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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **19BM2007** | **Duration** | **3hrs** |
| **Course Title** | **BIOMEMS TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | List any two typical MEMS products. | | CO1 | R | 1 |
| 2. | Define MEMS technology. | | CO1 | R | 1 |
| 3. | Identify two applications of MOEMS devices. | | CO2 | R | 1 |
| 4. | Examine the role of comb drive in micro-actuators. | | CO2 | U | 1 |
| 5. | Explain the applications of a digital micro-mirror device. | | CO3 | U | 1 |
| 6. | Analyze the role of soft tools for lab-on-chip devices. | | CO4 | An | 1 |
| 7. | Explain theapplications ofE-Nose. | | CO5 | U | 1 |
| 8. | Define the principle of micromachining. | | CO6 | R | 1 |
| 9. | Compare physical and chemical vapor deposition techniques. | | CO5 | An | 1 |
| 10. | Infer the role of mask in thin film process. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Demonstrate the working of a micropressure sensor used in healthcare monitoring. | | CO1 | A | 3 |
| 12. | Illustrate the operating principle of a microgripper. | | CO2 | U | 3 |
| 13. | Explain light modulation in MOEMS. | | CO3 | U | 3 |
| 14. | Analyze the use of microfluidic principles for drug delivery system. | | CO4 | An | 3 |
| 15. | Demonstrate the use of Atomic Force Microscope in nanoscale imaging. | | CO5 | A | 3 |
| 16. | Summarize the concept of nanoparticle-based sensing in cancer diagnostics. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Differentiate between capacitive and piezoelectric MEMS sensors. | CO1 | An | 6 |
|  | b. | Analyze the working of MEMS microvalve. | CO1 | An | 6 |
|  |  |  |  |  |  |
| 18. | a. | Developa MEMS-based accelerometer for medical applications. | CO6 | C | 6 |
|  | b. | Evaluate the applications of microaccelerometer in healthcare systems. | CO6 | E | 6 |
|  |  |  |  |  |  |
| 19. |  | Propose an optical microchip for biomedical applications. | CO2 | C | 12 |
|  |  |  |  |  |  |
| 20. |  | Analyze BioMEMS integration in implantable systems for continuous glucose monitoring. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Evaluate the role of simulation tools for analyzing MEMS devices. | CO4 | E | 8 |
|  | b. | List few piezoelectric materials and their parameters. | CO5 | R | 4 |
|  |  |  |  |  |  |
| 22. | a. | Summarize the role of materials such as silicon in MEMS fabrication. | CO5 | An | 6 |
|  | b. | Illustrate the applications of piezoresistive MEMS device. | CO6 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | Evaluate the merits of the deep reactive ion etching process in MEMS fabrication. | CO5 | E | 8 |
|  | b. | List microsensors and its applications in healthcare. | CO2 | R | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Demonstrate the use of simulation tools for designing MEMS device geometry. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Identify the principles of sensors and actuators. |
| **CO2** | Summarize the optical devices and applications. |
| **CO3** | Classify the performance of microfluidic devices to the environment. |
| **CO4** | Use the software tools for designing and analysing the sensors. |
| **CO5** | Recommend the suitable principles of testing for biomedical conditions. |
| **CO6** | Create simple systems for medical applications. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3002** | **Duration** | **3hrs** |
| **Course Title** | **ADVANCED BIOMEDICAL SIGNAL PROCESSING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | i) Describe in detail the process of Time Domain Filtering of biomedical signals.  ii) Compare and contrast the performance of Moving Average Filters, Median Filters, and Adaptive Filters in removing noise from bio signals with variable characteristics.  iii) Explain the concept of Synchronous Averaging and its clinical relevance in signal enhancement. | CO1 | An | 16 |
|  |  |  |  |  |  |
| 2. |  | i) With neat diagrams, explain the Frequency Domain Filtering approach used in biomedical signal analysis.  ii) Discuss the principles, advantages, and limitations of Low-Pass, High-Pass, Band-Pass, and Notch filters.  iii) Include examples illustrating their application in EEG rhythm separation and ECG noise suppression. | CO2 | An | 16 |
|  |  |  |  |  |  |
| 3. |  | Surface EMG signals often contaminate ECG recordings during ambulatory monitoring or stress testing, leading to misinterpretation of QRS complexes. Hence,  1. Explain how structured (EMG) noise differs from random noise in ECG acquisition.  2. Design a filtering approach (time or frequency domain) suitable for separating EMG artifacts from ECG.  3. Discuss how the residual EMG energy could still provide meaningful physiological information (e.g., muscle fatigue, tremor detection). | CO3 | E | 16 |
|  |  |  |  |  |  |
| 4. |  | In dermoscopic imaging, skin lesion images often contain illumination variations, sensor noise, and textural irregularities that obscure diagnostic features. Filtering techniques are used to enhance lesion borders and remove background noise.  1. Describe the role of spatial frequency filters (low-pass, high-pass, and band-pass) in preprocessing skin images for melanoma detection.  2. Discuss how median and Wiener filters differ in their approach to noise reduction in dermoscopic images.  3. Propose a filter-based pipeline that enhances contrast and sharpness for automated feature extraction in skin cancer classification. | CO4 | E | 16 |
|  |  |  |  |  |  |
| 5. | a. | Discuss about convolution and correlation in Biomedical Signal Processing | CO5 | An | 8 |
|  | b. | Justify the importance of signal’s characteristics in signal processing with examples. | CO5 | An | 8 |
|  |  |  |  |  |  |
| 6. |  | i) Explain the principle and working of Adaptive Noise Cancellation (ANC) in biomedical signal processing.  ii) Illustrate the LMS (Least Mean Squares) algorithm with a neat block diagram and discuss how it adapts to remove powerline interference from ECG signals. | CO4 | E | 16 |
|  |  |  |  |  |  |
| 7. |  | i) Explain the significance of mean, variance, autocorrelation, and power spectral density (PSD) in the statistical analysis of bio- signals.  ii) Illustrate how these parameters help characterize EEG and EMG signals in clinical diagnosis. | CO2 | E | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | i) Explain the need for adaptive segmentation in biomedical signal analysis.  ii) Discuss how segmentation helps in identifying clinically relevant events such as QRS complexes, sleep stages, or epileptic spikes. | CO6 | An | 10 |
|  | b. | Suggest a signal processing workflow for performing automated ECG or EEG variability analysis, indicating where filtering, segmentation, and feature extraction steps are integrated. | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Summarize the basic concepts of Digital Signal Processing Techniques |
| CO2 | Identify the nature of Biomedical Signals |
| CO3 | Apply the Filtering Techniques |
| CO4 | Analyze the Noise Cancellation Techniques for Biosignals |
| CO5 | Understand various techniques for detection of events |
| CO6 | Deveop Systems for Biosignal Acquisition and Analysis. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3003** | **Duration** | **3hrs** |
| **Course Title** | **APPLIED MEDICAL IMAGE PROCESSING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Compare voxel-based 3D modeling with polygon-based 3D modelling. | CO1 | U | 10 |
|  | b. | Explain the role of windowing in smoothing and edge detection. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Analyze the role of training datasets and ground truth images in supervised segmentation. | CO2 | An | 10 |
|  | b. | Explain convolutional neural networks (CNNs) for image segmentation. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 3. |  | Explain spatial transformations in image processing and their importance in medical imaging. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Analyze the concept of spatial transforms in clinical diagnosis and treatment planning. | CO3 | An | 20 |
|  |  |  |  |  |  |
| 5. |  | Interpret surface-based rendering and its importance in medical visualization. | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Compare different rendering techniques used in image visualization. | CO4 | U | 20 |
|  |  |  |  |  |  |
| 7. |  | Explain various optimization strategies used in image registration. | CO5 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Justify the role of deep learning approaches in image registration and their advantages. | CO5 | A | 20 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Interpret the principle and process of CT image reconstruction. | CO6 | A | 10 |
|  | b. | Analyze the role of IoT in clinical applications and healthcare. | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the fundamentals to represent the images as per the given requirement. |
| CO2 | Discuss the segmentation method for a given clinical application |
| CO3 | Explain the spatial transformation and its use for medical application |
| CO4 | Distinguish between various rendering techniques on medical images |
| CO5 | Assess the effect of image registration with respect to clinical application |
| CO6 | Discuss the techniques for reconstruction of CT images |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3010** | **Duration** | **3hrs** |
| **Course Title** | **MEDICAL SENSORS AND MEMS TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain the role of artificial intelligence in modern sensor technology. | CO1 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Illustrate a MEMS-based inertial sensor system with proper material selection, fabrication sequence, interface circuit and calibration-control process flow. | CO2 | An | 20 |
|  |  |  |  |  |  |
| 3. | a. | Explain the micromachining technique used in MEMS fabrication. | CO3 | A | 10 |
|  | b. | Compare silicon, silicon dioxide, silicon nitride and polymers for use in MEMS.​ | CO3 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Analyze the safety protocols and contamination control procedures essential for MEMS fabrication environments.​ | CO4 | An | 10 |
|  | b. | Explain the lithography technique used in the MEMS fabrication. | CO4 | A | 10 |
|  |  |  |  |  |  |
| 5. | a. | Explain the principle of thermal flow sensors with its biomedical application. | CO5 | An | 10 |
|  | b. | Analyze the Peltier effect, heat pumps and their MEMS thermal actuator applications. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Evaluate the impact of advanced surface and bulk micromachining technologies on MEMS device miniaturization and integration. | CO4 | E | 20 |
|  |  |  |  |  |  |
| 7. |  | Interrupt a comprehensive case study on the micromachining of a MEMS accelerometer, describing each process stage from wafer cleaning to final device testing. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain the use of optimization tools in the design of MEMS sensors and actuators. | CO6 | An | 10 |
|  | b. | Illustrate the integration of machine learning tools in the design and analysis of MEMS sensors. | CO6 | A | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | Evaluate the process and benefits of using mechanical and electrical solvers for multi-physics analysis in MEMS actuator systems. | CO6 | E | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Identify the principle of medical sensors and its interfacing circuits |
| CO2 | Classify the micro sensor materials, synthesis, fabrication and its characterization |
| CO3 | Choose the design tools to test and develop products to required specifications |
| CO4 | Infer the most relevant challenges facing in the fabrication process |
| CO5 | Judge a sensor based on standard performance criteria and environmental impact |
| CO6 | Construct the micro system for appropriateness for an application and user |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3011** | **Duration** | **3hrs** |
| **Course Title** | **HUMAN COMPUTER INTERFACE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | **Analyze** the role of cognitive and perceptual psychology in improving user interaction with technology. | CO1 | An | 10 |
|  | b. | **Dissect** the entire human–computer interaction process, explaining how perception, cognition, and action are involved. | CO1 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | **Classify** the different types of Brain–Computer Interfaces as invasive and non-invasive, explaining their merits and limitations. | CO2 | U | 10 |
|  | b. | **Survey** the different hardware and software systems used in EEG-based BCIs and their functional differences. | CO2 | An | 10 |
|  |  |  |  |  |  |
| 3. | a. | **Compare** different brain response types such as motor imagery and evoked potentials. | CO3 | An | 10 |
|  | b. | **Analyze** how virtual environments enhance user control through mental state monitoring. | CO3 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | **Compare** different standards and protocols used in brain data collection and processing. | CO4 | An | 10 |
|  | b. | Explain the major stages involved in data acquisition and preprocessing. | CO4 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | **Categorize** various feature extraction methods based on time and frequency domains. | CO5 | An | 10 |
|  | b. | **Compare** classical signal decomposition techniques such as Fourier and Wavelet transforms. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Examine the role of AR models and bandpass filters in improving signal clarity. | CO5 | A | 10 |
|  | b. | Explain the process of dimensionality reduction using PCA. | CO5 | A | 10 |
|  |  |  |  |  |  |
| 7. | a. | Explain the impact of filter selection on overall classification performance | CO5 | U | 10 |
|  | b. | **Distinguish** linear and nonlinear feature extraction approaches. | CO5 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | **Compare** LDA and regression models in translating features into control outputs. | CO6 | U | 10 |
|  | b. | Explain the function of Gaussian Mixture Models. | CO6 | U | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | **Interpret on the theme of virtual interaction and neural communication.** | CO6 | U | 10 |
