ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2019
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR BIOMEDICAL ENGINEERING

Date : October 13, 2019
Total Marks : 100
Writing Time : 150 minutes (2.5 hours)
Reading Time : 15 Minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
   - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
     Part II - 4 Short Answer Questions
     All questions under SECTION A are COMPULSORY.
   - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part in a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You are required to hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **8 printed pages**, including this instruction page.

GOOD LUCK

SECTION A

PART I: Multiple Choice Questions (30 marks)

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. Where is bacterial filter located in an anesthesia machine?
   a) Inspiratory side
   b) Expiratory side
   c) In between inspiratory and expiratory side
   d) None of the above.

2. What is the type membrane used in dialyzer of dialysis machine?
   a) Fiber optic membrane
   b) Hollow fiber and layered membrane
   c) Hollow fiber or layered membrane
   d) Semipermeable membrane

3. The polarization voltage causes _____.
   a) drift noise
   b) alternative noise
   c) polarized noise
   d) amplified noise

4. ECG waveform is recorded at _____ frequency.
   a) 0.5 – 30 Hz
   b) 0.05 – 200 Hz
   c) 5 – 1000 Hz
   d) None of the above.

5. When the patient is in apnea, how much time does it take for EtCO2 reading to change?
   a) 1 min early
   b) 2 min early
   c) 3 min early
   d) 4 min early

6. The sinus node basically controls the _____ of the heart.
   a) beat
   b) rhythm
   c) function
   d) impulse

7. While autoclaving the curve showing the bacterial count of survivals at each processing (heat) time is known as the _____.
   a) mean sterilization curve
   b) zero survival curve
   c) bacterial survival curve
   d) microbial sterilization curve

8. The packed cell volume (PCV) can be determined by centrifuging heparinized blood in a capillary tube (also known as a microhematocrit tube) at 10,000 RPM for _____.
   a) 1 min
   b) 3 min
   c) 5 min
   d) 10 min

9. Ventricular fibrillation occurs if _____ current pass directly through heart of a person
   a) 0.1 mA
   b) 0.01 mA
   c) 1.0 mA
   d) 100Ma

10. Ethylene oxide in hospital is used for
   a) respiratory therapy.
   b) disinfection.
   c) sterilization.
   d) endoscopic surgery.

11. In 1970, the first dental chair was made by _____, modifying a Windsor writing chair in America.
   a) Jose Philip
   b) Philip lewis
   c) John flagg
   d) Josiah Flagg

12. Tricuspid valve is also called _____.
   a) left atrio-ventricular valve
   b) pulmonary valve
   c) cardiac valve
   d) right atrio-ventricular valve

13. The basic functional unit of nervous system is _____.
   a) nerves
   b) axon
   c) neuron
   d) dendrite

14. In which of the following optic fiber sensor, the fiber is simply used to carry to and from an external optical device where the sensing takes place?
    a) Extrinsic fiber optic sensor.
    b) Energized fiber optic sensor.
    c) All fibers are used to simply carry light to and from external optical devices.
    d) Intrinsic fiber optic sensor.

15. The removal of waste products during dialysis is
    a) inversely proportional to the concentration gradient across the membrane.
    b) proportional to the concentration gradient across the membrane.
    c) proportional to the flow rate across the membrane.
    d) inversely proportional to the flow rate across the membrane.

16. What is used to convert movement of transducer due to an increase of tension in uterus into an electric signal?
    a) AC amplifier
    b) Strain gauge
    c) Synchronous detector
    d) Piezoelectric crystal

17. What is the PH of Arterial blood?
    a) 7.25
    b) 7.30
    c) 7.35
    d) 7.40

18. Potentiometer works on which of the following principle?
    a) variable resistance
    b) variable inductance
    c) variable capacitance
    d) variable electromagnet

19. Neutrophils are concerned with _____ and lymphocytes are concerned with _____.
    a) ingestion of bacteria; immunological responses
    b) production of bacteria; electrical responses
    c) electrical responses; production of bacteria
    d) immunological responses; ingestion of bacteria

20. What is used in modern instrument for intravascular oximetry?
    a) photodiode
    b) red and infrared LED’s
    c) optical fiber
    d) phototransistor

21. How much blood is present in an average adult?
    a) 10 - 12 L
    b) 2 - 3 L
    c) 5 - 6 L
    d) 20 - 25 L

22. Where are potentials picked up by patient electrodes taken to?
    a) Lead Selector switch
    b) Preamp
    c) Power Amplifier
    d) Instrumentational Amplifier

