |  |
| 5. | a. | Discuss the working principle of electrochemical biosensors with example? | CO3 | An | 10 |
|  | b. | Illustrate the concept of fluorescence Biosensors with an example. | CO3 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Describe the process of analyte detection and absorption using graphene nanosheets as biosensor applications. | CO4 | A | 10 |
|  | b. | Give an account of Fibre Optic Biosensors. | CO4 | An | 10 |
|  |  |  |  |  |  |
| 7. | a. | Describe the methodology of fabrication of biosensors? | CO5 | A | 10 |
|  | b. | Discuss any Two techniques involved in the microfabrication of biosensors. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | What do you mean by Electrode on Chip and its applications? | CO5 | E | 10 |
|  | b. | Describe the Lab-on-chip process with an example. | CO5 | C | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Narrate any ONE cellular biosensing methodology in nano-biotechnology. | CO6 | E | 10 |
|  | b. | Being a scholar, how will you design and validate a biosensor. | CO6 | C | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Define the fundamentals of molecular switches. |
| CO2 | Describe the various types of molecular machines. |
| CO3 | Demonstrate the interface of molecular switches with neurons. |
| CO4 | Differentiate functional molecules based on their working pattern. |
| CO5 | Distinguish between natural and artificial molecular machines of different types. |
| CO6 | To envisage newer methods of synthesizing molecular machines and devices. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  |  | 20 | 20 |  |  | 40 |
| CO2 |  |  | 20 | 20 |  |  | 40 |
| CO3 |  |  | 10 | 10 |  |  | 20 |
| CO4 |  |  | 10 | 10 |  |  | 20 |
| CO5 |  |  | 10 | 10 | 10 | 10 | 40 |
| CO6 |  |  |  |  | 10 | 10 | 20 |
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| **Course Code** | **20NT3004** | **Duration** | **3hrs** |
| **Course Name** | **NANOMATERIALS IN BIOLOGY AND MEDICINE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4×20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain the role of Richard Feynman and Eric Drexler in conceptualizing nanotechnology. | CO1 | Understand | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Explain top-down and bottom-up approaches in Nanotechnology. | CO1 | Remember | 20 |
|  |  |  |  |  |  |
| 3. |  | Citing suitable examples, explain the structure and properties of fullerenes and carbon nanotubes. | CO2 | Remember | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Describe the properties and applications of gold nanoparticles and carbon dots in biology and medicine. | CO3 | Apply | 20 |
|  |  |  |  |  |  |
| 5. |  | Describe the properties and applications of silver nanoparticles in biology and medicine. | CO3 | Apply | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the relationship between the size of metal nanoparticles and their spectroscopic properties. | CO4 | Understand | 20 |
|  |  |  |  |  |  |
| 7. |  | Give an account of magnetic nanoparticles, their preparation, properties, and applications. | CO5 | Analyze | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the applications of quantum dots in biology and medicine. | CO6 | Remember | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Describe the ethical challenges in nanotechnology and the vision of nanotechnology in future medicine. | CO6 | Analyze | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the various nanoparticle process methods. |
| CO2 | Relate the various nanoscale preparation methods. |
| CO3 | Identify 0D,1D,2D and 3D nanomaterials. |
| CO4 | Appreciate the plasmonic properties of nanomaterials. |
| CO5 | Interpret the magnetic properties of nanomaterials. |
| CO6 | Explain the absorption and luminescence of nanomaterials. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | 20 | - | 5 | - | - | 40 |
| CO2 | 20 | - | - | - | - | - | 20 |
| CO3 | - | - | 40 | - | - | - | 40 |
| CO4 | - | 20 | - | - | - | - | 20 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | 20 |  |  | 20 | - | - | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20NT3019** | **Duration** | **3hrs** |
| **Course Name** | **CANCER NANOMEDICINE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4×20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | For the treatment of chronic myeloid leukemia, how was the drug developed in understanding cancer biology? How was the treatment improved after the relapse phase of leukemia? | CO1 | Analyze | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Give an account of oncogenes and tumor suppressor genes. Explain the role of p53 in cancer suppression and how cancer is onset due to mutation. | CO1 | Remember | 20 |