|  | b. | **Contrast** the advantages and limitations of human decision-making versus AI-based decision-making. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Comprehend the concept of human–computer interaction and its cognitive foundations. |
| CO2 | Review the types and architectures of Brain–Computer Interfaces (BCIs) and their applications. |
| CO3 | Analyze human responses and user experience improvements in interactive and virtual environments. |
| CO4 | Examine the data acquisition, signal processing standards, and preprocessing techniques in HCI systems. |
| CO5 | Compute and compare feature extraction and dimensionality reduction techniques in human signal analysis. |
| CO6 | Summarize the models and algorithms for translating neural and behavioral data into intelligent control and interaction. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3012** | **Duration** | **3hrs** |
| **Course Title** | **HUMAN ASSISTIVE DEVICES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Illustrate the working principle and functional components of a heart–lung machine used during cardiopulmonary bypass surgery. | CO1 | A | 16 |
|  |  |  |  |  |  |
| 2. |  | Analyze the selection criteria, characteristics, and testing methods of biomaterials used for implantable cardiac devices such as prosthetic valves and ventricular assist devices. | CO2 | An | 16 |
|  |  |  |  |  |  |
| 3. | a. | Summarize the application of machine learning in the analysis and testing of assistive devices. | CO3 | U | 8 |
|  | b. | Explain the indication and principle of hemodialysis. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 4. |  | Explain the different types of models externally powered limb prosthesis feedback in Orthotic System. | CO4 | A | 16 |
|  |  |  |  |  |  |
| 5. |  | Differentiate the types of deafness and the corresponding hearing aids used for each type. | CO5 | An | 16 |
|  |  |  |  |  |  |
| 6. | a. | Explain the mock test setup for the assessing the function of artificial heart devices. | CO1 | An | 8 |
|  | b. | Classify the different types of visual impairments. | CO6 | An | 8 |
|  |  |  |  |  |  |
| 7. |  | Compare the working principles and applications of intra-aortic balloon pumps and ventricular assist devices. | CO2 | E | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. |  | Illustrate the block diagram and design requirement of tactile auditory substitution. | CO6 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Identify the requirements for human assist devices |
| CO2 | Classify the systems based on applications |
| CO3 | Relate soft tools for analysis and design of devices for specific applications |
| CO4 | Infer the merits of human assist system and its influence to environment. |
| CO5 | Choose the methodologies in measurement systems and conditions |
| CO6 | Combine instrumentation techniques for development of assist devices to human needs |

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**END SEMESTER EXAMINATION – NOV/DEC 2025**

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| **Course Code** | **21BM3021** | **Duration** | **3hrs** |
| **Course Title** | **ERGONOMICS IN HEALTHCARE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Explain the role of Human Factors and Ergonomics (HFE) in improving patient safety in healthcare settings. | CO1 | U | 8 |
|  | b. | Explain the role of Human Factors and Ergonomics (HFE) in improving patient safety in healthcare settings | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | **Discuss the concept of Human System Reliability and its importance in healthcare.** | CO2 | An | 8 |
|  | b. | Explain the concept of Human System Reliability. Discuss its importance, factors influencing it, and methods to improve reliability in human–machine systems. | CO2 | An | 8 |
|  |  |  |  |  |  |
| 3. | a. | Implement the concept and importance of Applied Anthropometry in healthcare and ergonomics. | CO3 | A | 8 |
|  | b. | Implement the importance of workplace design for healthcare workers. Discuss the key ergonomic and human factors principles that influence effective workplace design in healthcare settings. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 4. | a. | Explain the concept of Physical Stress and Fatigue Measurement. Discuss the methods used to measure physical stress and fatigue in the workplace and their importance in ergonomics and occupational health. | CO4 | R | 8 |
|  | b. | Explain the role of Deep Learning in the analysis of Electromyography (EMG) and Electroencephalography (EEG) signals. Discuss its applications, advantages, and challenges in biomedical signal processing. | CO4 | R | 8 |
|  |  |  |  |  |  |
| 5. | a. | Explain the concept of Risk Management for Medical Products and discuss its importance, process, and regulatory aspects in ensuring patient safety. | CO5 | R | 8 |
|  | b. | Explain the concept of Cognitive Work Analysis (CWA) and discuss its application in healthcare systems for improving safety, efficiency, and decision-making. | CO5 | R | 8 |
|  |  |  |  |  |  |
| 6. | a. | Discuss the various assessment and evaluation tools used for diagnosing and managing Musculoskeletal Disorders (MSDs). Explain their importance, methods, and applications in occupational and healthcare settings. | CO4 | U | 8 |
|  | b. | Explain the concept of Measurement System Design in healthcare. Discuss its components, principles, and applications in improving healthcare quality and safety. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Investigate the concept of Primary Care Ergonomics and discuss its importance in enhancing healthcare delivery and worker well-being. | CO6 | C | 8 |
|  | b. | Investigate the concept of Medication Safety and Ergonomics and discuss how ergonomic principles can enhance medication safety in healthcare settings. | CO6 | C | 8 |
| **PART – B** **(1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Evaluate the role and importance of ergonomics in the Emergency Department (ED). Explain how ergonomic principles can improve safety, efficiency, and well-being for both healthcare providers and patients. | CO6 | E | 10 |
|  | b. | Evaluate the role of infection prevention and ergonomics in healthcare. How can integrating ergonomic principles enhance infection control practices, and what strategies can be implemented to ensure both patient and healthcare worker safety? | CO6 | E | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Identify the problems in posture and work efficiency |
| CO2 | Classify the workspace and related systems |
| CO3 | Choose signal processing techniques for analysis and feature extraction |
| CO4 | Relate the anthropometric concepts to human system and environment |
| CO5 | Assess the methodologies in measurement system and conditions |
| CO6 | Construct instrumentation techniques for development of user friendly system |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3022** | **Duration** | **3hrs** |
| **Course Title** | **MEDICAL ETHICS AND SAFETY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Classify the different types of reliability failures in medical devices, giving suitable examples for each. | CO1 | An | 8 |
|  | b. | Evaluate the role of safety testing in improving medical device reliability and preventing patient harm. | CO1 | E | 8 |
|  |  |  |  |  |  |
| 2. | a. | Apply safety handling principles to avoid usability errors in clinical environments such as ICUs or ambulances | CO2 | A | 9 |
|  | b. | Examine the environmental safety issues arising from interference and impact of medical devices. | CO2 | An | 7 |
|  |  |  |  |  |  |
| 3. | a. | Distinguish between macroshock and microshock in terms of their mechanisms and biological consequences. | CO3 | An | 8 |
|  | b. | Evaluate leakage current limits in medical devices and justify their necessity for patient safety. | CO3 | E | 8 |
|  |  |  |  |  |  |
| 4. | a. | Assess the importance of CE, UL and ICMED certifications in ensuring global compliance of medical devices. | CO4 | E | 10 |
|  | b. | Apply regulatory classification principles to categorize sample medical devices into appropriate risk classes. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 5. | a. | Analyze the moral principles such as autonomy, beneficence and justice guide ethical medical practice. | CO5 | An | 9 |
|  | b. | Evaluate complex ethical dilemmas in biomedical research using real case examples. | CO5 | E | 7 |
|  |  |  |  |  |  |
| 6. | a. | Analyze the American Medical Association (AMA) code of ethics in relation to doctor–patient responsibilities. | CO6 | An | 8 |
|  | b. | Evaluate the relevance of data analytics in medical ethics for improving healthcare outcomes. | CO6 | E | 8 |
|  |  |  |  |  |  |
| 7. | a. | Investigate how confidentiality challenges arise in digital medical records and e-health platforms. | CO5 | An | 9 |
|  | b. | Apply ethical reasoning to resolve conflicts between professional independence and societal obligations. | CO5 | A | 7 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Differentiate the ethical responsibilities of doctors toward the profession versus their responsibilities toward society, with real-world scenarios. | CO6 | C | 10 |
|  | b. | Appraise how digital health technologies influence adherence to professional independence in medical ethics. | CO6 | E | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Identify the mechanical and electrical safety standards of medical equipment. |
| CO2 | Understand device specific safety goals. |
| CO3 | Interpret reasonable, acceptable and effective remedies and counter measure. |
| CO4 | Select the clinical suitability to the impact of the device on the environment. |
| CO5 | Device more reliable medical equipment incorporating safety goals. |
| CO6 | Combine new techniques for device management. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3027** | **Duration** | **3hrs** |
| **Course Title** | **PROSTHETIC DEVICE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Examine the biomechanical modeling of artificial limbs and evaluate how joint kinematics are replicated using different mechanical actuators. | CO1 | A | 10 |
|  | b. | Assess the challenges in human machine interfacing for upper-limb prosthetic control and propose strategies to overcome them. | CO1 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Compare the degrees of freedom in human limbs with their mechanical equivalents in prosthetic systems and interpret their functional implications. | CO1 | An | 15 |
|  | b. | Classify prosthetic limbs and evaluate their functional differences. | CO1 | An | 5 |
|  |  |  |  |  |  |
| 3. |  | Explain the working principles of myoelectric sensors and assess their contribution to controlling prosthetic limbs | CO2 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Illustrate the concept of sensor fusion and evaluate its effectiveness in improving accuracy and reliability in prosthetic motion control. | CO2 | A | 10 |
|  | b. | Assess the limitations of conventional sensor designs and suggest improvements for next-generation prosthetic interfaces. | CO2 | E | 10 |
|  |  |  |  |  |  |
| 5. | a. | Summarize the application of gait analysis in designing intelligent lower-limb prosthetics. | CO4 | E | 10 |
|  | b. | Evaluate trajectory tracking using electric actuators and identify the challenges in real-time prosthetic control. | CO3 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Interpret the use of non-linear control strategies in prosthetic motion systems with an example. | CO3 | A | 10 |
|  | b. | Compare and contrast open-loop and closed-loop control systems in prosthetic motion applications | CO4 | E | 10 |
|  |  |  |  |  |  |
| 7. | a. | Illustrate various prosthetic fabrication techniques and evaluate their impact on mechanical performance. | CO5 | A | 10 |
|  | b. | Assess how feedback sensors contribute to stability and balance in powered prosthetic legs. | CO5 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Summarize the role of computer-aided design (CAD) and simulation tools in testing prosthetic components. | CO5 | E | 10 |
|  | b. | Evaluate the ethical, clinical, and technical challenges in deploying AI-enabled prosthetic devices. | CO5 | An | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Discuss the key design considerations involved in developing upper-limb prostheses and explain their implications with relevant examples. | CO6 | A | 10 |
| b | Explain the design factors influencing lower-limb prostheses and illustrate how these considerations impact functionality with examples. | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Understand challenges and scope of artificial limbs to human. |
| CO2 | Design sensors and control systems for positioning and movement. |
| CO3 | Learn the basic of actuators and applications. |
| CO4 | Apply material fabrication and testing. |
| CO5 | Develop applications and assistive devices for limb. |
| CO6 | Implement and analyze medical device regulations. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21BM3028** | **Duration** | **3hrs** |
| **Course Title** | **ARTIFICIAL INTELLIGENCE IN HEALTHCARE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Apply the behavioral characteristics of intelligent agents to design an intelligent healthcare monitoring system. | CO1 | A | 10 |
|  | b. | Analyze the problem-solving approach of AI to identify how it addresses critical healthcare challenges. | CO1 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Apply heuristic and informed search strategies to optimize medical diagnosis and treatment planning. | CO2 | A | 10 |
|  | b. | Evaluate the performance of local search algorithms in solving healthcare optimization problems. | CO2 | E | 10 |
|  |  |  |  |  |  |
| 3. | a. | Construct a decision tree model for disease prediction using patient medical records. | CO3 | A | 10 |
|  | b. | Analyze the effectiveness of reinforcement learning techniques in medical diagnosis applications. | CO3 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Apply first-order predicate logic to represent medical facts and relationships for automated reasoning. | CO4 | A | 10 |
|  | b. | Evaluate the performance of forward and backward chaining techniques in clinical decision support systems. | CO4 | E | 10 |
|  |  |  |  |  |  |
| 5. | a. | Design a multi-agent system to facilitate communication and negotiation in hospital networks. | CO5 | C | 10 |
