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| **Course Code** | **17NT3003** | **Duration** | **3hrs** |
| **Course Name** | **NANO-LITHOGRAPHY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | What is dip pen lithography? What are the applications of this particular lithography? | CO3 | An | 10 |
|  | b. | How do you clean the substrate used in lithography? Name two substrates normally used. | CO1 | A | 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 | 10 |
| 3. | a. | Detail stereo lithography. | CO4 | U | 10 |
|  | b. | What is X-ray lithography? Explain the merits and demerits. | CO3 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | What is nanoscratching? How is it different from nanoindentation? | CO5 | E | 10 |
|  | b. | What are the different tools used for nanolithography? | CO4 | A | 10 |
| 5. | a. | Explain contact, proximity and projection printing technique with a suitable diagram. | CO1 | E | 10 |
|  | b. | What is focused ion beam lithography and its applications? | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain the fabrication of NPN and PNP BJT with lithographic masks. | CO2 | 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. | What is optical lithography? | CO1 | An | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Discuss the photolithographic process by positive and negative photo resist with a neat diagram. | CO2 | An | 10 |
|  | b. | What is extreme UV lithography? Explain in detail with necessary diagram. | 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 |  | 40 |
| CO2 |  | 10 | 10 | 10 |  |  | 30 |
| CO3 | 20 |  |  | 10 |  | 10 | 40 |
| CO4 | 10 | 10 | 20 |  |  |  | 40 |
| CO5 |  |  | 10 |  | 10 |  | 20 |
| CO6 |  | 10 |  |  |  |  | 10 |
|  | | | | | | | **180** |



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| **Course Code** | **17N3005** | **Duration** | **3hrs** |
| **Course Name** | **FUNCTIONALIZATION OF NANOSTRUCTURES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Describe the methods of functionalization of carbon dots. | CO1 | U | 10 |
|  | b. | Discuss the functionalization methods of carbon nanotubes. | CO1 | U | 10 |
| **(OR)** | | | | | |
| 2. | With suitable examples, explain how gold nanoparticles can be surface modified. Briefly explain the applications of the materials. | | CO2 | R | 20 |
|  |  | |  |  |  |
| 3. | Explain Diels-Alder and Bingel reactions in the functionalization of graphene oxides. | | CO2 | R | 20 |
| **(OR)** | | | | | |
| 4. | How can iron oxide nanoparticles be surface modified? Explain with suitable examples | | CO3 | R | 20 |
|  | | | | | |
| 5. | Describe the stability of magnetic nanoparticles and ligand modification of them. | | CO3 | An | 10 |
| **(OR)** | | | | | |
| 6. | Describe the methods of synthesis of silica nanoparticles synthesized? Explain their applications. | | CO4 | A | 20 |
|  |  | | |  |  |
| 7. | Give a detailed account on the applications of magnetic nanoparticles in drug delivery. | | CO4 | An | 20 |
|  | **(OR)** | | |  |  |
| 8. | Discuss the applications of quantum dots in biology and medicine. | | CO5 | A | 20 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | Describe the functionalization methods and biomedical applications 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** | **17NT3006 / 16NT3006** | **Duration** | **3hrs** |
| **Course Name** | **NANO-SAFETY AND ENVIRONMENTAL ISSUES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | What is the problem with nanoparticles with respect to safety? | CO1 | U | 04 |
|  | b. | Analyse the areas in which research is needed in order to respond to the challenge posed by nanoparticles. | CO1 | R | 16 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Which characteristics of nanoparticle are relevant for health effect? | CO1 | R | 10 |
|  | b. | What are the various engineering control methods practiced in nanoparticle risk reduction? | CO1 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain the life cycle analysis and Dupont’s nanorisk framework of risk reduction. | CO2 | U | 10 |
|  | b. | Analyse the role of material characterisation in risk reduction process. | CO2 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Analyse the various aspects associated with risk assessment of ENMs. | CO2 | A | 15 |
|  | b. | Explain any two parameters of risk-based policy making. | CO2 | U | 05 |
