



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

**IN
BIOMEDICAL ENGINEERING**

MODULE: Engineering Mathematics

PAPER NO: 450/22/M07

DURATION: 3 Hours

NOVEMBER/DECEMBER 2025 EXAMINATION

REQUIREMENTS

1. Non- Programmable Calculator.
2. Graph Paper

INSTRUCTIONS TO CANDIDATE

1. Answer all questions in Section A.
2. Answer any three (3) question in Section B.
3. Do not write your name on the answer booklet.
4. Do not write anything on this question paper.

This paper consists of 4 printed pages.

SECTION A

QUESTION 1

- a) If $f(t) = 5t + \frac{1}{\sqrt{t^3}}$, find $f'(t)$ (3 marks)
- b) If $f(x) = 4x^2 - 3x + 2$, find $f(-1)$ (2 marks)
- c) Determine $\int 3\sqrt{x} \, dx$ (3 marks)
- d) Prove that $\sin^2\theta \cot\theta \sec\theta = \sin\theta$ (2 marks)

QUESTION 2

- a) Evaluate

$$\frac{2}{(1+j)^4} \quad \text{where } j=\sqrt{-1} \quad (5 \text{ marks})$$

- b) Solve this following simultaneous equation

i) $\frac{1}{x+y} = \frac{4}{27}$

ii) $\frac{1}{2x-y} = \frac{4}{33} \quad (5 \text{ marks})$

QUESTION 3

- a) The speed of a train is reduced uniformly from 15ms^{-1} to 7.0ms^{-1} while traveling a distance of 90m.
- i) Compute the acceleration (3 marks)
- ii) Calculate how much, the train travels before coming to rest, provide acceleration remains constant. (3 marks)
- b) Given $32 = 70(1 - e^{-\frac{t}{2}})$
- determine the value of t , correct to 3 significant figures. (4 marks)

QUESTION 4

a) State Newtons 3 laws of motion. (6 marks)

b) Find the scalar product of the vectors a and b

$$a = i + 2j - k$$

$$b = 2i + 3j + k$$

(2 marks)

c) If $p = 2i + j - k$, Find the modulus of the vector p. (2 marks)

SECTION B

QUESTION 5

a) Plot the graph of $y = x + 2$
and determine the gradient and y intercept. (8 marks)

b) Solve the equation $4x^2 + 7x + 2 = 0$ (4 marks)

c) State any five (5) laws of indices. (5 marks)

d) Write $\frac{1}{2}\log 25$ as the logarithm of a single number. (3 marks)

QUESTION 6

a) Solve the equation
 $\log(x - 1) + \log(x + 8) = 2 \log(x + 2)$ (6 marks)

b) Solve the equation $9 = 4e^{-3x}$ (5 marks)

c) Write 0.000 018 in standard form. (2 marks)

d) Hooke's Law states that stress, δ , is directly proportional to strain ϵ within the elastic limit of the material. Given that when the stress for mild steel is 63MPa, the strain is 0.0003. Determine

i) The value of strain when stress is 42MPa. (4 marks)

ii) The value of stress when strain is 0.00072. (3 marks)

QUESTION 7

- a) The luminous intensity I , candelas of a lamps at varying voltage V is given by $I = 4 \times 10^{-4}V^2$. Determine the voltage at which the light intensity is increasing at a rate of 0.6 candelas per volt. (6 marks)
- b) A sinusoidal voltage has a maximum value of 100V. Calculate its RMS value using integration. (7 marks)
- c) State any two (2) double angle formulae in trigonometry. (2 marks)
- d) $I_3 \sin 30^\circ$ is the third harmonic of a waveform, Express the third harmonic in terms of the first harmonic $\sin \theta$, when $I_3=1$. (5 marks)

QUESTION 8

- a) Determine the modulus and argument of the complex number $Z = 2 + j3$ and express Z in the polar form. (6 marks)
- b) Solve the equation:
 $(1 + j2)(-2 - j3) = a + jb$ (4 marks)
- c) Convert 56_{10} to a binary number. (3 marks)
- d) Point A lies at the coordinates (2;3) and point B is at (8;7). Determine
- i) The distance AB (4 marks)
- ii) The gradient of the straight-line AB. (3 marks)

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NATIONAL CERTIFICATE

IN

BIOMEDICAL ENGINEERING

**MODULE: Electrical And Electronic Principles PAPER NO: 450/22/M05/2
II**

DURATION: 3 Hours

NOVEMBER/DECEMBER 2025 EXAMINATION

REQUIREMENTS

Non programmable calculator.