|  | b. | Assess the role of trust and reputation mechanisms in maintaining data integrity in healthcare agent systems. | CO5 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Develop an AI-based robotic control system for precision surgical procedures. | CO6 | C | 10 |
|  | b. | Analyze how AI perception and planning algorithms improve medical imaging accuracy. | CO6 | An | 10 |
|  |  |  |  |  |  |
| 7. | a. | Evaluate the reasoning efficiency of ontological engineering techniques used in healthcare diagnosis. | CO4 | E | 10 |
|  | b. | Design a Prolog-based medical expert system to support diagnostic reasoning. | CO4 | C | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Analyze the effectiveness of AI intelligent agents in solving real-time healthcare monitoring issues. | CO1 | An | 10 |
|  | b. | Develop an AI-driven simulation model to assist doctors in emergency medical decision-making. | CO1 | C | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Design an AI-enabled robotic system for automated blood pressure control. | CO6 | C | 10 |
|  | b. | Evaluate the contribution of speech recognition systems to enhancing healthcare accessibility. | CO6 | E | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the basics of Artificial Intelligence. |
| CO2 | Summarize the appropriate search algorithms for medical problem, |
| CO3 | Represent a problem using behavioral logics. |
| CO4 | Apply AI problem solving techniques |
| CO5 | Develop simple intelligent system for medical diagnosis |
| CO6 | Application development for healthcare problems in society |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2001** | **Duration** | **3hrs** |
| **Course Title** | **BIOSIGNAL PROCESSING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Through sampling, a \_\_\_\_\_\_\_\_\_-time signal is converted into a \_\_\_\_\_\_\_\_\_ time signal. | | CO1 | U | 1 |
| 2. | Define Fourier Transform. | | CO1 | R | 1 |
| 3. | Justify choosing poles on the left side of the S-plane while designing a Butterworth filter. | | CO2 | R | 1 |
| 4. | What is the mapping relation between s and z in the impulse invariant method? | | CO2 | R | 1 |
| 5. | Write the characteristic features of rectangular window. | | CO3 | U | 1 |
| 6. | Define the term "frequency response" of a filter. | | CO3 | R | 1 |
| 7. | Name one adaptive filtering algorithm used for removing artifacts in ECG signals. | | CO4 | U | 1 |
| 8. | What does the P-wave in an ECG represent? | | CO4 | R | 1 |
| 9. | Name one method for event detection in an ECG wave | | CO5 | U | 1 |
| 10. | Which interval on the ECG represents ventricular depolarization and repolarization? | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Analyze why anti-aliasing filters are essential before sampling a biosignal. | | CO1 | An | 3 |
| 12. | Compare the digital and analog filter in terms of its application in signals. | | CO2 | U | 3 |
| 13. | Analyze the advantages of IIR filters over FIR filters in real-time biomedical applications. | | CO3 | U | 3 |
| 14. | Describe the role of adaptive noise cancellation in removing noise from ECG signals. | | CO4 | U | 3 |
| 15. | List the QRS detection algorithms and mention its significance | | CO5 | U | 3 |
| 16. | Describe the role of EMG in assessing neuromuscular disorders. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No 17 to 23, Q. No 24 is Compulsory)** | | | | | |
| 17. |  | **Using the Decimation-in-Frequency FFT (DIF-FFT) algorithm, find the 8-point DFT of the sequence:** x(n)={4,  0,  2,  0,  4,  0,  2,  0}. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Design a Butterworth digital IIR low pass filter using bilinear transformation by taking T =0.1 second, to satisfy the following specifications.    . | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the impulse Invariant transformation method for converting an analog filter to a digital filter. Apply the transformation formula to convert an analog low-pass filter with the transfer function Ha​(s)=3**/**(s+0.5)(s+3)​ into its digital equivalent with T=1 Sec. | CO3 | A | 6 |
|  | b. | Differentiate Butterworth and Chebyshev Filters | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | **Demonstrate** the use of an adaptive filter in removing noise from a signal, and compare its performance to a fixed filter. | CO3 | A | 8 |
|  | b | Discuss the design steps of Butterworth low-pass digital filters using Bilinear Transformation. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 21. | a. | Describe the signal characteristics of EMG waveform | CO5 | R | 4 |
|  | b. | Deduce the Pan Tompkins method for QRS complex detection in Electrocardiogram | CO5 | An | 8 |
|  |  |  |  |  |  |
| 22. | a. | **Describe** the common types of artifacts encountered in ECG recordings and how noise cancellation is achieved in removing Maternal interference in fetal ECG. | CO4 | An | 8 |
|  | b. | **Explain the relationship between heart sounds in a phonocardiogram and the phases of the cardiac cycle.** | CO6 | U | 4 |
|  |  |  |  |  |  |
| 23. |  | Design a linear phase FIR low pass filter using rectangular window by taking 7 samples of window sequence and with a cutoff frequency, Wc = 0.2π rad/sample. | CO3 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | For an EEG of an abnormal brain condition, describe the various blocks of signal processing units used to detect the patient’s condition. | CO6 | An | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the fundamentals of signal processing |
| CO2 | Identify the effect of IIR Digital filter design |
| CO3 | Illustrate the various applications of IIR filter |
| CO4 | Discuss about the FIR Filter design and applications |
| CO5 | Show the various methods to analyze biosignals |
| CO6 | Explain the biosignal processing concepts for real time applications |

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**END SEMESTER EXAMINATION – NOV/ DEC 2025**

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| **Course Code** | **22BM2006** | **Duration** | **3hrs** |
| **Course Title** | **BIOMATERIALS AND ARTIFICIAL ORGANS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Name the material which is widely used for load bearing implants. | | CO1 | R | 1 |
| 2. | Give examples for common crystalline metals used in healthcare. | | CO1 | U | 1 |
| 3. | Identify the second stage of wound healing process. | | CO2 | R | 1 |
| 4. | List the types of cell-material interaction. | | CO2 | R | 1 |
| 5. | Dialysis membrane must be \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_. | | CO3 | R | 1 |
| 6. | The direct contact procedure is recommended for \_\_\_\_\_\_\_\_\_\_\_\_\_ materials. | | CO3 | R | 1 |
| 7. | Name the material implanted within the body that helps to monitor the state and improve the body function. | | CO4 | R | 1 |
| 8. | Explain the area of focus of immunogenicity assays. | | CO4 | U | 1 |
| 9. | List the parts of bubble oxygenators. | | CO5 | R | 1 |
| 10. | Name the medical procedure in which a dialyzer is used. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Explain the types of biomaterials. | | CO1 | An | 3 |
| 12. | Summarize the application of radiation. | | CO2 | U | 3 |
| 13. | Analyze the most common complications associated with implantation of any biomaterial regardless of form or function. | | CO3 | An | 3 |
| 14. | Differentiate protein-based studies and relative gene-based studies. | | CO4 | U | 3 |
| 15. | List the three parts of the human ear and state one function of each. | | CO5 | R | 3 |
| 16. | Write the advantages and disadvantages of parallel plate dialyzer. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Analyze the properties of polymers in the biomaterials. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. | a. | A sports person wants to heal his wound fast. Select a non-surgical procedure and uses injections to stimulate and enhance the body’s healing. | CO2 | A | 6 |
|  | b. | Explain the surgical procedure that involves trusted source removing skin from one area of the body and moving it to a different area of the body. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. |  | Evaluate the laboratory testing which involve the exposure of substances extracted from test material to cell culture lines. | CO3 | E | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the metallic implant material along with its advantages and disadvantages. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Illustrate the working principle of bubble oxygenators. | CO5 | A | 12 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 22. | a. | Explain the two major mediators for sound conduction to the inner ear. | CO5 | An | 8 |
|  | b. | Sketch the functional block diagram of an audiometer. | CO5 | A | 4 |
|  |  |  |  |  |  |
| 23. |  | Explain the role of immune cells in the biological response to biomaterials. | CO1 | An | 12 |
|  |  |  |  |  |  |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Illustrate the function of hemodialysis machine and its types. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Identify and know the structural variations in biomaterials. |
| **CO2** | Determine and classify the various properties of biomaterials. |
| **CO3** | Explain the methods for testing implants with different aspects of biomaterials. |
| **CO4** | Recall the cell-biomaterial interactions for constructing artificial organs. |
| **CO5** | Assess the Interfacing materials and ethical implications. |
| **CO6** | Apply the biomaterials in healthcare sectors. |



**END SEMESTER EXAMINATION – NOV/DEC 2025**

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| **Course Code** | **22BM2014** | **Duration** | **3hrs** |
| **Course Title** | **SIGNALS AND SYSTEMS FOR BIOMEDICAL ENGINEERS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Analog signals are also known as \_\_\_\_\_\_\_\_\_\_ signals | | CO1 | U | 1 |
| 2. | Justify the importance of a proper sampling frequency. | | CO1 | R | 1 |
| 3. | State the formula for trigonometric Fourier series expansion | | CO2 | R | 1 |
| 4. | How do you term a signal periodic? | | CO2 | R | 1 |
| 5. | State the transform applied for non-stationary signals | | CO3 | U | 1 |
| 6. | The window used in Gabor Transform is based \_\_\_\_\_\_\_\_\_ function | | CO3 | R | 1 |
| 7. | State one property of the Region of Convergence in terms of Laplace Transform. | | CO4 | U | 1 |
| 8. | Substantiate for linearity property of Laplace Transform. | | CO4 | R | 1 |
| 9. | List two methods of finding Inverse Z-Transform | | CO5 | U | 1 |
| 10. | A 3-D view of the transformed signal is known as \_\_\_\_\_\_\_\_\_\_ | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate causal and anti-causal signals | | CO1 | U | 3 |
| 12. | Give substantiation for Discrete Time Inverse Fourier Transform in signal analysis | | CO2 | U | 3 |
| 13. | List three applications of Joint Time Frequency Analysis. | | CO3 | R | 3 |
| 14. | Sketch the ROC of the following  X(z)= 3/1−3𝑧−1 | | CO4 | U | 3 |
| 15. | Define Z Transform. What are its applications? | | CO5 | U | 3 |
| 16. | List the properties of Physiological Systems | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Discuss about the various operations on signals with proper illustrations | CO1 | R | 6 |
|  | b. | Discuss in detail about the classification of systems | CO1 | R | 6 |
|  |  |  |  |  |  |
| 18. | a. | Find the Fourier Transform of the following  i) x(t)= 𝑡2𝑒−4t𝑢(𝑡)  ii) x(t)= 𝑒−2t𝑢(𝑡−4) | CO2 | A | 8 |
|  | b. | Find the Fourier Series for the periodic signal with the function  } | CO2 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | Explain the Wavelet transform with proper substantiation for the distribution of JTF | CO3 | An | 6 |
|  | b. | Illustrate and explain how joint time-frequency analysis is applied to heart sounds to detect valve pathologies inside the heart | CO3 | An | 6 |
|  |  |  |  |  |  |
| 20. | a. | Given x(t)=e−tu(t), find the inverse Laplace Transform of e−3sX(2s). | CO4 | A | 6 |
|  | b. | List the properties of the Region of Convergence in Laplace Transform. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | If the given signal is anti-causal find the Inverse z Transform of the following using long division method | CO5 | A | 6 |
|  | b. | Find the Inverse z Transform of the following using partial fraction method | CO5 | A | 6 |
|  |  |  |  |  |  |
| 22. |  | Compute the Fourier series of the function  where the fundamental period is 2π | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Find the Cosine Fourier series for the periodic signal given below | CO2 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss about the Physical Factors Determining the Dynamic Behavior of Physiological Signal. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Identify the nature of biomedical signals |
| **CO2** | Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier analysis |
| **CO3** | Classify systems based on their properties and determine the response of LTI system using Laplace transform |
| **CO4** | Apply Laplace transform and Z- transform to analyze continuous-time and discrete-time signals and systems |
| **CO5** | Summarize system properties based on impulse response by FIR, IIR filtering techniques |
| **CO6** | Demonstrate mathematical tools in characterization of physiological system |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2019** | **Duration** | **3hrs** |
| **Course Title** | **HUMAN ANATOMY AND PHYSIOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Identify two organelles of human cell. | | CO1 | R | 1 |
| 2. | State the types of tissues. | | CO1 | R | 1 |
| 3. | Identify the major bones in the human skeletal system. | | CO2 | R | 1 |
| 4. | Describe the role of cartilage in joint function. | | CO2 | U | 1 |
| 5. | Identify the primary organs involved in the respiratory system. | | CO3 | R | 1 |
| 6. | Explain the function of alveoli in gas exchange. | | CO3 | U | 1 |
| 7. | Classify the types of blood groups. | | CO4 | U | 1 |
| 8. | Identify the two special senses in the human body | | CO4 | R | 1 |
| 9. | Describe the function of the cornea in focusing light. | | CO5 | U | 1 |
| 10. | Identify the function of the synapse. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Describe the structure and function of the cell membrane. | | CO1 | R | 3 |