|  |  |  |  |  |  |
| 5. | a. | What are the distinct mechanisms concerning the deposition of solid material? | CO3 | R | 08 |
|  | b. | Explain the two distinctive mechanisms of clearance of solid material from the lungs. | CO3 | U | 12 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Analyse the pulmonary clearance of insoluble solids. | CO3 | A | 10 |
|  | b. | Explain the bio-persistence of inhaled solid material. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 7. | a. | Explain any three terms which are used in ecotoxicological tests. | CO4 | R | 06 |
|  | b. | Discuss the short term test in the ecotoxicological procedure. | CO4 | A | 14 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Analyse the ecotoxicity measurement of polychlorinated biphenyls. | CO4 | U | 12 |
|  | b. | Describe the measurement of genotoxicity by using AMES test. | CO4 | R | 08 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain under and over regulations impact. | CO5 | R | 05 |
|  | b. | Analyse the FDA regulation on nanosafety and environmental issues. | CO6 | A | 15 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 26 | 14 |  |  |  |  | 40 |
| CO2 | 10 | 15 | 15 |  |  |  | 40 |
| CO3 | 08 | 22 | 10 |  |  |  | 40 |
| CO4 | 14 | 12 | 14 |  |  |  | 40 |
| CO5 | 05 |  |  |  |  |  | 05 |
| CO6 |  |  | 15 |  |  |  | 15 |
|  | | | | | | | **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** | | **CO** | **BL** | **Marks** |
| **PART – A (5 × 20 = 100 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Mention whether the following statements are True or False:   1. Every time a cell divides, there is a chance of a replication error. 2. Ras gene is called the guardian of the genome. 3. The tumor suppressor genes carry gain of function mutations. 4. Kinases transfer phosphate groups onto oncogenes. | CO1 | R | 4 |
| b. | Identify the flow chart and add the missing information by answering the questions (A)–(D) in each step. | CO1 | U | 4 |
| c. | Match the following:   |  |  | | --- | --- | | **Cancer-causing agent type** | **Name** | | Non-mutagenic carcinogen | Metal ions | | Mutagenic | Asbestos | | ROS producing | Benzphenanthrene | | Carcinogen | UV light | | CO1 | U | 4 |
| d. | The following is a graphical representation of Ames tests on well-established carcinogens as mutagenic agents, carried out by Robert Weinberg. Which one of these paths (A or B) happens in real experiments? What is the reason? Explain the plausible observation in the experiments. | CO1 | An | 4 |
|  | e. | Analyze the stages of cancer depicted in the following image. Answer the questions shown at different stages of cancer. | CO1 | An | 4 |
| **(OR)** | | | | | |
| 2. | a. | The following image represents the profile of Chronic Myeloid Leukemia. To cure CML, Gleevec® was developed. Fill up the empty boxes shown at various stages of the profile; explain what the stages mean, and provide reasons for those. In finding an alternative for Gleevec®, what was the therapeutic introduced? How did it work? | CO1 | An | 6 |
| b. | **Match the following:**   |  |  | | --- | --- | | **Name of the process** | **Process** | | Introducing isolated DNA into cells | Replication error | | DNA is copied wrongly | Clonal evolution of cancer | | Mutations unfold over generations of cells | Invasion | | Cancer cells penetrate nearby cells | Transfection | | CO1 | R | 4 |
| c. | The following molecules on the reactant side form a carcinogen on their coupling. They form DNA adducts and do DNA corruption, proceeding to the onset of cancer. Fill up the places where question marks are provided, and complete the reaction, showing structural modifications of the compound. | CO1 | A | 5 |
|  | d. | |  |  | | --- | --- | |  | (ii) | | (iii) | (iv) |   Comment on the images below and explain them, using the context. The missing information is shown with questionmarks. | CO1 | An | 5 |
| 3. | a. | Identify the chemotherapeutic drug shown below. Which classification does this drug belong to? How do this kind of drugs act in curing cancer? Mention one side effect of this drug. | CO1 | A | 4 |
| b. | A person is diagnosed with lung cancer and the disease is staged using the TMN system as follows: T4, N4, M2. Explain how you understand the stage of cancer and what kind of treatment you will prescribe. Comment on the severity of the disease. | CO2 | An | 4 |
