VINAYAKA MISSION'S RESEARCH FOUNDATION, SALEM

(Deemed to be University under section 3 of the UGC Act 1956)

Ph.D Entrance Test – November – 2025

Faculty of Engineering & Technology

Biomedical Engineering

Instructions / Note:

1. Answer all the questions. Each question carries one mark.
2. No negative marks for wrong answers.
3. Read each question carefully and answer in the OMR sheet provided for each question with only blue/ black pen to fill the circles in the OMR Sheet.
4. Question number 1 - 35 questions belong to Research Methodology component and Question number 36-70 questions belong to the subject at PG level
5. Return the question paper along with the OMR sheet.

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36. Which of the following statements accurately describes the function of arteries and veins?
    A. Arteries carry deoxygenated blood and veins carry oxygenated blood
    B. Arteries carry blood away from the heart, while veins carry blood towards the heart
    C. Arteries are always oxygenated, and veins are always deoxygenated
    D. Arteries and veins both carry blood away from the heart

37. The force–velocity relationship in skeletal muscle shows that _____
    A. Muscle force increases linearly with shortening velocity
    B. Maximum power output occurs at about one-third of maximal shortening velocity
    C. Eccentric contractions generate less force than concentric contractions
    D. Force is independent of contraction speed

38. Which type of pacemaker avoids competition between the heart's natural rhythm and the pacemaker's rhythm?
    A. Constant voltage pacemaker
    B. Fixed rate pacemaker
    C. Demand pacemaker
    D. Biventricular pacemaker

39. What is the primary role of growth factors in tissue engineering scaffolds?
    A. Promote cell signaling for proliferation and differentiation
    B. Increase proliferation of cell
    C. Enhance differentiation
    D. Prevent infection

40. Which of the following statements is true about the amplitude and frequency characteristics of bioelectric signals?
    A. ECG has the highest amplitude (mV range), while EEG has the lowest amplitude (μV range)
    B. EEG has the highest frequency range (up to 50 Hz), while ECG has the lowest (around 0.05-120 Hz)
    C. EMG signals range from microvolts (μV) to millivolts (mV), and their frequency content is higher than ECG or EEG
    D. The amplitude of all bioelectric signals is typically in the range of volts

41. The Young's modulus of cortical bone is approximately _____
    A. 0.1–0.5 MPa
    B. 10–50 MPa
    C. 1–5 GPa
    D. 15–20 GPa

42. Which cell type is commonly used in cartilage tissue engineering?
    A. Fibroblast
    B. Chondrocyte
    C. Osteoblast
    D. Myocyte

43. A temperature sensing device can be modeled as a first-order system with a time constant of 6 seconds. If it is suddenly exposed to a step input from 25°C to 150°C, the temperature indicated after 10 seconds will be approximately _____
    A. 118.2°C
    B. 126.4°C
    C. 134.6°C
    D. 142.8°C

44. In assistive technology design**,** modularity allows _____
    A. Easier maintenance, customization, and upgrades
    B. Reduced adjustability
    C. Higher rigidity of the system
    D. Uniformity of components only

45. You find an unresponsive adult victim with no pulse and no normal breathing. An AED is available. What is the correct sequence of actions?
    A. Power on the AED, attach pads, analyze the rhythm, and deliver a shock if advised
    B. Power on the AED, attach pads, deliver a shock, and then analyze the rhythm
    C. Attach pads, check pulse, shock the victim, and analyze rhythm
    D. Start CPR immediately, then power on the AED after 5 cycles

46. The Reynolds number (Re) in blood flow is typically low in microvessels because _____
    A. Density of blood is small
    B. Velocity and vessel diameter are small
    C. Viscosity is very low
    D. Flow is turbulent

47. Which of the following correctly sequences the path of deoxygenated blood from the body to the lungs?
    A. Right atrium \ Right ventricle \ Lungs
    B. Right ventricle \ Right atrium \ Lungs
    C. Left atrium \ Left ventricle \ Lungs
    D. Right atrium \ Lungs \ Right ventricle

48. A radiologist uses an AI system that analyzes thousands of CT scans to identify a rare type of lung nodule. This system is trained to detect subtle patterns invisible to the human eye. What is the most likely AI methodology employed?
    A. Rule-based expert systems
    B. Deep Learning and Genetic algorithms
    C. Deep learning, specifically Convolutional Neural Networks (CNNs)
    D. Machine Learning and Fuzzy logic

49. What is the RMS value of a signal described by the following MATLAB code?

```
t = 0:0.001:1;
y = sin(pi*7*t) + cos(pi*12*t);
```

    A. 0.707
    B. 1.414
    C. 1.0
    D. 0.95

50. A patient wants to put their protected health information (PHI) on an external storage device to take to another provider. According to HIPAA security rules, what is the correct course of action for the EHR specialist?
    A. Use the patient's external storage device as is
    B. Encrypt the information on the device to protect it
    C. Tell the patient PHI cannot be stored on external devices
    D. Give the unencrypted information to the patient