INSTRUCTIONS TO CANDIDATE

- 1. Answer all questions in Section A. 40 marks**
- 2. Each question in Section A carries 10 marks.**
- 3. Answer any three (3) questions in Section B. 60 marks**
- 4. Each question in Section B carries 20 marks.**
- 5. Do not write your name or surname in the question paper or answer script.**
- 6. Do not write anything on the question paper.**

This paper consists of 7 printed pages.

SECTION A

40 MARKS

Answer all questions.

QUESTION 1

- (a) (i) State any two (2) limitations of Thevenin's theorem. (2 marks)
- (ii) State any two (2) benefits of Thevenin's theorem. (2 marks)
- (b) Use Thevenin's theorem to find the current flowing in the 10Ω resistor for the circuit shown in Fig Q1b. (6 marks)

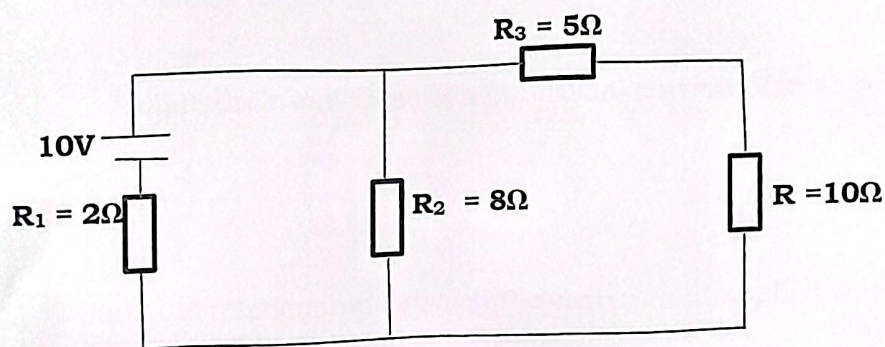


Fig Q1b

QUESTION 2

- (a) State the maximum power transfer theorem. (2 marks)
- (b) A D.C source has an open circuit voltage of 30V and an internal resistance of 1.5Ω .
- (i) state the value of the load resistance that gives maximum power dissipation. (1 mark)
- (ii) determine the value of this power. (4 marks)
- (c) Explain the advantages of this maximum power transfer theorem. (3 marks)

QUESTION 3

- (a) Determine the periodic time for the following frequencies
- (i) 50Hz (2 marks)
 - (ii) 20Hz (2 marks)
- (b) Determine the following for a 240V main supply
- (i) Peak value (2 marks)
 - (ii) Mean value (2 marks)
- (c) Calculate the **r.m.s** value of a sinusoidal current of maximum value 20A. (2 marks)

QUESTION 4

- (a) State the relationship between the current and applied voltage in a purely resistive series a.c circuit. (2 marks)
- (b) A coil has an inductance of 40mH and negligible resistance. Calculate its inductive reactance and the resulting current if connected to
- (i) 240V, 50Hz supply (4 marks)
 - (ii) 100V , 1kHz supply (4 marks)

SECTION B

60 MARKS

Answer any three (3) questions.