|  |  |  |  |  |  |
| 3. |  | What are the roles of monoclonal antibodies and topoisomerase inhibitors in chemotherapy for cancer? Cite examples and explain their mechanism of action. | CO2 | Remember | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Describe the role of antibiotics and alkylating agents in the treatment of cancer. | CO3 | Understand | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain the concept of Positron Emission Tomography and its applications in cancer diagnosis. | CO3 | Apply | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the working principle, mechanism, and advantages of ultrasonographyin diagnosing cancer. | CO4 | Apply | 20 |
|  |  |  |  |  |  |
| 7. |  | Elaborate on the role of lanthanide-based materials in the diagnosis of cancer. | CO5 | Analyze | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the applications of cyclodextrins in anti-cancer formulations. | CO6 | Remember | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Describe the applications of nanomaterials in the treatment of cancer. | CO6 | Analyze | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the mechanism of mutation and cancer-causing cells. |
| CO2 | Identify the different cancer diagnosis techniques. |
| CO3 | To explain the pros and cons of cancer nanotechnology methods. |
| CO4 | To justify the best method from the student’s perspective. |
| CO5 | To choose methods of improvising cancer diagnosis and treatment using nanomaterials. |
| CO6 | Demonstrate the applications of nanomaterials in cancer diagnosis and treatment. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | - | - | 5 | - | - | 25 |
| CO2 | 20 | 15 | - | - | - | - | 35 |
| CO3 | - | 20 | 20 | - | - | - | 40 |
| CO4 | - | - | 20 | - | - | - | 20 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | 20 |  |  | 20 | - | - | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **17NT3009** | **Duration** | **3hrs** |
| **Course Name** | **NANOTECHNOLOGY FOR CANCER DIAGNOSIS AND TREATMENT** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4×20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain how some aromatic compounds fail to respond to tests for carcinogenicity in vitro, citing a suitable example. | CO1 | Analyze | 5 |
|  | b. | Describe clonal evolution theory in the context of carcinogenesis. What are proto-oncogenes? How did Weinberg explain those? | CO2 | Understand | 15 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Give an account of mutations in the development of cancer. Explain the types of mutations. | CO1 | Remember | 20 |
|  |  |  |  |  |  |
| 3. |  | What is meant by chemotherapy? Explain the role of hormones and biological response modifiers in chemotherapy for cancer. | CO2 | Remember | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Elaborate on the role of DNA binders and topoisomerase inhibitors in treating cancer. | CO3 | Understand | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain the concept of Magnetic Resonance Imaging and its applications in cancer diagnosis. | CO3 | Apply | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the working principle, mechanism, and advantages of SPECT in diagnosing cancer. | CO4 | Apply | 20 |
|  |  |  |  |  |  |
| 7. |  | With suitable diagrams, describe the role of nanoparticles indiagnosing cancer. | CO5 | Analyze | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the applications of gold or silver nanoparticles in cancer diagnosis. | CO6 | Remember | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | How are magnetic nanoparticles applied in the targeted delivery of cancer drugs? What are the design principles employed to make nanomaterials suitable for drug transport? | CO6 | Analyze | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the mechanism of mutation and cancer-causing cells. |
| CO2 | Identify the different cancer diagnosis techniques. |
| CO3 | To explain the pros and cons of cancer nanotechnology methods. |
| CO4 | To justify the best method from the student’s perspective. |
| CO5 | To choose methods of improvising cancer diagnosis and treatment using nanomaterials. |
| CO6 | Demonstrate the applications of nanomaterials in cancer diagnosis and treatment. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | - | - | 5 | - | - | 25 |
| CO2 | 20 | 15 | - | - | - | - | 35 |
| CO3 | - | 20 | 20 | - | - | - | 40 |
| CO4 | - | - | 20 | - | - | - | 20 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | 20 |  |  | 20 | - | - | 40 |
|  | | | | | | | **180** |