| c. | What are the limitations of the conventional chemotherapy? | CO1 | U | 4 |
| d. | What are the environmental factors that lead to the onset of cancer? | CO2 | U | 4 |
| e. | Define adjuvant, neoadjuvant, and rescue therapies. | CO1 | R | 4 |
| **(OR)** | | | | | |
| 4. | a. | Identify the chemotherapeutic drug shown below. Which classification does this drug belong to? How do this kind of drugs act in curing cancer? | CO1 | A | 4 |
| b. | A person is diagnosed with breast cancer and the disease is staged using the TMN system as follows: T2, N0, M0. Explain how you understand the stage of cancer and what kind of treatment you will prescribe. Comment on the severity of the disease. | CO2 | An | 4 |
| c. | What are topoisomerase inhibitors? Mention the names of three antibiotics used in treating cancer. | CO2 | R | 4 |
| d. | Describe various phases involved in the normal cell cycle. | CO2 | R | 4 |
| e. | List out four important information about hormones in the treatment of cancer. | CO2 | R | 4 |
|  | | | | | |
| 5. | a. | In an MRA velocity mapping study, the phase shift of blood flowing through a vessel is measured. If the flow velocity is 40 cm/s, and the applied magnetic field gradient has a strength of 0.1 T/m, calculate the phase shift in radians experienced by the blood protons during their transit through the magnetic field gradient. | CO3 | E | 6 |
| b. | The gyromagnetic ratio for protons is approximately 42.58 MHz/T. Calculate the Larmor frequency for protons in a 3.0 T MRI scanner. | CO3 | E | 4 |
| c. | Explain with a neat diagram the principles and applications of single-photon emission computed tomography. | CO2 | U | 10 |
| **(OR)** | | | | | |
| 6. | a. | A SPECT scan records 10,000 gamma-ray counts over a 5-minute acquisition period. Calculate the count rate in counts per minute (CPM) and counts per second (CPS). | CO3 | E | 4 |
| b. | A radiopharmaceutical with a half-life of 6 hours is used in a SPECT scan. If 10 mCi (millicuries) of the radiopharmaceutical are initially administered, how much activity remains after 24 hours? | CO3 | E | 6 |
| c. | Explain with a neat diagram the principles and applications of ultrasonography. | CO2 | U | 10 |
|  | | | | | |
| 7. | a. | Analyze with a histopathology perspective and identify the parts labelled as A, B, C, D, E, and F in the tissue images given below: | CO5 | An | 6 |
| b. | Given a quantum dot with an absorption cross-section of 5 × 10-15 cm2, how many quantum dots are needed to absorb all photons in a laser beam with an intensity of 1 W/cm2 and a wavelength of 600 nm? | CO4 | E | 4 |
| c. | Justify the advantages of using metal nanoclusters in imaging cancer cells. | CO4 | An | 10 |
| **(OR)** | | | | | |
| 8. | a. | Analyze with a histopathology perspective and identify the parts labelled as A, B, C, D, E, and F in the tissue images given below: | CO5 | An | 6 |
| b. | If quantum dots are 15 times brighter than organic dyes, and an organic dye emits 1,000 photons per second, how many photons per second will the quantum dots emit under the same conditions? | CO4 | E | 4 |
| c. | How can gold nanoparticles can be effectively be applied in cancer cell imaging? | CO4 | An | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | Create a nanoscale drug delivery system for the following pathological condition:   * A patient suffers from breast cancer * The cancer is staged as per the TMN system as T4, N2, M1 * Most of the cancerous cells are situated on the epithelial tissues * The person is allergic to penicillin   Suggest multi-modal treatment with a plan on designing the nanomaterial with your own ideas. | CO6 | C | 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 | **R** | **U** | **A** | **An** | **E** | **Create** | **Total** |
| CO1 | 12 | 12 | 13 | 19 | - | - | 56 |
| CO2 | 12 | 24 | - | 8 | - | - | 44 |
| CO3 | - | - | - | - | 20 | - | 20 |
| CO4 | - | - | - | 20 | 8 | - | 28 |
| CO5 | - | - | - | 12 | - | - | 12 |
| CO6 | - | - | - | - | - | 20 | 20 |
|  | **24** | **36** | **13** | **59** | **28** | **20** | **180** |



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| **Course Code** | **17NT3010** | **Duration** | **3hrs** |
| **Course Name** | **NANO-BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 × 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain with neat diagrams, the human nervous system and information passage through neurons. | CO1 | U | 20 |