| 12. | Differentiate between compact bone and spongy bone. | | CO2 | U | 3 |
| 13. | Explain the inspiration phase of respiration. | | CO3 | U | 3 |
| 14. | Classify blood vessels based on their functions and structure. | | CO4 | U | 3 |
| 15. | Analyze the functions of the urinary system. | | CO5 | An | 3 |
| 16. | Label a typical neuron. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the transport mechanism across cell membrane. | CO1 | A | 6 |
|  | b. | Describe the types and functions of tissues in the human body. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Differentiate between the types of joints with physiological significance. | CO2 | U | 6 |
|  | b. | Construct a labeled diagram showing the major bones of the human body. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Explain the mechanism of acid-base regulation in the body. | CO3 | U | 6 |
|  | b. | Describe the process of oxygen and carbon dioxide transport in blood. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | Describe the structure and functioning of the heart with a neat diagram. | CO4 | U | 6 |
|  | b. | Explain the cardiac cycle and the conduction system of the heart. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | Summarize the pathway that light follows from entering the eye to being processed in the brain. | CO5 | U | 6 |
|  | b. | Differentiate between myopia and hyperopia with their causes. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Relate heart sounds with the opening and closing of heart valves. | CO4 | A | 6 |
|  | b. | Evaluate the conversion of sound waves into nerve impulses in the ear. | CO5 | E | 6 |
|  |  |  |  |  |  |
| 23. | a. | Analyze the electrical activity of the brain using EEG. | CO6 | An | 6 |
|  | b. | Describe the functions of endocrine glands in hormone regulation. | CO1 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the structure of a neuron with its functions. | CO6 | U | 6 |
|  | b. | Analyze the roles of the sympathetic and parasympathetic divisions of the autonomic nervous system. | CO6 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| **CO1** | Recall the basic elements of human body. |
| **CO2** | Compare the major bones and their processes as they relate to each region of the body. |
| **CO3** | Interpret the major organs and components of the respiratory system and understand their functions. |
| **CO4** | Recognize the major organs and vessels of the cardiovascular system and understand their functions. |
| **CO5** | Summarize the basic components and functions of urinary and special sensing systems. |
| **CO6** | Demonstrate the structure and functions of nervous system. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2021** | **Duration** | **3hrs** |
| **Course Title** | **BIOMEDICAL SENSORS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART-A(10X1=10 MARKS)** | | | | | |
| 1. | Compute the capacitance of a parallel plate capacitive transducer having plate area 4 m² and separation 2 m, if the permittivity of air is 8.85 × 10⁻¹² F/m. | | CO 2 | An | 1 |
| 2. | Find the sensitivity (mV/°C) of a thermocouple that shows an output change of 2 V for a temperature rise of 0.5 °C. | | CO 1 | A | 1 |
| 3. | State how precision and accuracy influence the evaluation of static characteristics of a measurement system. | | CO 4 | U | 1 |
| 4. | Identify two common metals used in electrode fabrication. | | CO 5 | R | 1 |
| 5. | State the different categories of biosensors based on the type of biorecognition element used. | | CO 6 | R | 1 |
| 6. | When the core of an LVDT is positioned at the null point, what will be the resulting output voltage? | | CO 1 | R | 1 |
| 7. | Which among the following are undesirable static characteristics in measurement systems: (a) Sensitivity and accuracy (b) Drift, static error, and dead zone (c) Reproducibility and non-linearity  (d) Drift, static error, dead zone, and non-linearity | | CO 1 | A | 1 |
| 8. | List the types of synthetic or biological capture agents utilized in affinity-based biosensors for specific target recognition. | | CO 3 | U | 1 |
| 9. | Where are Pacinian corpuscles, a type of mechanoreceptor, located in the human body? | | CO 5 | R | 1 |
| 10. | Specify the approximate resistance range exhibited by dry human skin. | | CO 4 | R | 1 |
| **PART B (6 X 3= 18 MARKS)** | | | | | |
| 11. | Illustrate the working principle of an ultrasonic sensor used in biomedical applications. | | CO 1 | U | 3 |
| 12. | Define baroreceptors and mention their physiological role. | | CO 2 | R | 3 |
| 13. | A parallel plate capacitive transducer is used to measure linear displacement. Initially, the plate separation is 5 mm, and the capacitance is 100 pF. If the displacement reduces the gap by 1 mm, analyze how the capacitance changes and calculate the percentage variation in capacitance. Assume air as the dielectric medium. | | CO 5 | U | 3 |
| 14. | Interpret the roles of rods and cones in human vision | | CO 6 | A | 3 |
| 15. | Define rise time and explain its significance in sensor response. | | CO 4 | U | 3 |
| 16. | Compare J-type and K-type thermocouples in terms of material composition and temperature range. | | CO 3 | U | 3 |
| **PART C (6 X 12= 60 MARKS)**  **(Answer any five Questions from Q.no 17 to 23. Q.No 24 is a Compulsory Question)** | | | | | |
| 17. | a. | Describe the components of a Medical Instrumentation system with necessary diagrams. | CO 2 | R | 8 |
|  | b. | Elaborate on any four static charcateristics of sensor. | CO2 | U | 4 |
| 18. |  | Discuss, how resistance based sensors are used in measuring heat and light. | CO 1 | U | 12 |
| 19. | a. | Elaborate on any two types of displacement measurement systems. | CO1 | U | 8 |
|  | b | Differentiate J-type thermocouples from K-type thermocouples. | CO3 | U | 4 |
| 20. |  | Analyze the use of pressure sensor in blood pressure measurement and explain the analog and digital method of Blood Pressure measurement. | CO 3 | U | 12 |
| 21. |  | Explain how LEDs’ and LASERs’ are modified as fiber optic source. | CO 4 | U | 12 |
| 22. | a. | Describe how electrochemical type bio sensor is used in detecting blood glucose. | CO 3 | A | 8 |
|  | b. | Brief on biomedical applications of Ultrasound sensor | CO 4 | A | 4 |
| 23. |  | Elaborate on half cell potential and the types of elctrodes used in acquiring bio-potentials. | CO6 | A | 12 |
|  |  | **COMPULSORY** | | | |
| 24. | a. | Explain about the receptors present in human body to sense pressure and comprehend how a pressure stimuli is sensed. | CO5 | An | 8 |
|  | b. | Schematically represent the sensory pathway. | CO5 | A | 4 |

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

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|  | **COURSE OUTCOMES** |
| CO1 | Identify the need of a closed loop system with feedback and appreciate the use of sensors. |
| CO2 | Interpret the errors in measurement by analyzing the performance characteristics of the sensors. |
| CO3 | Develop advanced medical sensors based on the basic transduction principles. |
| CO4 | Demonstrate the advanced sensor approach based on light and sound |
| CO5 | Apply the suitable design criteria for developing a medical sensor for a particular application. |
| CO6 | Summarize the use of electrodes in measuring electrical potential in human body |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2025** | **Duration** | **3hrs** |
| **Course Title** | **DIGITAL ELECTRONICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Which number system has a base of 16 | | CO1 | U | 1 |
| 2. | What is the De- Morgan’s first Theorem | | CO1 | R | 1 |
| 3. | Odd parity of word can be conveniently tested by \_\_\_\_\_ | | CO2 | R | 1 |
| 4. | The time required for a gate or inverter to change its state is called \_\_\_\_ | | CO2 | R | 1 |
| 5. | How many full adders are required to construct an m-bit parallel adder? | | CO3 | U | 1 |
| 6. | What is a multiplexer? | | CO3 | R | 1 |
| 7. | In the T Flip-Flop, what does T stand for? | | CO4 | U | 1 |
| 8. | What will be the output from a D flip – flop if the clock is low and D = 0 | | CO4 | R | 1 |
| 9. | How much storage capacity does each stage in a shift register represent? | | CO4 | U | 1 |
| 10. | What are the basic gates in MOS logic family? | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Reduce the expression ABC+ABC using Boolean theorems. | | CO2 | An | 3 |
| 12. | Show how to connect NAND gates to get an AND gate and OR gate? | | CO2 | U | 3 |
| 13. | Analyze the principle and design of Parallel binary adder | | CO3 | An | 3 |
| 14. | Write about the operations of JK flip flops | | CO4 | U | 3 |
| 15. | Write short notes on Asynchronous Counters | | CO4 | An | 3 |
| 16. | List the types of PLDs and explain the architecture of PLAs | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No. 17 to 23, Q.No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain briefly about SOP and POS Canonical Forms with example | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. | a. | Write about Excess 3 and Gray Code with an example | CO2 | R | 6 |
|  | b. | Explain about Karnaugh map Don’t care conditions | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. |  | Propose the combinational circuit for a half adder and half sub tractor | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the working of SR and JK flip-flops with logic symbols, truth tables, characteristic equations | CO4 | R | 12 |
|  |  |  |  |  |  |
| 21. |  | Describe the operation of universal shift register with neat block diagram. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain the characteristics and implementation of the CMOS digital logic families | CO6 | R | 6 |
|  | b. | Explain the characteristics and implementation of the ECL digital logic families | CO6 | R | 6 |
|  |  |  |  |  |  |
| 23. |  | Differentiate asynchronous and synchronous type counters | CO5 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Elaborate the operation of PROM in detail | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL**M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Compute the Number System Conversions |
| CO2 | SimplifytheBooleanExpressionUsingVariousSimplificationTechniques |
| CO3 | Design various Combinational Circuits |
| CO4 | Simulate various Sequential Circuits |
| CO5 | Implement Combinational Circuits Using PLD |
| CO6 | Analyze Different Digital Logic Families |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2027** | **Duration** | **3hrs** |
| **Course Title** | **MEDICAL DIAGNOSTIC AND THERAPEUTIC EQUIPMENT II** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | List the physiological parameters commonly monitored using a multiparameter monitor. | | CO1 | R | 1 |
| 2. | State the principle of spectrophotometer. | | CO1 | R | 1 |
| 3. | List the sedative agents used in anesthesia machine. | | CO2 | R | 1 |
| 4. | Quote the types of dialyzers. | | CO2 | R | 1 |
| 5. | Identify the types of infrared sources used in physiotherapy. | | CO3 | U | 1 |
| 6. | State the significance of shock waves. | | CO3 | R | 1 |
| 7. | Define spontaneous emission. | | CO4 | R | 1 |
| 8. | Indicate the significance of ophthalmoscope. | | CO4 | U | 1 |
| 9. | Explain cryogenic therapy. | | CO5 | U | 1 |
| 10. | Explain the purpose of an arthroscope in medical practice. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | State the significance of Holter monitor. | | CO1 | R | 3 |
| 12. | Justify the need of vaporizer and flowmeter in anesthesia machine. | | CO2 | E | 3 |
| 13. | Compare fistula with graft in dialysis. | | CO3 | An | 3 |
| 14. | Enumerate the therapeutic use of ultrasonic therapy. | | CO4 | R | 3 |
| 15. | Indicate the significance of biofeedback instrumentation. | | CO5 | U | 3 |
| 16. | Justify the need for infusion and syringe pumps in clinical practice. | | CO6 | E | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Analyze the interaction of different components of a mixture with the stationary and mobile phases to achieve separation in chromatography. | CO1 | An | 9 |
|  | b. | Evaluate the feasibility of using non-invasive spectroscopic methods for hemoglobin estimation compared to invasive optical methods. | CO1 | E | 3 |
|  |  |  |  |  |  |
| 18. | a. | Illustrate the working principle of boyle’s machine with a neat diagram. | CO2 | A | 8 |
|  | b. | Illustrate the use of Entonox apparatus in safely, ensuring proper administration of medical gases. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | Interpret the clinical functioning of Hemodialysis machine. | CO3 | A | 8 |
|  | b. | Relate hemodialysis and peritoneal dialysis. | CO3 | An | 4 |
|  |  |  |  |  |  |
| 20. | a. | Assess the effectiveness of shortwave diathermy in managing musculoskeletal disorders, considering factors like patient outcomes and treatment protocols. | CO4 | E | 6 |
|  | b. | Explain the working principle of ND-YAG Laser. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | Describe an audiometric test, highlighting the equipment and environment required for accurate results. | CO5 | U | 8 |
|  | b. | Relate the types of ophthalmoscopes. | CO5 | A | 4 |
|  |  |  |  |  |  |
| 22. | a. | Explain the working principle of lithotripter with a neat sketch. | CO4 | U | 8 |
|  | b. | Identify the types of lithotripsy. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 23. | a. | Examine the working mechanism of the tonometer, emphasizing pressure readings. | CO5 | A | 8 |
|  | b. | Evaluate the usage of implantable infusion pump in clinical settings. | CO6 | E | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Assess the significance of endoscopy in modern medicine. | CO6 | E | 8 |
|  | b. | Compare SXA with DXA. | CO6 | An | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Describe the principle involved in clinical and optical equipment |
| **CO2** | Identify the various therapeutic devices for pulmonary diseases. |
| **CO3** | Apply the appropriate therapeutic device related to kidney ailment. |
| **CO4** | Demonstrate the functions and applications of electrotherapy and lasers |
| **CO5** | Assess the merits and demerits of the diagnostic equipment for basic senses. |
| **CO6** | Design new therapeutic devices for application based on given specifications |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2028** | **Duration** | **3hrs** |
