

DIPLOMA IN BIOMEDICAL ENGINEERING TECHNOLOGY

LEVEL 6 YEAR II EXAMINATION

FINAL INTEGRATED SUMMATIVE EXAMINATION

SITTING: JULY/ AUGUST 2026

SUBJECT: CLINICAL ENGINEERING I (THEORY)

TIME: THREE (3) HOURS **TOTAL MARKS: 100**

INSTRUCTIONS TO CANDIDATE **PASS MARK: 50**

1. Write your Examination number and National Registration Card (NRC) number on the answer booklet provided. Ensure you append your signature in the space provided on the answer booklet.
2. Write the ANSWER SCRIPT SERIAL NUMBER on the examination register and on the entry slip.
3. This paper has TWO (2) Sections.
   - Answer ALL questions in section A
   - Answer FIVE (5) questions in Section B. Question one (1) is compulsory then answer any other four (4) questions from the remaining six (6) questions.
4. Diagrams may be used where necessary to clarify your answer.
5. Cell phone and programmable calculators are not allowed in the examination room

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION A: MULTIPLE CHOICE QUESTIONS **TOTAL MARKS: 20**
ANSWER ALL QUESTIONS BY CHOOSING THE BEST OPTION

1. Which of the following biomedical sensors is specifically used to measure electrical activity generated by the heart?
   B. Electrode
   B. Transducer
   C. Thermistor
   D Plethysmograph
2. In an ECG (Electrocardiogram) measurement, the standard Einthoven triangle involves how many active electrodes?
   A. 2
   B. 3
   C. 4
   D. 12
3. What physiological signal does an EEG (Electroencephalogram) measure?
   A. Muscle activity
   B. Brain electrical activity
   C. Eye movement
   D. Nerve conduction velocity
4. Which of the following is an invasive technique for measuring blood pressure directly?
   A. Sphygmomanometer
   B. Pulse Oximetry
   C. Intra-arterial catheter/transducer
   D. Doppler ultrasound
5. What does the term "SpO2" measure in a biological monitoring system?
   A. Heart rate
   B. Oxygen saturation of arterial blood
   C. Carbon dioxide levels
   D. Blood glucose level
6. Which sensor converts the mechanical vibrations of heart sounds into electrical signals?
   A. Phono-transducer
   B. Thermocouple
   C. Strain gauge
   D. Photoelectric sensor
7. According to global medical device classifications (e.g., FDA or WHO), which class represents the *highest* patient risk and requires the most stringent regulatory controls?
   A. Class I
   B. Class IIa
   C. Class IIb
   D. Class III
8. An X-Ray machine is primarily classified into which category of medical equipment?
   A. Diagnostic equipment
   B. Therapeutic equipment
   C. Rehabilitation equipment
   D. Monitoring equipment

9. A dialysis machine is an example of what type of medical equipment?
   A. Monitoring equipment
   B. Therapeutic equipment
   C. Diagnostic equipment
   D. Rehabilitation equipment

10. Which of the following is considered an "auxiliary" or "supportive" piece of hospital equipment?
   A. Infusion pump
   B. Suction machine
   C. Hospital bed
   D. Ultrasound scanner

11. What is the primary intended use of a surgical C-arm?
   A. To measure blood glucose
   B. To provide live fluoroscopic imaging during surgery
   C. To administer anaesthesia
   D. To sterilize surgical tools

12. Surgical lasers belong to which category of medical devices?
   A) Therapeutic
   B) Diagnostic
   C) In Vitro Diagnostic (IVD)
   D) Patient monitoring

13. What is the primary purpose of calibrating a laboratory pH meter?
   A. To sterilize the glass electrode
   B. To ensure the accuracy of the acidity/alkalinity measurement
   C. To clean the reference solution
   D. To lubricate the moving parts

14. The table top of an operating table is designed to:
   A. Store surgical instruments
   B. Support the patient during surgery
   C. House hydraulic pumps
   D. Control anesthesia flow

15. The foot switch/control unit on an operating table is used to:
   A. Adjust table height and tilt hands-free
   B. Lock the wheels during transport
   C. Monitor patient vital signs
   D. Power the anesthesia machine