QUESTION 5

A coil of inductance 159.2mH and resistance 40Ω is connected in parallel with a $30\mu\text{F}$ capacitor across a 240V , 50Hz supply. Calculate: -

- (a) the current in the coil and its phase angle. (8 marks)
- (b) the current in the capacitor and its phase angle. (5 marks)
- (c) The supply current in its phase angle. (6 marks)
- (d) The circuit impedance (1 mark)

QUESTION 6

- (a) Draw the basic structure of an op-amp and describe the function of each pin. (6 marks)
- (b) In the inverting amplifier below in **Fig Q6b** $R = 1\text{k}\Omega$ and $R_f = 2\text{k}\Omega$. determine the output voltage when the input voltage is
 - (i) $+0.4\text{V}$ (2 marks)
 - (ii) -1.2V (2 marks)

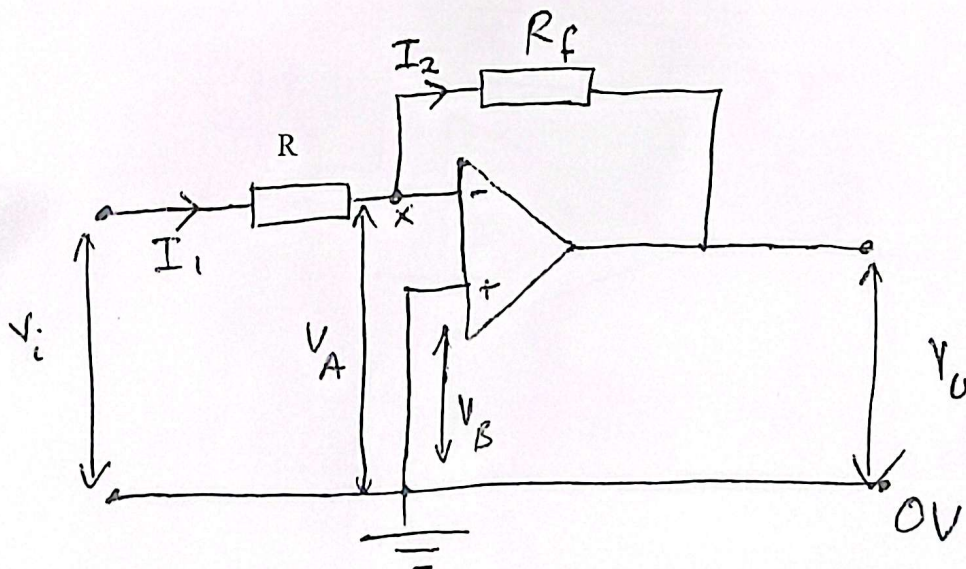


Fig Q6b

- (c) For the summing up- amp shown in **Fig Q6c**, determine the output voltage, V_o . (4 marks)

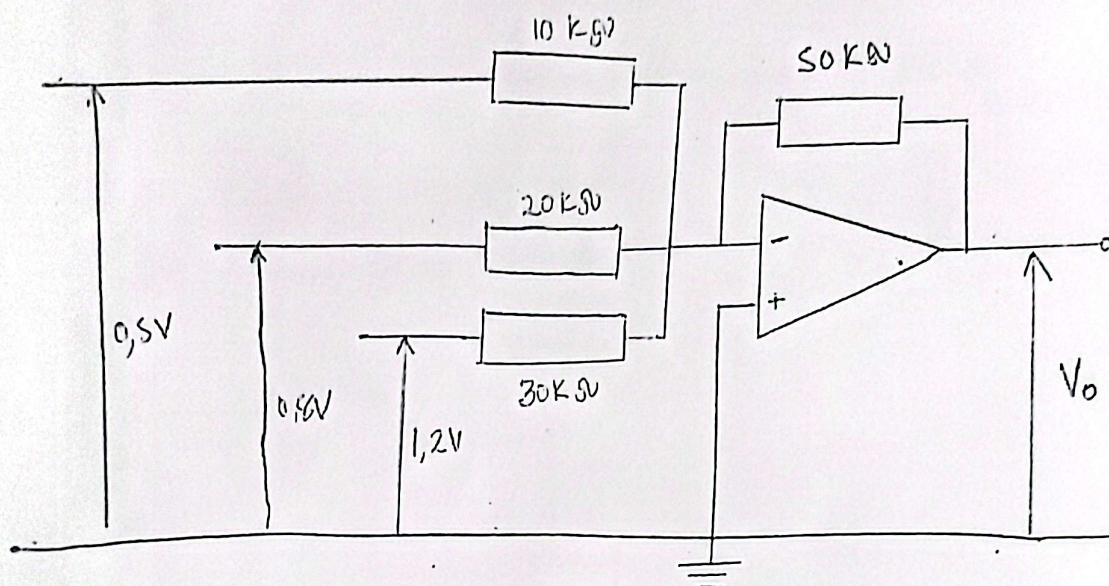


Fig Q6c

- (d) Explain the concept of the voltage follower. (3 marks)
- (e) For the op-amp any shown in **Fig Q6e**, determine voltage gain if input voltage is -0.4V. (3 marks)