| **(OR)** | | | | | |
| 2. |  | Discuss in detail the bioinspiration employed in framing neural networks. Describe artificial neural networks and their components. | CO2 | A | 20 |
|  | | | | | |
| 3. | a. | Explain the working of ATP synthase and bilirubin, functioning as molecular machines with a neat diagram. | CO2 | U | 16 |
|  | b. | Report the reasons for the preference of molecules over atom-by-atom arrangement in nanoscale machinery. | CO2 | An | 4 |
| **(OR)** | | | | | |
| 4. | a. | With three molecules of your choice, describe their possible application as molecular switches. | CO3 | An | 15 |
|  | b. | Illustrate and explain DNA microarrays. | CO3 | U | 5 |
|  | | | | | |
| 5. | a. | Explain motor proteins and their functions. | CO1 | U | 10 |
|  | b. | Illustrate the structure of collagen and explain its self-assembly. | CO2 | An | 10 |
| **(OR)** | | | | | |
| 6. |  | Comment on the novelty of microtubule structure by providing its suitable schematic representation. Explain treadmilling of microtubules. | CO3 | An | 20 |
|  | | | | | |
| 7. | a. | Explain aptamers and their applications. | CO4 | U | 10 |
|  | b. | Explain the main ideas behind artificial life. Comment on the possibility of artificial life in three points. | CO4 | An | 10 |
| **(OR)** | | | | | |
| 8. | a. | Comment on molecular design using biological selection. | CO5 | An | 10 |
|  | b. | Describe self-replication with suitable illustrations. | CO5 | A | 10 |
| **PART – B (1 × 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Give an elaborate account on biological computers. | CO6 | U | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| **CO 1** | Explain the concepts of nanobiotechnology |
| **CO 2** | Identify new materials based on nanobiotechnology. |
| **CO 3** | Apply nanomaterials to interface with the biological systems. |
| **CO 4** | Prepare newer nanomaterials with a focus on nanobiotechnology |
| **CO 5** | Articulate the trend of the present scenario on nanobiotechnology research |
| **CO 6** | Explain the foreseen ideas on nanobiotechnology for electronics and medicine |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 30 | - | - | - | - | 30 |
| CO2 | - | 16 | 20 | 14 | - | - | 50 |
| CO3 | - | 5 | - | 35 | - | - | 40 |
| CO4 | - | 10 | - | 10 | - | - | 20 |
| CO5 | - | - | 10 | 10 | - | - | 20 |
| CO6 | - | 20 | - | - | - | - | 20 |
|  | **-** | **81** | **30** | **69** | **-** | **-** | **180** |



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| **Course Code** | **17NT3011** | **Duration** | **3hrs** |
| **Course Name** | **PHOTOVOLTAICS: ADVANCED MATERIALS AND DEVICES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Describe the types of visible and non-visible lights present in the electromagnetic spectrum and justify the suitable one for solar cell application. | CO1 | U | 10 |
|  | b. | Explain the principle of a diode based solar cell with a neat sketch. | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Evaluate the Voc. Jsc, FF and Efficiency of an ideal solar cell with its characteristic equations. | CO1 | E | 20 |
|  |  |  |  |  |  |
| 3. | a. | Assess the current state of silicon solar cell technology by considering its efficiency, cost-effectiveness, and environmental impact. | CO2 | E | 12 |
|  | b. | Analyze the impact of doping in solar cells. | CO2 | An | 8 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain the carrier transport mechanisms, recombination rates, and interface effects that affects the characteristics of solar cell under different operating conditions. | CO3 | A | 20 |
|  |  |  |  |  |  |
| 5. | a. | Explain the unique material properties and characteristics of CdSe, CdTe, CIGS, and CZTS used in solar cell applications. | CO4 | A | 12 |
|  | b. | Explain the fundamental principles of operation of thin film solar cells. | CO4 | U | 8 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Assess the performance of organic solar cells with respect to the electrical properties and explain the operation of DSSC polymer solar cell. | CO5 | E | 20 |
|  |  |  |  |  |  |
| 7. | a. | Assess the advantages and disadvantages of tandem and triple-junction solar cells in comparison to single-layer solar cells with necessary diagrams and equations. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Write short notes on flexible solar cells and its applications. | CO4 | A | 10 |