| **Course Title** | **VIRTUAL INSTRUMENTATION FOR BIOMEDICAL ENGINEERS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Interpret data execution order in data flow programming. | | CO1 | U | 1 |
| 2. | Define polymorphism. | | CO1 | R | 1 |
| 3. | Recall and write the concept of data constructs. | | CO2 | R | 1 |
| 4. | Name the components in a cluster. | | CO2 | R | 1 |
| 5. | Interpret the role of obtain notifier function. | | CO3 | U | 1 |
| 6. | Identify the variable that is used to access front panel objects in several VIs. | | CO3 | R | 1 |
| 7. | List the types of error handling in VI. | | CO4 | R | 1 |
| 8. | List the advantages of state machine. | | CO4 | R | 1 |
| 9. | Interpret subVI time. | | CO5 | U | 1 |
| 10. | List the major components of a VI. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Discuss the best practices followed to maintain data flow integrity. | | CO1 | U | 3 |
| 12. | Interpret the different types of events initiated by event structure. | | CO2 | U | 3 |
| 13. | Compare and contrast TCP and UDP communication protocols. | | CO4 | U | 3 |
| 14. | Interpret the working of functional global variables. | | CO3 | U | 3 |
| 15. | Describe the user interface controls in LabVIEW. | | CO5 | U | 3 |
| 16. | Examine the importance of LabVIEW in signal processing. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain the programming practices that enforce or break data flow. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Discuss the concept of Flat and Stacked Sequence with relevant examples. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Design a VI to create a queue for displaying a sequence of medical tasks. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the steps involved in creating a sub-VI with an example. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the concept of profile memory and its performance. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Demonstrate the concept and working of for loop and while loop with relevant examples. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the user interface event handler and queued message event handler. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Design a VI for displaying and monitoring the vital parameters of human body. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Summarize the basics of LabVIEW programming |
| **CO2** | Interface with real time signals |
| **CO3** | Analyse the application of VIs in medical instrumentation in developing medical instruments |
| **CO4** | Interpret the concepts of data communication and synchronization |
| **CO5** | Perform signal processing operations using virtual instrumentation |
| **CO6** | Apply virtual instrumentation for biomedical applications |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2030** | **Duration** | **3hrs** |
| **Course Title** | **ERGONOMICS AND SPORTS BIOMECHANICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define human factors in the context of work place design. | | CO1 | R | 1 |
| 2. | Explain the cause of health risk in work place. | | CO1 | U | 1 |
| 3. | Apply ergonomic principles to suggest one improvement for a computer workstation. | | CO2 | A | 1 |
| 4. | Describe how simulation-based training supports teamwork in healthcare. | | CO2 | U | 1 |
| 5. | Infer methods to improve safety in work floor. | | CO3 | U | 1 |
| 6. | Mention the role of OSHA in improving health safety in workplace. | | CO3 | R | 1 |
| 7. | Explain how musculoskeletal injuries affect worker health. | | CO4 | R | 1 |
| 8. | List few sports activities that involve aerial movement. | | CO4 | R | 1 |
| 9. | Infer the adverse effects of poor lighting conditions in working area. | | CO5 | U | 1 |
| 10. | Apply biomechanical principles to improve take-off efficiency in springboard diving. | | CO5 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Infer the ergonomic posture for an efficient workplace. | | CO1 | U | 3 |
| 12. | Interpret ergonomic assessment tools to identify postural risks. | | CO1 | U | 3 |
| 13. | Mention the merits of head-up display in healthcare devices. | | CO2 | R | 3 |
| 14. | Recognize the role of ergonomist in improving work place safety. | | CO2 | R | 3 |
| 15. | Biomechanical training improves muscle strength and sports performance. Justify. | | CO3 | E | 3 |
| 16. | List the types of injuries occur during sports and methods for eliminating them. | | CO3 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Examine the physiological mechanisms leading to fatigue under repetitive tasks in industry. | CO1 | An | 6 |
|  | b. | Evaluate the prolonged static postures contribute to musculoskeletal disorders and decreased work efficiency. | CO1 | E | 6 |
|  |  |  |  |  |  |
| 18. | a. | Apply human factors principles in the design of assistive device that supports mobility. | CO2 | A | 6 |
|  | b. | Analyse the ergonomic challenges faced by elderly individuals in home care. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. |  | Evaluate the simulation-based methods for team training in surgery applications. | CO3 | E | 12 |
|  |  |  |  |  |  |
| 20. |  | Analyze muscle-strengthening activity for improving for power and flight posture in ski jumpers. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Evaluate wearable sensor technology to record biomechanical data in field-based sports training. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. | a. | Analyse biomechanical principles used to enhance sports performance. | CO5 | An | 6 |
|  | b. | List the methods of reduce injury in track and field events. | CO5 | R | 6 |
|  |  |  |  |  |  |
| 23. | a. | Evaluate the overall impact of biomedical innovations for simulation training. | CO6 | E | 6 |
|  | b. | List the advantages and limitations of traditional coaching. | CO6 | R | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Evaluate the role of real-time motion feedback systems in improving training efficiency. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Apply ergonomic principles to the creation of safer, healthier and more efficient and effective  activities in the workplace |
| CO2 | Develop appropriate control measures for ergonomic risk factors |
| CO3 | Analyze workplace according to good ergonomic principles |
| CO4 | Paraphrase biomechanics adaptations to various aspects of sports training |
| CO5 | Summarize environmental change adaptations in sports training |
| CO6 | Interpret the risks associated with adaptations |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **22BM2031** | **Duration** | **3hrs** |
| **Course Title** | **3-D PRINTING** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Which material type was primarily used in the first generation of 3D printing machines? | | CO1 | U | 1 |
| 2. | What term has recently been adopted by ASTM consensus standards to replace rapid prototyping? | | CO1 | R | 1 |
| 3. | Which file format is typically used to export CAD models for 3D printing? | | CO2 | R | 1 |
| 4. | List the post-processing step performed after a 3D printed part is fabricated. | | CO2 | R | 1 |
| 5. | Explain why metals are preferred for orthopedic implants in 3D printing. | | CO3 | U | 1 |
| 6. | Name one metal commonly used in biomedical 3D printing. | | CO3 | R | 1 |
| 7. | Describe the advantage of using Bio Build software in biomedical applications. | | CO4 | U | 1 |
| 8. | State any one type of orthopedic implant. | | CO4 | R | 1 |
| 9. | Describe the significance of topology optimization in implant design. | | CO5 | U | 1 |
| 10. | State the advantage of 3D printing in cardiovascular surgery. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Describe two significant milestones in the historical development of 3D printing and their impact on biomedical applications. | | CO1 | U | 3 |
| 12. | Explain the key differences between 3D printing and CNC machining in medical device manufacturing. | | CO2 | U | 3 |
| 13. | Explain the differences between metal and hybrid 3D printing systems and their applications in orthopedic implants. | | CO3 | U | 3 |
| 14. | Illustrate the steps involved in transforming CT or MRI scan data into a 3D printable file. | | CO4 | U | 3 |
| 15. | Analyze the advantages and limitations of using computer-based approaches in designing patient-specific scaffolds. | | CO5 | An | 3 |
| 16. | Describe how software tools assist in planning and simulating medical procedures using 3D printing. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Evaluate how 3D printing supports customization and personalization in the manufacturing of prosthetics and medical models. | CO6 | E | 6 |
|  | b. | Explain and justify how rapid prototyping helps to save time and cost in product development. Also, explain any one type of rapid prototyping process. | CO1 | E | 6 |
|  |  |  |  |  |  |
| 18. | a. | Examine the steps involved in the generic 3D printing process and analyze how each step influences the final product quality. | CO2 | An | 6 |
|  | b. | Analyze the relationship between computer-aided design (CAD) tools and 3D printing performance in modern product development. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. | a. | Discuss about the Stereolithography (SLA) or Fused Deposition Modelling (FDM) in terms of their practical biomedical applications with sketch. | CO4 | E | 6 |
|  | b. | Describe the important milestones in 3D printing and explain how they have influenced biomedical applications worldwide. | CO3 | E | 6 |
|  |  |  |  |  |  |
| 20. | a. | Describe the advantages and limitations of combining CAD and 3D printing for planning complex dental implant procedures. | CO4 | A | 6 |
|  | b. | Describe the practical advantages of using BioBuild in planning patient-specific implants and one potential limitation of the software. | C03 | A | 6 |
|  |  |  |  |  |  |
| 21. | a. | Assess how future enhancements in BioBuild software could improve the printing of complex implants with integrated moving parts. | CO5 | E | 6 |
|  | b. | Explain how scaffold-based tissue engineering can be integrated with 3D printing to design orthopedic implants containing moving parts without assembly. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | Explain the importance of 3D visualization and RP file generation in 3D printing for manufacturing orthopedic implants. | CO1 | U | 6 |
|  | b. | Evaluate the unique advantages of 3D printing in creating patient-specific implants compared to traditional manufacturing methods. | CO6 | E | 6 |
|  |  |  |  |  |  |
| 23. | a. | Differentiate and analyze 3D printing and CNC machining with a simple labeled illustration. | CO2 | U | 6 |
|  | b. | Explain the advantages and limitations of past, present, and future 3D printing technologies. | CO1 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain how image processing and build orientation optimization contribute to better mechanical performance of 3D printed implants. | CO6 | A | 6 |
|  | b. | Evaluate the overall benefits and limitations of using BioBuild workflow for producing patient-specific 3D printed medical devices. | CO6 | E | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Understand the importance of 3D printing in Manufacturing |
| **CO2** | Design and document their design process |
| **CO3** | Identify how technology shifts throughout history have made 3D printing possible |
| **CO4** | Describe the advantages and limitations of each 3D printing technology |
| **CO5** | Design and print objects containing moving parts without assembly. |
| **CO6** | Evaluate the unique advantages of 3D printing to their designs. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23BM2004** | **Duration** | **3hrs** |
| **Course Title** | **ICU AND OPERATION THEATRE EQUIPMENT** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define abscess. | | CO1 | R | 1 |
| 2. | Name one advantage of robotic surgery. | | CO1 | R | 1 |
| 3. | What is CSSD? | | CO2 | R | 1 |
| 4. | Mention one chemical used for sterilization. | | CO2 | R | 1 |
| 5. | What is the function of a haemodialysis machine? | | CO3 | R | 1 |
| 6. | List the parameters measured by a multipara monitor. | | CO3 | R | 1 |
| 7. | What is the purpose of surgical diathermy? | | CO4 | R | 1 |
| 8. | What is the function of an intra-aortic balloon pump? | | CO4 | R | 1 |
| 9. | What is the standard color code for oxygen gas pipeline? | | CO5 | R | 1 |
| 10. | Define electrical hazard. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Illustrate the different types of suture materials used in surgery. | | CO1 | U | 3 |
| 12. | Differentiate between disinfection and sterilization. | | CO2 | U | 3 |
| 13. | Write a short note on dialyzers and membranes. | | CO3 | U | 3 |
| 14. | Summarize about cryosurgery and mention its applications. | | CO4 | U | 3 |
| 15. | Write short notes on centralized oxygen supply. | | CO5 | U | 3 |
| 16. | Define leakage current. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Identify the different types of wounds and explain their healing process. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. | a. | Conclude the layout and functions of Central Sterile Supply Department (CSSD). | CO2 | E | 8 |
|  | b. | Outline the working principle and clinical importance of an ABG machine. | CO2 | E | 4 |
|  |  |  |  |  |  |
| 19. |  | Explain the working of a haemodialysis machine with neat diagram. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Analyze the role of Boyle’s apparatus mechanisms in maintaining artificial circulation and respiration in a heart–lung machine. | CO4 | An | 9 |
|  | b. | List the various operation theatre equipment used in cardiac surgery. | CO4 | An | 3 |
|  |  |  |  |  |  |
| 21. | a. | Explain the different gases used in centralized systems and their applications. | CO5 | U | 6 |
|  | b. | Describe the components and functioning of centralized air supply and suction systems. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 22. |  | Analyze the various electrical hazards encountered in hospital environments and evaluate the methods used to protect patients and healthcare personnel. | CO6 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain in detail about the heart-lung machine and its clinical applications. | CO4 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain various sterilization techniques used in hospitals. | CO2 | U | 8 |