51. When considering the forces acting on a joint, Newton's third law (for every action, there is an equal and opposite reaction) is applied. What does this help determine in joint analysis?
    A. The acceleration of the limb
    B. The total energy absorbed by the joint
    C. The ground reaction forces during movement
    D. The electrical signals generated by muscle contraction

52. The Human-in-the-loop (HITL) approach in rehabilitation robotics emphasizes _____
    A. Fully autonomous operation
    B. Adaptive control incorporating real-time human feedback
    C. Predefined motion control without sensing
    D. Purely mechanical actuation

53. Which of the following is not the property of the instrumentational amplifier?
    A. Extremely high input impedance.
    B. Low bias and offset currents.
    C. High slew rate.
    D. Very low CMRR

54. Corrosion resistance of metallic biomaterials primarily depends on _____
    A. Bulk composition only
    B. Formation and stability of a passive oxide film
    C. Surface roughness only
    D. Sterilization temperature

55. Which event occurs during muscle contraction?
    A. H-zone disappears
    B. A-band widens
    C. I-band shortens
    D. Width of A-band is unaffected

56. Which model of telemedicine is best suited for situations where a specialist needs to review a patient's case at a later time, such as dermatological images or radiology scans?
    A. Real-time/synchronous communication
    B. Remote patient monitoring (RPM)
    C. Store-and-forward/asynchronous communication
    D. Mobile health (mHealth)

57. A biomedical engineer is designing an implantable neural recording device. A critical challenge is the material choice for the electrodes that will be in direct contact with brain tissue. Which material is generally *avoided* for long-term implantable electrodes due to polarization effects and potential toxicity?
    A. Silver-Silver Chloride (Ag-AgCl)
    B. Platinum
    C. Tungsten
    D. Stainless steel

58. In rehabilitation robotics, assist-as-needed (AAN) control is primarily used to _____
    A. Apply constant force throughout training
    B. Adapt robotic assistance based on patient performance and effort
    C. Move the patient passively without interaction
    D. Restrict patient-initiated motion

59. The key challenge in designing an artificial heart is _____
    A. Achieving perfect electrical insulation
    B. Balancing hemocompatibility and mechanical durability
    C. High thermal conductivity
    D. Biodegradability

60. Which amplifier will reject any common mode signal that appears simultaneously at both amplifier input terminal and amplifies only the voltage difference that appears across its input terminals?
    A. AC Coupled Amplifiers
    B. Carrier Amplifiers
    C. Differential Amplifiers
    D. DC Amplifiers

61. In MRI**,** the T1 relaxation time represents _____
    A. Spin–spin relaxation (loss of phase coherence)
    B. Spin–lattice relaxation (energy exchange with surroundings)
    C. Free induction decay
    D. Chemical shift interaction

62. In the design of a powered prosthetic limb, the choice of actuator primarily depends on _____
    A. Skin impedance
    B. Cosmetic appeal
    C. Desired torque-speed characteristics and energy efficiency
    D. Manufacturing cost alone

63. An AI system trained on a massive dataset of medical images to identify subtle patterns indicative of a rare disease is an example of which type of AI learning?
    A. Reinforcement Learning
    B. Unsupervised Learning
    C. Supervised Learning
    D. Self-Supervised Learning

64. The normal angle of torsion in an adult hip joint typically falls within which range?
    A. 0° - 5°
    B. 10° - 20°
    C. 45° - 60°
    D. 90° - 110°

65. According to IEC 60601-1, the term "Basic Safety and Essential Performance" refers to ____
    A. Mechanical design strength of the device
    B. Compliance with software validation
    C. Protection against electrical, mechanical, and radiation hazards essential for safe operation
    D. Only electrical safety

66. A clinician observes that a patient's transfemoral (above-knee) prosthesis is showing a "circumduction" gait deviation (the prosthesis swings out to the side in an arc during the Swing phase). Which of the following is a common cause for this problem?
    A. The prosthetic knee joint has too little friction/resistance
    B. The prosthesis is too short
    C. The suspension is too tight
    D. The prosthesis has been excessively lengthened

67. A 5 MHz Doppler ultrasound transducer is used to measure blood flow velocity in an artery. The speed of sound in blood is assumed to be 1500 m/s. The transducer is held at an angle of 45° to the direction of blood flow, and a maximum frequency shift (Doppler shift) of 3 kHz is observed. What is the approximate maximum velocity of the blood flow in m/s?.
    A. 0.32 m/s
    B. 0.45 m/s
    C. 0.64 m/s
    D. 0.90 m/s

68. Which of the following is a key consideration for equipment planning when designing a new hospital?
    A. The aesthetic appeal of the equipment
    B. The availability of the equipment for sale in the local market
    C. The integration of equipment with the hospital's IT infrastructure and the workflow of clinical staff
    D. The potential for equipment to be used for marketing purposes

69. A Brain–Computer Interface (BCI) used in rehabilitation typically converts _____
    A. EEG signals → robotic or computer control commands
    B. EEG signals → affront neuron
    C. EEG signals → electronic devices
    D. EEG signals → neural networks

70. When considering the forces acting on a joint, Newton's third law (for every action, there is an equal and opposite reaction) is applied. What does this help determine in joint analysis?
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