|  | b. | Interpret the challenges of solar cell fabrication. | CO6 | U | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Categorize the different fabrication methods of photovoltaic cells and explain the process of Screen printing fabrication method. | CO6 | An | 10 |
|  | b. | List the factors affecting the photovoltaic properties. | CO6 | R | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the basics of solar cells |
| CO2 | Estimate and analyse the performance characteristics of solar cells |
| CO3 | Evaluate the characteristics of different silicon solar cells |
| CO4 | Assess the performance of Cadmium Telluride Thin Film Solar Cells |
| CO5 | Analyze the performance of Dye Sensitized Solar Cell and Polymer Organic Thin-Film Solar cells |
| CO6 | Demonstrate knowledge of solar cells for space applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 10 | 10 | - | 20 | - | 40 |
| CO2 | - | - | - | 8 | 12 | - | 20 |
| CO3 | - | - | 40 | - | - | - | 40 |
| CO4 | - | 8 | 22 | - | - | - | 30 |
| CO5 | - | - | - | - | 20 | - | 20 |
| CO6 | 10 | 10 | - | 10 | - | - | 30 |
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| **Course Code** | **17NT3013** | **Duration** | **3hrs** |
| **Course Name** | **NANOSCALE TRANSISTORS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Analyze the transistor as a black box with its I-V characteristics. | CO1 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Explain the SCE and DIBL from the voltage-doping transformation model and obtain the threshold voltage of MOSFET. | CO2 | A | 20 |
|  |  |  |  |  |  |
| 3. |  | Explain the various gate structure of nanoscale transistor with neat diagram. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain the work function and threshold voltage tuning of Fin FET with various gate materials. | CO4 | An | 20 |
|  |  |  |  |  |  |
| 5. |  | Elaborate the design of poly-silicon gate with neat diagram. | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the wafer bending and Nitride stress liners methods for enhancing the mobility in FET. | CO4 | An | 20 |
|  |  |  |  |  |  |
| 7. |  | Elaborate the various contacts of Fins with suitable diagrams. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the importance and various design of raised source and drain with neat diagram. | 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 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | - | - | 20 | - | - | 20 |
| CO2 | - | - | 20 | - | - | - | 20 |
| CO3 | - | - | 40 | - | - | - | 40 |
| CO4 | - | - | 20 | 40 | - | - | 60 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | - | - | - | 20 | - | - | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **17NT3015** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL NANOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 × 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain the types of data storage devices and hard disks, mentioning their memory capacity. | CO2 | R | 15 |
| b. | Describe solid-state memory devices. Give examples. | CO2 | U | 5 |
| **(OR)** | | | | | |
| 2. | a. | Describe the bistable magnetization in a ferromagnetic material. | CO1 | U | 10 |
| b. | Explain ferromagnetic nanorings and the concept of vortices and onions involved in the mechanism of data storage. | CO1 | U | 10 |
|  | | | | | |
| 3. | a. | Explain optical pick-up heads in data read and write. | CO2 | R | 10 |
| b. | Describe dye-sensitized solar cells in detail. | CO2 | U | 10 |
| **(OR)** | | | | | |
| 4. |  | Describe thin film silicon solar cells and quantum dot solar cells. | CO3 | U | 20 |
|  | | | | | |
| 5. |  | Explain nanoencapsulation and enhancement of drug therapy. | CO4 | R | 20 |
| **(OR)** | | | | | |
| 6. |  | Discuss the applications of nanotechnology in food industry. | CO4 | A | 20 |
|  | | | | | |
| 7. |  | Describe nanomaterials in biosensors and chips. | CO5 | A | 20 |
| **(OR)** | | | | | |
| 8. |  | Describe nanomaterials in bone substitutes and dentistry. | CO5 | A | 20 |
| **PART – B (1 × 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the biomedical applications of nanomaterials and predict the plausible advancements in the future. | CO5 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| **CO 1** | Appraise the magnetic storage devices |