|  | b. | Summarize the importance of Biomedical Waste Management. | CO2 | U | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Choose suitable surgical materials, decontamination method and management. |
| **CO2** | Design new monitoring devices for ICU. |
| **CO3** | Assess the importance of critical care equipment based on their applications. |
| **CO4** | Analyse the merits of the operation theatre equipment based on its applications. |
| **CO5** | Compare the various techniques and trends used in clinical diagnosis, therapy and surgery. |
| **CO6** | Apply the knowledge acquired on patient safety in hospital premises. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23BM3001** | **Duration** | **3hrs** |
| **Course Title** | **MEDICAL INSTRUMENTATION DESIGN** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Differentiate the roles of the atria and ventricles in the cardiovascular system and the functioning of the valves to ensure unidirectional blood flow. | CO1 | An | 8 |
|  | b. | Explain how blood flows through the pulmonary and systemic circuits of the body. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 2. | a. | Assess the suitability of various bio-electrodes like surface, needle, and microelectrodes for recording different physiological signals | CO2 | E | 9 |
|  | b. | Examine the equivalent circuit of the electrode–electrolyte interface and discuss how half-cell potential influences signal acquisition. | CO2 | An | 7 |
|  |  |  |  |  |  |
| 3. | a. | Illustrate the functional blocks of an EEG amplifier system and the design parameters such as CMRR and bandwidth affect performance. | CO3 | A | 10 |
|  | b. | Judge the effectiveness of wireless EEG technology for neurological monitoring compared with conventional wired systems. | CO3 | E | 6 |
|  |  |  |  |  |  |
| 4. | a. | Assess the sensor selection and design considerations of a digital blood pressure monitoring system with reference to accuracy and user comfort. | CO4 | An | 8 |
|  | b. | Assess the principle of Doppler effect in enabling ultrasonic flow meters to measure the velocity of blood within vessels. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 5. | a. | Propose a design for a smart cardiac pacemaker system that adapts pacing rate based on real-time physiological feedback. | CO5 | C | 9 |
|  | b. | Appraise the diagnostic significance of treadmill testing and phonocardiography in detecting cardiac abnormalities. | CO5 | E | 7 |
|  |  |  |  |  |  |
| 6. | a. | Employ the concept of resting and action potentials to explain how depolarization and repolarization generate measurable bio-potentials. | CO2 | A | 9 |
|  | b. | Analyze the differences between ECG, EEG, and EMG signals based on their source, amplitude, and frequency components. | CO2 | An | 7 |
|  |  |  |  |  |  |
| 7. | a. | Design a block diagram of a Wireless EEG system, detailing the signal acquisition, amplification, filtering, and wireless data transmission stages. | CO3 | C | 10 |
|  | b. | **Assess** the use of Bispectral Index (BIS) monitoring in assessing depth of anesthesia and patient safety. | CO3 | E | 6 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Construct an integrated medical instrumentation system that monitors multiple physiological parameters in real time. | CO6 | C | 10 |
|  | b. | Justify the selection of sensors and communication modules in a wearable biomedical device intended for continuous patient monitoring. | CO6 | E | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Identify the basic functions of various human physiological systems. |
| CO2 | Analyze the features of electrodes and the interfacing of circuits. |
| CO3 | Categorize the design procedures involved in neurological signal analysis. |
| CO4 | Analyze working of various measurement instruments related to cardiac activity. |
| CO5 | Design an suitable Instrumentation system for respirating analysis. |
| CO6 | Assess the medical device safety and testing of devices |

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**END SEMESTER EXAMINATION – NOVEMBER / DECEMBER 2025**

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| **Course Code** | **23BM3008** | **Duration** | **3hrs** |
| **Course Title** | **BIOMEDICAL ENGINEERING ENTREPRENEURSHIP** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Propose a new biomedical product idea integrating AI and justify its potential societal and economic impact. | CO1 | C | 8 |
|  | b. | Discuss how team building influence the success of biomedical start-ups. | CO1 | C | 8 |
|  |  |  |  |  |  |
| 2. | a. | Apply TAM, SAM, and SOM concepts to estimate the market size for a new medical device innovation. | CO2 | A | 12 |
|  | b. | Identify the various types of entrepreneurs. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 3. | a. | Develop a comprehensive business plan for a new biomedical startup using the Lean Canvas model. | CO3 | A | 8 |
|  | b. | Compare and contrast traditional business plans with lean approaches in the biomedical startup ecosystem. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 4. |  | Demonstrate a detailed plan for identifying and applying for grants to support a biomedical research project. | CO4 | U | 16 |
|  |  |  |  |  |  |
| 5. |  | Explain in detail about patent and process of obtaining a Patent. | CO5 | U | 16 |
|  |  |  |  |  |  |
| 6. | a. | Discuss the procedures followed by NABL for accrediting medical laboratories and testing centers. | CO6 | An | 8 |
|  | b. | List preventive steps to avoid occupational health hazards in healthcare environments. | CO6 | An | 8 |
|  |  |  |  |  |  |
| 7. | a. | Analyze the role of funding agencies in promoting research and innovation. | CO4 | An | 8 |
|  | b. | Examine how do collaborations with hospitals and clinical institutions help in product validation. | CO4 | An | 8 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. |  | Explain the procedures for segregation, treatment, and safe disposal of biomedical waste in hospitals. | CO6 | U | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the role of biomedical engineers in entrepreneurship. |
| CO2 | Acquire the skills and techniques required towards market analysis. |
| CO3 | Develop business plan. |
| CO4 | Categorize the resources and funding schemes. |
| CO5 | Judge the right product based on market needs. |
| CO6 | Create awareness on environmental safety and protection. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23BM3009** | **Duration** | **3hrs** |
| **Course Title** | **DEEP LEARNING FOR HEALTHCARE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Illustrate the concept and learning process of a Back Propagation Network (BPN) with example demonstrating weight adjustment and error minimization. | CO1 | A | 10 |
|  | b. | Evaluate the role and significance of regularization and normalization in enhancing neural network training stability and capability. | CO1 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Examine the principles and architecture of a Deep Belief Network (DBN) and illustrate its role in hierarchical feature learning | CO2 | A | 10 |
|  | b. | Illustrate the working of a Convolutional Neural Network (CNN) with an example of convolution, pooling, and classification stages. | CO2 | An | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain Autoencoders their architecture and learning process in unsupervised feature representation. | CO2 | An | 10 |
|  | b. | Evaluate the functionality of a Generative Adversarial Network (GAN) and assess its effectiveness in medical imaging applications such as data augmentation and anomaly detection. | CO2 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Summarize AI-powered digital biomarkers for disease progression tracking, emphasizing their contribution to predictive and personalized healthcare. | CO4 | E | 10 |
|  | b. | Assess the challenges and limitations of deep learning in computational medicine, focusing on data quality, interpretability, and ethical considerations. | CO3 | E | 10 |
|  |  |  |  |  |  |
| 5. | a. | Illustrate the integration of Electronic Health Record systems with genomics and its implications on patient care. | CO3 | An | 12 |
|  | b. | Summarize the advantages of digital therapeutics in healthcare field. | CO6 | E | 8 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Assess the limitations of existing digital healthcare systems and propose AI-based methods to enhance patient outcomes. | CO4 | E | 10 |
|  | b. | Illustrate the system combining EHR and wearable sensor data for predictive healthcare. | CO3 | A | 10 |
|  |  |  |  |  |  |
| 7. | a. | Interpret the loss functions beused to improve deep learning model accuracy in medical tasks. | CO5 | A | 10 |
|  | b. | Explain data augmentation its application and benefits in improving generalization of medical AI models. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Evaluate the strategies for addressing class imbalance in healthcare datasets. | CO5 | E | 10 |
|  | b. | Evaluate the impact of noisy, missing, or biased data on deep learning models in healthcare. Propose strategies for preprocessing and data cleaning. | CO5 | E | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Illustrate a deep learning framework integrating ultrasound and MRI images for precise organ and tumor segmentation. | CO6 | An | 10 |
| b. | Propose a transformer-based deep learning model for adaptive radiotherapy planning using CT scan sequences. Express how temporal attention and physics-based loss functions improve dose prediction and personalize treatment | CO6 | C | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Comprehend the concept of deep learning |
| CO2 | Review the concepts of advanced neural networks. |
| CO3 | Analyse the deep learning techniques in computational medicine. |
| CO4 | Examine the importance of digital deep learning biomarkers. |
| CO5 | Compute the challenges in applying medical deep learning techniques. |
| CO6 | Summarize the features of deep learning in diagnostic and therapeutic devices. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **24BM2008** | **Duration** | **3hrs** |
| **Course Title** | **ROBOTS IN HEALTHCARE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Identify the type of automation that is relatively difficult to accommodate change in the product design. | | CO1 | U | 1 |
| 2. | List the key elements of dynamic stabilization. | | CO1 | R | 1 |
| 3. | Sketch the mechanism of Stewart Platform. | | CO2 | A | 1 |
| 4. | List the applications of Cartesian Co-ordinate configuration. | | CO2 | R | 1 |
| 5. | Differentiate mobile robot and industrial robot. | | CO3 | U | 1 |
| 6. | Classify the types of end effector. | | CO3 | U | 1 |
| 7. | Define Torque. | | CO4 | R | 1 |
| 8. | Sketch the connection of unipolar stator. | | CO4 | A | 1 |
| 9. | Identify the part that provides power to move the joints in a robot. | | CO5 | U | 1 |
| 10. | List the functions of Robot controller. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Explain the examples of External sensors. | | CO1 | An | 3 |
| 12. | Classify the types of velocity sensors. | | CO2 | U | 3 |
| 13. | Describe the applications of acoustic sensor. | | CO3 | R | 3 |
| 14. | Interpret the common principles used in range sensor. | | CO4 | U | 3 |
| 15. | Sketch the working of range sensor. | | CO5 | A | 3 |
| 16. | Differentiate intrinsic and extrinsic fiber optic sensor. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Discriminate between the different types of grippers. | CO1 | E | 12 |
|  |  |  |  |  |  |
| 18. | a. | Describe the working of pneumatic and hydraulic actuators. | CO2 | R | 6 |
|  | b. | Analyze the design consideration in gripping. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. |  | Describe the construction of manipulator. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Describe the components of pneumatic drive systems. | CO4 | R | 6 |
|  | b. | Differentiate strain gauge sensor and piezoelectric sensor. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | In a robotic physiotherapy device, the therapist wants the patient’s hand to be placed at point (x,y)=(35cm,20cm). The robotic arm has:  •Upper arm length L1=30 cm  •Forearm length L2 =20cm  Calculate the possible shoulder and elbow joint angles (θ1 ,θ2 ) for the robot to position the patient’s hand at that target. | CO5 | A | 6 |
|  | b. | Analyze the importance of basic kinematics in robotics. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Describe the key elements of Robot Anatomy. | CO5 | R | 6 |
|  | b. | Examine the essential characteristics of robots. | CO5 | R | 6 |
|  |  |  |  |  |  |
| 23. |  | Explain the recent trends and developments in biorobotics. | CO6 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Interpret the clinical applications of robots. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Identify the concepts of robotic motions and its dynamics |
| **CO2** | Summarize the principles of sensors and actuators for robots |
| **CO3** | Apply software tools for analysis of robotic motion |
| **CO4** | Comprehend Kinematics of robotic arm movement |
| **CO5** | Evaluate the path planning algorithms for mobile robots |
| **CO6** | Create simple robots for surgical applications |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **24BM2015** | **Duration** | **3hrs** |
| **Course Title** | **BIOMEMS TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | **Define the term BioMEMS.** | | CO1 | R | 1 |
| 2. | **Describe the main functions of microgrippers.** | | CO1 | U | 1 |
| 3. | **List the major characteristics of light.** | | CO2 | R | 1 |
| 4. | **Write the applications of a grating light valve.** | | CO2 | A | 1 |
| 5. | **Name the device operating on the thermocapillary effect principle.** | | CO3 | R | 1 |
| 6. | **List the fundamental properties of fluids.** | | CO3 | R | 1 |
| 7. | **Define Lab-on-a-Chip technology.** | | CO4 | R | 1 |
| 8. | **Identify the applications of DNA sensors.** | | CO4 | U | 1 |
| 9. | **Explain the three basic steps involved in photolithography.** | | CO5 | U | 1 |
| 10. | **List the essential parts of a Scanning Electron Microscope (SEM).** | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Write the application of MEMS and microsystem in healthcare industry. | | CO1 | A | 3 |