23. What is used as a photodetector in pulse oximetry?
    a) Phototransistor
    b) Solar cell
    c) Photodiode
    d) Photographic plates

24. Speech audiometry normally allows measurements to be made within the frequency range of_____.
    a) 300 - 3000 Hz
    b) 30 - 300 Hz
    c) 300 - 3000 KHz
    d) 3 - 30K Hz

25. Which of the following instrument is used to measure blood flow in the skin?
    a) NMR Blood Flowmeter
    b) Ultrasonic Blood Flowmeter
    c) Electromagnetic Blood Flowmeter
    d) Laser Doppler Blood Flowmeter

26. From the options given below, select the one that best describes: Transcutaneous.
    a) passing to the heart.
    b) passing to the bones.
    c) passing to the skin.
    d) passing to the lungs.

27. _____ method is based on the absorption of electromagnetic radiation in the visible, ultraviolet and infrared ranges.
    a) Cardiotocography
    b) Ultrasonic therapy
    c) Spectrophotometry
    d) Diathermy

28. The blood pressure within the glomerular capillaries is _____ of mercury.
    a) 80 mmHg
    b) 70 - 80 mmHg
    c) 90 mmHg
    d) 70 - 90 mmHg

29. Device used for producing heat stimulus by application of high frequency energy is
    a) respirometry.
    b) diathermy machine.
    c) laser machine.
    d) coagulation analyser.

30. What is the proper way to use screwdriver while using on screws?
    a) 40% turn, 60% force
    b) 20% turn, 80% force
    c) 80% turn, 20% force
    d) 50% turn, 50% force

PART II – Short Answer Questions (20 marks)

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.

1. Explain three types of measurement of living body information? Name two devices used to measure electrical impulse of human body? (3+2 marks)

2. What are the two types of nebulizer? Explain with diagram the working principle of ultrasound nebulizer? (1+4 marks)

3. Name the kind of energy that the following devices produce: (5 marks)
    a) Defibrillator
    b) Infant incubator
    c) Ultrasound machine
    d) X-ray apparatus
    e) Lung ventilator

4. Name the types of ECG recordings? How do you correct drift noise in ECG machine? (2+3 marks)

SECTION B: Case Study (50 marks)

Choose either Case I or Case II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.

Case I

The ECG machine in Damphu hospital keeps breaking down. You as a biomedical engineer are assigned to investigate the cause of the problem and help the clinical staff in properly using the machine. Upon inspecting, you found that the main cause of frequent breakdown is due to mishandling by clinical staff. Train the biomedical technicians to reduce breakdown of ECG machine and train both clinicians and BMED staff on proper handling of the machine.

1. Explain ECG normal waveform with the diagram. Tabulate the frequency range, duration and amplitude of a normal ECG bioelectric signal. (2+10 marks)
2. List down the important parts of ECG recorder? (2 marks)
3. What are the different types of ECG lead configurations? (2 marks)
4. How is EINTHOVEN Triangle used in ECG measurement? Explain with the diagram? (20 marks)
5. What are the various sounds produced by the heart? (2 marks)
6. Name the parts of heart conduction system? (2 marks)
7. What is the colour coding of ECG leads? (2 marks)
8. Mention four types of leakage current of ECG machine? (2 marks)
9. Why is electrode paste used in patients while recording ECG waveform? (2 marks)
10. What are the different types of surface electrodes? (2 marks)
11. What are the requirements of physiological signal amplifier or biomedical pre-amplifier used in ECG machine? (2 marks)

Case II

You have been assigned to one of the district hospitals for setting up x-ray unit at the hospital. The management has requested you to support the various activities pertaining to setting up the x-ray machine and your technical advice is critical in successfully completing the work. The hospital has asked you to work with doctors, technicians and the management and provide your inputs wherever necessary.

1. What is radiology? What is the medical term used for x-ray imaging after injection of contrast into the bile ducts? (3+2 marks)

2. Explain in detail, the step by step procedure for installing the x-ray machine at the hospital and your role in doing so? (10 marks)

3. Define following terms used at Radiology department: (10 marks)
   a) CT
   b) Digital subtraction angiography
   c) Contrast studies
   d) Brachytherapy
   e) Fluoroscopy

4. Draw a block diagram of x-ray unit. Explain the essential components of x-ray unit? (20 marks)

5. What is your role as biomedical engineer after completion of the assigned work? (5 marks)

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