| **CO 2** | Demonstrate the optical storage devices |
| **CO 3** | Apply nano in energy storage devices |
| **CO 4** | Design nano encapsulated drug for targeted delivery |
| **CO 5** | Develop nano chip for biomedical applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 20 | - | - | - | - | 20 |
| CO2 | 25 | 15 | - | - | - | - | 40 |
| CO3 | - | 20 | - | - | - | - | 20 |
| CO4 | 20 | - | 20 | - | - | - | 40 |
| CO5 | - | - | 40 | 20 | - | - | 60 |
|  | **45** | **55** | **60** | **20** | **-** | **-** | **180** |



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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** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain the electrode reactions at low temperature fuel cells with neat diagram. | CO1 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Explain the working principle of a fuel cell with neat diagram. | CO1 | A | 20 |
|  |  |  |  |  |  |
| 3. |  | Write the function of nanocrystalline solar cells with its I-V characteristics. | CO2 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain the electron injection from oxide/substrate into electrolyte | CO2 | A | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain solid state semiconductor-sensitized solar cells with neat diagram. | CO3 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Write the multilayer semiconductors based solar cell with neat diagram. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | Explain the energy storage in super-capacitors with neat diagram. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the nanoporous inorganic materials used for the hydrogen storage with neat diagram. | CO5 | A | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the various carbon materials used for the hydrogen storage with neat diagram. | CO6 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | - | 40 | - | - | - | 40 |
| CO2 | - | - | 40 | - | - | - | 40 |
| CO3 | - | - | - | 20 | - | - | 20 |
| CO4 | - | - | 20 | - | - | - | 20 |
| CO5 | - | - | 20 | 20 | - | - | 40 |
| CO6 | - | - | 20 | - | - | - | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **17NT3019** | **Duration** | **3hrs** |
| **Course Name** | **SYNTHESIS AND APPLICATIONS OF NANOMATERIALS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Differentiate top-down and bottom-up approach in the synthesis of nanomaterials. | CO1 | U | 5 |
|  | b. | Describe the process of ball milling and discuss in detail about the different types of mills. | CO1 | U | 15 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Explain the arc plasma and laser ablation method in the preparation of nanomaterials | CO2 | U | 20 |
|  |  |  |  |  |  |
| 3. | a. | Define the concept of self-assembly. | CO3 | U | 5 |
|  | b. | Explain the concept of formation of self-assembled monolayers with suitable examples. | CO3 | U | 15 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain the process of spin coating with a suitable sketch. | CO2 | U | 10 |
|  | b. | Differentiate solvothermal and hydrothermal method in the synthesis of nanomaterials. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | Describe the process of pulsed laser deposition in the deposition of thin films with a suitable sketch. | CO5 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain the instrumentation and working principle of spray pyrolysis with a suitable sketch. | CO5 | U | 20 |
|  |  |  |  |  |  |
| 7. | a. | Explain the structure and properties of graphene. | CO1 | U | 5 |
|  | b. | Describe the classification of carbon nanotubes based on chirality and mention their properties. | CO1 | U | 15 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Define zeolites. | CO4 | U | 2 |
|  | b. | Describe the structure of core-shell nanostructure and hybrid nanocomposites and mention their application. | CO4 | U | 18 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain the application of nanostructures as single electron transistor and discuss their design and working principle. | CO6 | U | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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 nanomaterial coatings |
| CO6 | Appraise the advanced techniques like lithography |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 40 |  |  |  |  |  |
| CO2 |  | 30 |  |  |  |  |  |
| CO3 |  | 30 |  |  |  |  |  |