| 12. | Classify the optical switches based on the input and output ports. | | CO2 | An | 3 |
| 13. | Summarize the applications of microneedle. | | CO3 | U | 3 |
| 14. | Write notes on emerging BioMEMS technology. | | CO4 | A | 3 |
| 15. | Explain the process of microfabrication. | | CO5 | An | 3 |
| 16. | List the applications of DNA based biosensor. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Illustrate the working principle of thermal sensor and micro actuators. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain the working principle of the Digital Micromirror Device (DMD) along with micromirror. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | Explain microfluidic channel and micro dispenser. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the working of E-tongue with relevant diagrams. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Evaluate the Etching process in micromachining. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain the various typical MEMS and microsystem products. | CO1 | A | 6 |
|  | b. | Analyze the different software tools for designing and analyzing the MEMS products. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 23. | a. | Compare microelectronics and microsystem. | CO1 | An | 6 |
|  | b. | Explain the beam splitter and its application. | CO2 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Illustrate the working of Scanning Electron Microscopy used in nanomaterial characterization. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Identify the principles of sensors and actuators |
| **CO2** | Summarize the optical devices and applications |
| **CO3** | Classify the performance of microfluidic devices to the environment |
| **CO4** | Use the software tools for designing and analyzing the sensors |
| **CO5** | Recommend the suitable principles of testing for biomedical conditions |
| **CO6** | Create simple systems for medical applications |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **24BM2016** | **Duration** | **3hrs** |
| **Course Title** | **ASSISTIVE DEVICES FOR HEALTHCARE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Classify devices such as canes, walkers, and wheelchairs under the appropriate category of assistive aids. | | CO1 | A | 1 |
| 2. | Explain how tools that assist users in remembering appointments and managing tasks function as cognitive aids. | | CO1 | U | 1 |
| 3. | Explain the origin of the term “bionic” by describing the two fields it integrates. | | CO2 | U | 1 |
| 4. | Identify the Shape Memory Alloy that can return to its original shape when heated | | CO2 | R | 1 |
| 5. | Name two examples of daily living aids. | | CO3 | R | 1 |
| 6. | Explain how mobility assistive devices enhance or restore the functional capabilities of individuals with movement impairments. | | CO3 | U | 1 |
| 7. | Describe the function of a screen reader and explain how it assists individuals with visual impairments. | | CO4 | U | 1 |
| 8. | Explain how assistive listening systems improve hearing experiences in noisy classroom environments by transmitting the teacher’s voice directly. | | CO4 | U | 1 |
| 9. | List one benefit of User-Created AI Assistive Devices. | | CO5 | R | 1 |
| 10. | Name one key technology used in AI-based AAC devices. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Explain assistive technology with two examples | | CO1 | A | 3 |
| 12. | Explain the term “smart materials”with their applications. | | CO2 | A | 3 |
| 13. | Analyze the advantages and limitations of powered mobility devices (wheelchairs, scooters, standing wheelchairs). | | CO3 | An | 3 |
| 14. | Explain the concept of Braille displays in assisting students to access the digital content. | | CO4 | A | 3 |
| 15. | Explain how AI helps mobility aids detect obstacles and guide users. | | CO5 | An | 3 |
| 16. | Explain how Assistive Listening Devices help people with partial hearing loss. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain the working principle and applications of the Tongue-Drive System. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. | a. | Evaluate the use of bionic devices such as cochlear implants and retinal implants in sensory restoration. | CO2 | An | 8 |
|  | b. | Explain the role of sensors in a smart Assistive device | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. |  | Explain the role of Vision Enhancement device enabling individuals to perform tasks such as reading, mobility, object recognition, and facial identification. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Discuss the working principle of Braille translation software. | CO4 | U | 4 |
|  | b. | Explain the concept of Braille printers in making book chapters and mention their categories. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 21. |  | Analyze the importance of Braille displays in promoting independence for blind individuals | CO4 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | 1. Vikram, who cannot walk, frequently travels alone in urban environments. Explain how AI-based Wheel chair can help him navigate streets safely. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Arjun, who is deaf, lives alone. Apply your knowledge to recommend a set of AI-based alerting devices and text services to help him stay safe and connected. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Propose a personalized AI assistant combining speech recognition and activity monitoring to guide Mr. Das through his daily routine. | CO6 | C | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| **CO1** | Describe the concept of assistive devices. |
| **CO2** | Discriminate the materials used in assistive devices. |
| **CO3** | Analyze the types of assistive devices. |
| **CO4** | Demonstrate the importance of assistive devices in vision. |
| **CO5** | Observe the importance of assistive devices in hearing aid. |
| **CO6** | Summarize the features of assistive device based on artificial intelligence |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **24BM2017** | **Duration** | **3hrs** |
| **Course Title** | **PYTHON PROGRAMMING FOR BIOMEDICAL APPLICATIONS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Name the datatypes for storing roll numbers in Python. | | CO1 | R | 1 |
| 2. | List the advantages of Python Programming. | | CO1 | R | 1 |
| 3. | Recall the semantics of “for loop”. | | CO2 | R | 1 |
| 4. | List the logical operators used in conditional statements. | | CO2 | R | 1 |
| 5. | Name the method for reading the text from a file in Python. | | CO3 | R | 1 |
| 6. | List the string operators that are used to convert the string to uppercase and lowercase. | | CO3 | R | 1 |
| 7. | Specify the python code to extract the keys from a dictionary | | CO4 | U | 1 |
| 8. | Give an example for tuple. | | CO4 | U | 1 |
| 9. | Provide the code to call a method using object | | CO5 | U | 1 |
| 10. | Specify the various scopes of a variable. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Write the Python script to calculate the average blood glucose level using fasting and post-meal glucose values. | | CO1 | A | 3 |
| 12. | Write the Python script to check for the status of oxygen saturation. | | CO2 | A | 3 |
| 13. | Write the algorithm to convert plain text to cipher text. | | CO3 | A | 3 |
| 14. | Discuss the different types of list methods in Python. | | CO4 | U | 3 |
| 15. | Describe the top-down design strategy adopted for problem solving. | | CO5 | U | 3 |
| 16. | Infer the libraries used in Python programming for speech recognition. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the different arithmetic expressions with its precedence. | CO1 | U | 8 |
|  | b. | Write a Python program to repeat the string “Medical Emergency” for 10 times. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 18. |  | Discuss the different conditional statements in Python programming with its syntax and semantics. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Discuss the different string operators with examples. | CO3 | U | 8 |
|  | b. | Write a Python script to store the patient’s medical information in a text file. | CO3 | A | 4 |
|  |  |  |  |  |  |
| 20. | a. | Write the Python script to manage and update patient oxygen level records using list operations. | CO4 | A | 6 |
|  | b. | Write a Python script to store and display patient details such as Name, Age, Blood Group, and Diagnosis using a dictionary. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 21. |  | Illustrate with a Python program for defining the objects and methods involved in designing a class for hospital management system. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | Examine the purpose of the different escape sequences with example programs. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Illustrate the concept of dictionary and the different operations performed on a dictionary with example programs. | CO4 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Develop a Python program for a patient health monitoring system that records patients’ details. The program should display whether the health status of the patient is Normal or Critical based on the entered values. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| **CO1** | Interpret the structure and components of a Python program. |
| **CO2** | Demonstrate loops and decision statements in Python. |
| **CO3** | Apply string and file operations for data manipulation in Python programming. |
| **CO4** | Implement lists, tuples, and dictionaries in Python programs. |
| **CO5** | Assess object‐oriented programs with Python classes. |
| **CO6** | Develop simple code for Biomedical applications. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25BM101** | **Duration** | **3hrs** |
| **Course Title** | **MATHEMATICS FOR BIOMEDICAL ENGINEERS I** | **Max. Marks** | **100** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | *Identify* the arithmetic mean of the body temperatures (in °C) recorded for a patient at five different times during the day: 36.5, 36.8, 37.0, 37.2, and 36.9. | 1a | U | 1 |
| 2. | *Identify* the range of hours of sleep recorded for seven patients before surgery, with the following data: 6, 5, 8, 7, 5, 6, and 9. | 1d | U | 1 |
| 3. | *List* any two properties of correlation coefficient. | 2b | R | 2 |
| 4. | *Identify* the key difference between Spearman’s rank correlation and Pearson’s correlation when analyzing biomedical data. | 2e | R | 2 |
| 5. | *List* the tab z value at 1% and 5 % level of significance for one tailed test problems. | 3a | R | 3 |
| 6. | *Define* null and alternative hypothesis. | 3a | R | 3 |
| 7. | The volume of air in the lungs during breathing is modeled by , where is in liters and in seconds. *Identify* the rate of airflow (change in volume) at any time. | 4a | U | 4 |
| 8. | *Identify* the critical points of | 4b | U | 4 |
| 9. | *State* the Fourier Transform pais. | 5a | R | 5 |
| 10. | A simplified ECG signal is modeled as a linear ramp function . *Compute* the root mean square (RMS) value of this signal in the time domain. | 5h | A | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | *Determine* the mean deviation, standard deviation, and coefficient of standard deviation for the body temperatures (in °F) of seven patients recorded as: 98.4, 99.1, 98.7, 100.2, 99.5, 98.9, and 99.3. | 1e | A | 1 |
| 12. | A group of patients was monitored to study the relationship between Heart Rate (bpm) and Oxygen Saturation (SpO₂ %), and obtained the below data:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Heart Rate (X) | 72 | 80 | 68 | 76 | 85 | | SpO₂ (Y) | 98 | 95 | 99 | 96 | 97 |   *Compute* the rank correlation coefficient. | 2c | U | 2 |
| 13. | The average cholesterol level in adults is with a population standard deviation of . A new drug is tested on 36 patients, and their mean cholesterol is found to be . At the 5% level of significance, *identify* whether the drug affects cholesterol. | 3b | U | 3 |
| 14. | In a two-variable system describing the glucose-insulin interaction, the functions are . *Compute* the Jacobian determinant at . | 4d | A | 4 |
| 15. | A decaying signal representing the electrical activity of a neuron after a stimulus is modeled as: *Determine* the Fourier Sine Transform of this neural signal to analyze its frequency content. | 5f | A | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | *Determine* the median and mode of the recovery time (in days) of the persons given below:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Time (days) | 5–10 | 10–15 | 15–20 | 20–25 | 25–30 | | Frequency | 6 | 10 | 14 | 12 | 8 | | 1c | A | 1 |
| **(OR)** | | | | |
| 17 | A clinical researcher collected data on the resting pulse rates (in bpm) of a group of patients and grouped the data as shown:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Pulse Rate (bpm) | 60 – 70 | 70 – 80 | 80 – 90 | 90 – 100 | 100 – 110 | | Frequency | 5 | 8 | 12 | 7 | 3 |   *Compute* the Range and Quartile Deviation (QD) of the pulse rates. | 1d | An | 1 |
|  |  |  |  |  |
| 18 | A group of patients was monitored, and the following values were recorded as below:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Heart Rate (bpm) | 60 | 70 | 80 | 90 | 100 | 110 | | (%) | 99 | 98 | 97 | 96 | 95 | 94 |   *Compute*the correlation coefficient. | 2b | An | 2 |
| **(OR)** | | | | |
| 19 | In a study on the effect of exercise duration (minutes, X) on resting heart rate (bpm, Y), data were collected from 5 participants:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Exercise Duration (X) | 10 | 20 | 30 | 40 | 50 | | Resting Heart Rate(Y) | 82 | 78 | 74 | 70 | 66 |   *Determine* the regression coefficients. | 2e | A | 2 |
|  |  |  |  |  |
| 20 | A new wearable heart rate monitor is tested against a standard clinical ECG device. The resting heart rates (in bpm) for 8 adults measured by each device are:   * Wearable: 72, 75, 74, 73, 76, 72, 71, 74 * ECG: 70, 71, 72, 70, 73, 71, 69, 72   Assuming the population standard deviations are for the wearable and bpm for the ECG, *justify*, at the 5% significance level, whether the wearable device overestimates the resting heart rate compared to the ECG. | 3c | An | 3 |
| **(OR)** | | | | |