16. The transporter in mobile operating tables is designed to:
   A. Move the table between operating rooms
   B. Store surgical instruments
   C. Provide suction power
   D. Regulate anesthesia gases

17. Which part of the operating table provides stability and houses the movement mechanisms?
   A. Head plate
   B. Column (central base)
   C. Back plate
   D. Leg plate

18. Modern operating tables are designed for:
    A. Single surgical specialty only
    B. Versatility across multiple procedures
    C. Transport of surgical staff
    D. Monitoring patient vitals

19. What routine maintenance must be performed on high-speed dental handpieces to prevent bearing failure?
    A. Sharpening the drill bits
    B. Autoclaving without prior cleaning
    C. Rinsing with cold water only
    D. Lubrication with specialized oil after every use

20. Which component of the suction machine generates negative pressure?
    A. Regulator
    B. Pump
    C. Filter
    D. Suction bottle

TOTAL MARKS: 80

SECTION B:

THERE ARE SEVEN (7) QUESTIONS IN THIS SECTION, ANSWER FIVE (5) QUESTIONS. QUESTION ONE (1) IS COMPULSORY.

QUESTION 1 (COMPULSORY)

a) Define biological signals. [2 marks]

b) Draw a clearly labeled block diagram of a bioinstrumentation (biological signal measurement) system and explain the function of each component in the system. [10 marks]

c) Explain the working principle of strain gauge transducers in measuring physiological parameters such as blood pressure. [5 marks]

d) Describe the importance of filtering in biological signal processing. [3 marks]

[TOTAL 20 marks]

QUESTION 2

a) State the importance of blood pressure measurement in a hospital. [2 marks]

b) List **four (4)** main components of a manual blood pressure machine. 4 marks]

c) Explain the working principle of an automatic digital blood pressure monitor. [5 marks]

d) Describe **two (2)** routine preventive maintenance checks/tests to be carried out on a digital blood pressure machine by a biomedical engineering technologist. [4 marks]

[TOTAL 15 marks]

QUESTION 3

Explain the function of each of the following parts of a suction machine.

a) Vacuum Pump [3 marks]

b) Vacuum Gauge [3 marks]

c) Overflow Protection System [3 marks]

d) Bacterial/Viral Filter [3 marks]

e) Vacuum Regulator [3 marks]

[TOTAL 15 MARKS]

QUESTION 4

a) State the purpose of a surgical lamp in an operating theatre. [2 marks]

b) List **two (2)** types of surgical lamps commonly used in hospitals. [2 marks]

c) Explain the differences between halogen and LED operating theatre lamps in terms of energy efficiency, maintenance cost and heat production. [9 marks]

d) Explain **a** safety precaution that must be considered during usage of surgical lamps in the theatre. [2 marks]

[TOTAL MARKS 15]

QUESTION 5

a) State **two (2)** primary functions of the dental treatment unit [2 marks]

b) Explain the function of the following equipment in the dental department:

i) Dental furnace [2 marks]

ii) Amalgamator [2 marks]

iii) Dental Polymerisation unit [3 marks]

iv) Amalgam separator [2 marks]

c) Describe **two (2)** common faults associated with dental equipment in a hospital.

[4 marks]

[TOTAL 15 marks]

QUESTION 6

a) Define autoclaving [2 marks]

b) State **two (2)** methods used to confirm that sterilization has been achieved. [2 marks]

c) Explain the following autoclave cycles:

i) Purge phase [2 marks]

ii) Pre-heating phase [2 marks]

iii) Exposure phase [2 marks]

iv) Exhaust phase [2 marks]

d) Describe the cause of the following problems in an autoclave.

i) Hissing sound [2 marks]

ii) Scales building up on the heating elements [1 mark]

[TOTAL 15 MARKS]

QUESTION 7

a) Define the following:

i) Ventilator [2 marks]

ii) Assisted control mode [3 marks]

b) Explain the following ventilator parameters:

i) PEEP [2 marks]

ii) CPAP [2 marks]

iii) VCV [2 marks]

iv) I: E ratio [2 marks]

v) PCV [2 marks]

[TOTAL 15 MARKS]