| CO4 |  | 20 |  |  |  |  |  |
| CO5 |  | 40 |  |  |  |  |  |
| CO6 |  | 20 |  |  |  |  |  |
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| **Course Code** | **17NT3039** | **Duration** | **3hrs** |
| **Course Name** | **SEMICONDUCTOR NANOSTRUCTURES AND NANO-PARTICLES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Describe the strained layers of semiconductor nanostructures. | CO1 | R | 10 |
|  | b. | Analyse the effect of strain on valence bands under unstrained, compression and the layers under tension. | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Illustrate the band structure in quantum wells with suitable schematic. | CO2 | R | 10 |
|  | b. | Analyse the excitonic effect in quantum wells for Ga As-AlGa As wells. | CO2 | An | 10 |
| 3. | a. | Demonstrate the Chemical vapour deposition method of preparing Nano material with a neat schematic. | CO3 | E | 20 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Apply Electrospin method for depositing metal oxide-polymer nano films and explain the effect of process parameters and the thickness of the fibers. | CO3 | An | 15 |
|  | b. | Compare the physical and chemical methods of nanomaterials synthesis in terms of the semiconductor device applications. | CO3 | R | 5 |
| 5. | a. | Analyze the melting point and the surface energy properties that alters due to size reduction to nanoscale using Gibs free energy equation. | CO4 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Evaluate the Aspect ratio for bulk and nanostructure. | CO4 | E | 5 |
|  | b. | Compare the quantum states like well, wire and dot while when size reduction of bulk to one dimensional, 2D and 3D. | CO4 | An | 15 |
| 7. | a. | Evaluate the photovoltaic parameters using the plot of volt ampere characteristics. | CO5 | E | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Design a Quantum dot Solar cell structure and describe the working to achieve full solar spectrum. | CO5 | C | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Design a single electron transistor and plot the IV characteristics depicting the step potential. | CO6 | C | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Analyse the Semiconductor Nanostructure |
| CO2 | Demonstrate the method for nanostructure fabrication techniques |
| CO3 | Appraise the physical properties of nano materials |
| CO4 | Evaluate the parameters of nanodevices through optical and electrical characterics |
| CO5 | Analyse the nanowire based devices and the methods of fabrication |
| CO6 | Design nano devices with different quantum nanostructure |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 |  | 10 |  |  |  | 20 |
| CO2 | 10 |  |  | 10 |  |  | 20 |
| CO3 | 5 |  |  | 15 | 20 |  | 40 |
| CO4 |  |  |  | 35 | 5 |  | 40 |
| CO5 |  |  |  |  | 20 | 20 | 40 |
| CO6 |  |  |  |  |  | 20 | 20 |
|  | | | | | | | **180** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Define the term ‘mutation’ in molecular biology. | CO1 | R | 6 |
|  | b. | Illustrate the details of oncogenes and its significance in cancer nano-medicine. | CO1 | An | 14 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Discuss the growth factor signalling in brief. | CO1 | U | 6 |
|  | b. | Explain the details of tumor suppressor genes and its significance in cancer nano-medicine. | CO1 | A | 14 |
|  |  |  |  |  |  |
| 3. | a. | Describe the treatment cancer chemotherapy in brief. | CO2 | A | 6 |
|  | b. | Illustrate chemotherapeutic agents in detail in the treatment of cancer. | CO2 | An | 14 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain the clinical assessment of biomarkers. | CO2 | U | 6 |
|  | b. | Describe the chemotherapeutic drug nanoparticles for cancer treatment in detail | CO2 | A | 14 |
|  |  |  |  |  |  |
| 5. | a. | Explain the concept of Computed Tomography (CT) Scan in detail. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Illustrate the principle and working of Magnetic Resonance Imaging in detail. | CO3 | An | 20 |
|  |  |  |  |  |  |
| 7. | a. | Discuss the ways to use single photon emission CT ultrasonography in cancer treatment. | CO4 | U | 6 |
|  | b. | Explain the concept of luminescent quantum dots and discuss its applications in cancer diagnosis and treatment. | CO4 | A | 14 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Describe the advantages of gold nanoparticles in the diagnosis/treatment of cancer. | CO5 | R | 6 |