| 21 | A health researcher wants to compare the effectiveness of two vaccines.   * Vaccine A: Out of 200 people, 170 developed immunities. * Vaccine B: Out of 180 people, 150 developed immunities.   At the significance level, *justify* whether there is any significant difference in the effectiveness of the two vaccines. | 3e | An | 3 |
|  |  |  |  |  |
| 22 | A blood vessel's radius varies as along its length to 4 cm. *Evaluate* the surface area of the vessel formed by revolving the curve about the -axis using integration. | 4g | E | 4 |
| **(OR)** | | | | |
| 23 | The concentration of a pain-relief drug in blood plasma is modeled by , where is in and is time in hours. *Evaluate* the time at which the concentration is maximum, and find the maximum concentration. | 4e | E | 4 |
| **Compulsory Question:** | | | | |
| 24 | A simplified biomedical signal is modeled as a cubic function . *Evaluate* the Fourier Transform of this signal and describe its frequency content. | 5b | E | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **25BM201** | **Duration** | **3hrs** |
| **Course Title** | **Medical Physics** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | Define the characteristics of audible sound waves. | 1a | R | 1 |
| 2. | Classify the sound waves based on their fundamental characteristics. | 1b | U | 1 |
| 3. | Identify two important advantages of magnetostriction oscillator. | 2a | R | 2 |
| 4. | Compare ‘infrasound waves’ with ‘ultrasound waves’. | 2b | U | 2 |
| 5. | List the low frequency electromagnetic waves. | 3a | R | 3 |
| 6. | Describe microwave radiation. | 3b | U | 3 |
| 7. | Name the types of radioactive decay popularly known to general public. | 4a | R | 4 |
| 8. | Differentiate ‘beta minus emissions’ from ‘beta plus emissions’. | 4b | U | 4 |
| 9. | State the basic definition of alpha particle decay. | 5a | R | 5 |
| 10. | Discuss two important applications of beta-emitting radiopharmaceuticals. | 5b | U | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | Apply Sabine’s formula of reverberation time to calculate the acoustical efficiency of a hospital room whose volume is (length =80 m; breadth = 30 m and height = 10 m) and the total absorption coefficient is 6333.33 O.W.U. or sabines. Infer whether this reverberation time is good for speech communication inside a crowded hospital atmosphere. | 1c | A | 1 |
| 12. | Express whether the following ferromagnetic rod can be used for producing ultrasonic waves. This rod is having a length of 20 mm. The density of this pure metal is 7.25 x 103 kg/m3 and its Young’s modulus is 115 x 109 N/m2. | 2c | U | 2 |
| 13. | Calculate the electric field produced by a 103 W laser beam focused by a lens of cross section area 10-6 cm2. Analyze whether this can be used for dermatology applications.  [Given that ε0 = 8.854 x 10-12 C2N-1m-2.; c = 3 x 108 m/s] | 3c | A | 3 |
| 14. | Infer whether the following nuclear reaction is possible or not. Deduce the reason for the same. | 4c | U | 4 |
| 15. | Compute the maximum energy that is imparted on an electron by a low energy photon of energy 51.1 keV hitting the electron in a direct hit. Given that the rest mass energy of electron is 511 keV. | 5c | A | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | Determine the reverberation time of an operation theater having a volume of 2500 m3. Its total absorption is equivalent to 200 m2 of open window unit or sabines. In order to bring its reverberation time to half its initial value, compute the change in its total absorption. | 1d | A | 1 |
| **(OR)** | | | | |
| 17 | Evaulate the factors that affect the acoustic quality of a biomedical industrial room and suggest remedies for the same. | 1e | An | 1 |
|  | | | | |
| 18 | Explain the methods to find the first three excited frequencies for the following system. A piezoelectric crystal is used in the production of ultrasonic waves that are used for calculating blood flow rate in a newborn baby. It is having a thickness of 2 mm that is vibrating at resonance. It is having a Young’s Modulus value Y = 7.9 x 1010 N/m2 and density ρ = 2650 kg m-3. | 2d | A | 2 |
| **(OR)** | | | | |
| 19 | Correlate the applications of ultrasonic waves in sonography and other diverse areas of medical field. | 2e | An | 2 |
|  | | | | |
| 20 | Predict the intensity of a 100 W incandescent bulb at a distance of 10 m from a given surface. Calculate its electric field and infer the suitability of this electromagnetic source in medical industry especially in dermatology field.  [Given that ε0 = 8.854 x 10-12 C2N-1m-2.; c = 3 x 108 m/s] | 3d | A | 3 |
| **(OR)** | | | | |
| 21 | Deduce importance of Infrared Thermography in biomedical field and explain its working principle in detail. | 3e | An | 3 |
|  | | | | |
| 22 | Solve the Q value for the following nuclear reaction. The nuclear masses are given by the following in atomic mass units. [U-238 – 238.050788 u, Th-234 – 234.043601 u and He-4 – 4.002603 u]. Based on the Q value, infer whether this reaction is possible or not. [1 amu = 931.494 MeV]  Give a detailed explanation for the same. | 4d | A | 4 |
| **(OR)** | | | | |
| 23 | Distinguish between gamma ray interaction and x-ray interaction with tissues of different densities and explain their medical significance. | 4e | An | 4 |
| **Compulsory Question:** | | | | |
| 24 | Evaluate the attenuation thickness of a soft tissue that is equivalent to 1 cm of a bone tissue. Justify the result with proper reasoning. | 5d | E | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **25BM202** | **Duration** | **3hrs** |
| **Course Title** | **FUNDAMENTALS OF BIOMEDICAL ENGINEERING** | **Max. Marks** | **100** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | Define CMRR. | 1a | R | 1 |
| 2. | Discuss the performance requirements of medical instrumentation system. | 1c | U | 1 |
| 3. | List the need for isolation in biomedical instrument. | 2c | R | 2 |
| 4. | Explain the need for isolation circuits in biomedical applications. | 2c | A | 2 |
| 5. | Identify the parts of an Oximeter. | 3d | R | 3 |
| 6. | Label the representation of Einthoven Triangle. | 3b | R | 3 |
| 7. | Differentiate cardiac pacemaker and a cardiac defibrillator. | 4a | U | 4 |
| 8. | State two clinical applications of an infusion pump. | 4b | R | 4 |
| 9. | Define attenuation in X-ray imaging. | 5a | R | 5 |
| 10. | List two advantages of ultrasound imaging over other imaging modalities. | 5e | R | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | Interpret the general constraints in the design of medical instrumentation system. | 1e | A | 1 |
| 12. | Explain the characteristics of instrumentation amplifier. | 2d | A | 2 |
| 13. | Explain the principle and clinical significance of PPG. | 3a | A | 3 |
| 14. | Explain the basic working principle of a cardiac pacemaker. | 4a | A | 4 |
| 15. | Differentiate PET from SPECT. | 5c | U | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | Explain the basic components of a medical instrumentation system with a neat block diagram. | 1b | A | 1 |
| **(OR)** | | | | |
| 17 | Explain the various sources of biomedical signals with their relevance in medical instrumentation. |  | U | 1 |
| 18 | Examine the use of current amplifiers for low-level biomedical signals, highlighting circuit design and applications. | 2e | A | 2 |
| **(OR)** | | | | |
| 19 | Interpret the working principle and types of isolation amplifiers in biomedical applications. | 2c | A | 2 |
| 20 | Interpret the concept of the measurement of electrical activity of the heart. | 3b | A | 3 |
| **(OR)** | | | | |
| 21 | Compare the working principles and diagnostic applications of EEG and EMG systems. | 3c | U | 3 |
| 22 | Examine the design and functioning of cardiac defibrillators, highlighting energy delivery and safety features. | 4b | U | 4 |
| **(OR)** | | | | |
| 23 | Compare infusion pumps and syringe pumps in terms of mechanism, accuracy, and clinical applications. | 4d | U | 4 |
| **Compulsory Question:** | | | | |
| 24 | Write the physics, transducer technology, and imaging modes used in diagnostic ultrasound. | 5e | A | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25BM203** | **Duration** | **3hrs** |
| **Course Title** | **ELECTRICALAND ELECTRONICS FOR BIOMEDICAL ENGINEERS** | **Max. Marks** | **100** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | Identify the component that stores charge between two plates separated by an insulator. | 1a | U | 1 |
| 2. | List the advantages of AC system. | 1c | R | 1 |
| 3. | Classify the types of DC circuits. | 1a | U | 1 |
| 4. | List the types of operations performed by a microprocessor. | 3d | R | 2 |
| 5. | Sketch the circuit configuration of a common emitter BJT. | 2c | A | 2 |
| 6. | **Distinguish** between the primary sensing and variable manipulation elements in ECG signal processing. | 4a | E | 4 |
| 7. | **Explain** the testing and validation procedures followed before clinical approval of biomedical devices. | 4b | E | 4 |
| 8. | Identify a device that measures the amount of electrical energy consumed by a powered device. | 4c | U | 4 |
| 9. | List the types of Instrument transformer. | 4d | R | 4 |
| 10. | State any two disadvantages of MRI in medical diagnosis. | 5a | A | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | Explain the purpose of an embedded system. | 3e | A | 3 |
| 12. | Compare error detection and error correction. | 3a | An | 3 |
| 13. | Explain the pinch-off condition in JFET. | 2d | U | 2 |
| 14. | Interpret the breakdown characteristics of a Zener diode. | 2b | A | 2 |
| 15. | **Determine the DC output power delivered to the analog signal processing circuit of an ECG machine,** if the machine uses a full-wave rectifier with an AC input power of 25 W and a rectifier efficiency of 81.2%. | 2f | A | 2 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | Explain the principle and mechanism involved in the generation of AC voltage. | 1c | A | 1 |
| **(OR)** | | | | |
| 17 | Estimate **the patient-to-ground current** Ix through the 2 Ω skin/gel path in an ECG setup where: Device A has a floating supply at +10 V through 5 Ω, Device B has a floating supply at +50 V through 10 Ω and the patient node connects to ground through 2 Ω. | 1b | E | 1 |
|  |  |  |  |  |
| 18 | Interpret the working of depletion type MOSFET. | 2e | A | 2 |
| **(OR)** | | | | |
| 19 | Explain the characteristics of PN junction diode. | 2a | A | 2 |
|  |  |  |  |  |
| 20 | Interpret the role of microprocessor in patient monitoring system. | 3d | A | 3 |
| **(OR)** | | | | |
| 21 | Explain the steps involved in generating Hamming code for reliable biomedical data transmission. | 3b | A | 3 |
|  |  |  |  |  |
| 22 | Examine the way functional blocks of a biomedical instrument work together to acquire and process physiological signals. | 4a | A | 4 |
| **(OR)** | | | | |
| 23 | **Infer** the steps involved in calibrating a medical thermometer to ensure measurement precision. | 4b | An | 4 |
| **Compulsory Question:** | | | | |
| 24 | **Interpret** the significance of MRI in diagnosing neurological disorders. | 5a | A | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25BM204** | **Duration** | **3hrs** |
| **Course Title** | **PROGRAMMING FOR PROBLEM SOLVING USING C FOR BIOMEDICAL ENGINEERS** | **Max. Marks** | **100** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | *Interpret* the difference between an algorithm and a flowchart. | 1e | U | 1 |
| 2. | *Name* different types of translators used in programming. | 1f | R | 1 |
| 3. | *Differentiate* between constants and variables with syntax. | 2c | U | 2 |
| 4. | *Identify* the purpose of different jump statements. | 2f | U | 2 |
| 5. | *Recall* the syntax for declaring a one-dimensional array. | 3b | R | 3 |
| 6. | *Differentiate* character arrays from strings in C. | 3d | U | 3 |
| 7. | *Define* a function in C. | 4a | R | 4 |
| 8. | *Differentiate* ‘call by value’ from ‘call by reference’. | 4e | U | 4 |
| 9. | *List* any two differences between Structure and Union in C. | 5e | R | 5 |
| 10. | *Discuss* the operators associated with Pointers. | 5a | U | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | *Differentiate* between decision-making and looping structures in flowcharts with examples. | 1e | An | 1 |
| 12. | *Evaluate* the following expression used in a biomedical device calibration process, and trace the final values of sensorOffset, amplifierGain, and calibratedValue after execution.  int sensorOffset = 5;  int amplifierGain = 10;  int calibratedValue = sensorOffset++ + ++amplifierGain - --sensorOffset + amplifierGain++; | 2e | E | 2 |
| 13. | *Choose* a relevant searching technique to locate a specific patient-ID in an array of IDs. | 3c | A | 3 |
| 14. | *Infer* the relationship between function definition, declaration, and invocation in the execution of a C program. | 4a | An | 4 |
| 15. | *Calculate* the average blood glucose level using pointers from an array of patient readings. | 5b | A | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16. | *Compute* an octal-coded biomedical sensor output (7536)₈ can be interpreted in binary, decimal, and hexadecimal for digital processing. | 1b | A | 1 |
| **(OR)** | | | | |
| 17. | *Examine* the importance of algorithm testing and validation in biomedical data conversion programs. | 1e | An | 1 |
|  |  |  |  |  |
| 18. | *Develop* a C program that classifies different levels of Hypoxia on oxygen saturation (SpO2) levels. | 2f | A | 2 |
| **(OR)** | | | | |
| 19. | *Compare* the execution flow of while and do-while loops with respect to entry and exit conditions. | 2f | An | 2 |
|  |  |  |  |  |
| 20. | *Develop* a C program to store and display the body temperature readings of 3 patients over 4 days. | 3b | A | 3 |
| **(OR)** | | | | |
| 21. | *Explain* the use of string manipulation functions such as strcpy(), strcat(), and strcmp() with examples. | 3f | An | 3 |
|  |  |  |  |  |
| 22. | *Develop* a C function to calculate Body Mass Index with necessary input parameters. | 4b | A | 4 |
| **(OR)** | | | | |
| 23. | *Evaluate* the accuracy of a function-based modular design for managing hospital database records in C. | 4d | E | 4 |
|  |  |  |  |  |
| **Compulsory Question:** | | | | |
| 24. | *Develop* a patient database that displays patient ID, name, age, and blood pressure values in a table format using Structures. | 5e | A | 5 |