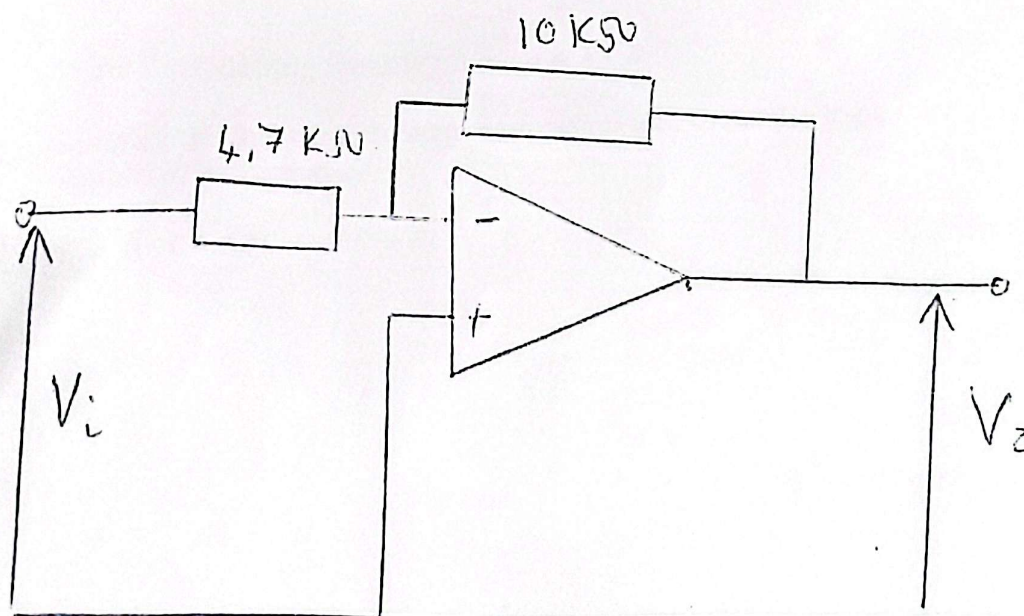


Fig Q6e

QUESTION 7

- (a) Differentiate between digital and analog signals. (3 marks)
- (b) (i) Find the Boolean equation for the output of X in **Fig Q7b**. (2 marks)
- (ii) Evaluate X when $A = 0, B = 1, C = 1$ (2 marks)
- (iii) Evaluate X when $A = 1, B = 1, C = 1$ (3 marks)

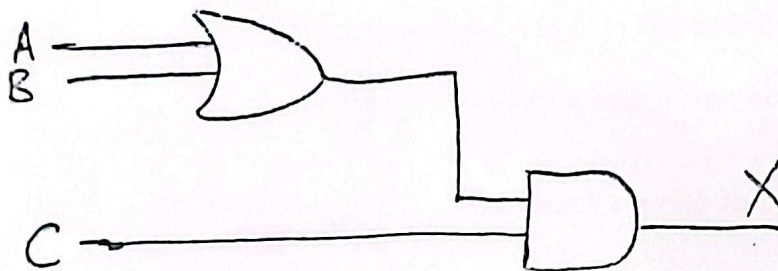


Fig Q7b

- (c) Prove the following identity : $A + \bar{A}B = A + B$ (3 marks)
- (d) Simplify the following Boolean expression and draw the logic circuits for simplified expressions: - (7 marks)
- $$Y = \bar{A}BC + A\bar{B}C + ABC + B\bar{C}$$

QUESTION 8

(a) $\overline{A(B + \overline{C})D}$

Simplify the above expression using De Morgan's theorem. (4 marks)