|  | b. | Illustrate luminescent quantum dots in the treatment of cancer in detail. Also discuss its significance in the diagnosis of cancer. | CO5 | An | 14 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Describe the clinical trials and its significance in brief in the treatment of cancer. | CO6 | A | 6 |
|  | b. | Explain the principle of magnetic drug targeting in the treatment of cancer and discuss its processes in this application in detail. | CO6 | An | 14 |

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the mechanism of mutation and cancer-causing cells |
| CO2 | Explain the methods in cancer chemotherapy and identify anticancer drugs |
| CO3 | Identify the different cancer diagnosis techniques |
| CO4 | To explain the pros and cons of cancer nanotechnology methods |
| CO5 | To choose methods of improvising cancer diagnosis using nanomaterials |
| CO6 | Demonstrate the applications of nanomaterials in cancer treatment |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 6 | 6 | 14 | 14 |  |  | 40 |
| CO2 |  | 6 | 20 | 14 |  |  | 40 |
| CO3 |  |  | 20 | 20 |  |  | 40 |
| CO4 |  | 6 | 14 |  |  |  | 20 |
| CO5 | 6 |  |  | 14 |  |  | 20 |
| CO6 |  |  | 6 | 14 |  |  | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **20NT3020** | **Duration** | **3hrs** |
| **Course Name** | **NANOMATERIAL-BASED ENERGY DEVICES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Illustrate the construction of traditional solar cells and explain their applications, advantages and limitations. | CO1 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Discuss the advantages and challenges associated with quantum-dot solar cells, and how can their unique properties contribute to the integration of renewable energy sources in various applications? | CO1 | An | 20 |
|  |  |  |  |  |  |
| 3. |  | 1. Explain the process of generating voltage using thermocouple and list the factors that affect the magnitude of the voltage output. 2. Discourse the practical applications and advantages of using thermocouples in temperature measurement and control systems. | CO2 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Illustrate the construction and operational principle of thermoelectric and piezoelectric generators and write the specific characteristics, advantages, and limitations of them. | CO3 | A | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain the components and working principles of lithium-ion batteries, and discuss their applications in electronic devices, electric vehicles, and energy storage solutions. | CO4 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Describe the principle, composition, construction and working of Zinc carbon batteries. Write their specific applications, advantages and challenges in terms of performance, cost-effectiveness, and environmental impact. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | Demonstrate the principle, construction and working of fuel cells. Write the specific applications, advantages and disadvantages of various types of fuel cells. | CO5 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the principle, construction and working of solid oxide fuel cells. How do these cells differ with other types of fuel cells in terms of efficiency, durability, and applications? | CO5 | A | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Distinguish pseudo-capacitance from other traditional double-layer capacitance in electrochemical capacitors. Discuss the role of various oxides as a pseudo-capacitive material in super-capacitors and energy storage devices. | CO6 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the various solar cell parameters and different types of solar cells. |
| CO2 | Appreciate the working principle and applications of thermo-electric generators. |
| CO3 | Demonstrate the working principle and applications of piezo-electric generators |
| CO4 | Compare the different types of electro-chemical energy storage systems. |
| CO5 | Understand the basic and types of fuel cells. |
| CO6 | Apply various nanomaterials in super capacitor. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 20 |  | 20 |  |  | 40 |
| CO2 |  |  | 20 |  |  |  | 20 |
| CO3 |  |  | 20 |  |  |  | 20 |
| CO4 |  | 20 | 20 |  |  |  | 40 |
| CO5 |  |  | 40 |  |  |  | 40 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **180** |