(b) Define the term transient. (3 marks)

(c) A capacitor is charged to 100V and then discharged through a $50k\Omega$ resistor. If the time constant of the circuit is 0.8s. Determine: -

(i) The value of the capacitor (3 marks)

(ii) The time for the capacitor voltage to fall to 20V (3 marks)

(iii) The current flowing when the capacitor has been discharging for 0.5s (4 marks)

(iv) The voltage drop across the resistor when the capacitor has been discharging for one second. (3 marks)

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IN

BIOMEDICAL ENGINEERING

SUBJECT: Human Anatomy and Physiology PAPER NO: 450/22/M04

DURATION: 3 Hours

NOVEMBER/DECEMBER 2025 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

- 1) Answer any five (5) questions.
- 2) Each question carries 20 marks.

This paper consists of 3 printed pages.

QUESTION 1

- a) Define the anatomical terms:
- i) Median (2 marks)
 - ii) Coronal (2 marks)
 - iii) Transverse (2 marks)
 - iv) Anatomical position (2 marks)
 - v) Dorsal cavity (2 marks)
 - vi) Proximal (2 marks)
- b) Distinguish between the two types of feedback mechanisms including examples. (8 marks)

QUESTION 2

- a) State five (5) functions of the skeletal system. (5 marks)
- b) Classify the joints of the musculoskeletal system including an example for each class. (10 marks)
- c) Describe the layers of the skin (5 marks)

QUESTION 3

- a) Draw and label a nephron indicating the function of each component (10 marks)
- b) i) State the characteristics of cardiac muscles. (4 marks)
- ii) Discuss three (3) factors that influence blood pressure. (6 marks)

QUESTION 4

- a) Describe the various respiratory volumes and capacities. (10 marks)
- b) Explain the events that take place when signal is passing from one to another. (10 marks)

QUESTION 5

- a) State the functions of the following hormones in reproduction:
- i) Testosterone (2 marks)
 - ii) Follicle stimulating hormone (2 marks)
 - iii) Gonadotropin (2 marks)
 - iv) Oestrogen (2 marks)
 - v) Progesterone (2 marks)
- b) Describe the male reproductive system. (10 marks)

QUESTION 6

- a) State the functions of the endocrine system. (10 marks)
- b) Describe the digestion of food from ingestion to excretion. (10 marks)

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IN

BIOMEDICAL ENGINEERING

**MODULE: Safety Health Environmental
Quality**

PAPER NO: 450/22/M01

DURATION: 3 Hours

NOVEMBER/ DECEMBER 2025 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

1. Section A contains two (2) questions.
2. Each question carries twenty (20) marks.
3. Section B contains four (4) questions, answer any three (3) questions.
4. Do not write your name in the question paper or answer script.

This paper consists of 3 printed pages.

SECTION A

Answer all

QUESTION 1

- a) Define the following terms:
- i) Safety (2 marks)
 - ii) Hazard (2 marks)
 - iii) Sterilisation (2 marks)
 - iv) Decontamination (2 marks)
 - v) Housekeeping (2 marks)
- b) Outline any five (5) categories of personal protective equipment. (10 marks)

QUESTION 2

- a) i) Identify any five (5) legislation that govern health and safety in the workplace. (5 marks)
- ii) Outline any five (5) first aid rules for dealing with an electric shock injury. (5 marks)
- b) Explain the Five (5) major aspects that a SHE officer should emphasise on to ensure overall coverage of safety, health and quality management. (10 marks)

SECTION B

QUESTION 3

- a) List any five (5) sterilising agents. (5 marks)
- b) Discuss any five (5) factors influencing the selection of disinfection/sterilising agents. (15 marks)

QUESTION 4

- a) Identify four (4) prohibited acts when using electricity. (4 marks)
- b) i) With the aid of a diagram, describe the fire tetrahedron. (8 marks)
- ii) Explain the four 4 ways of extinguishing fire. (8 marks)

QUESTION 5

- a) outline five (5) principles of SHEQ. (10 marks)
- b) explain the ways poor working conditions affect health and safety of workers. (10 marks)

QUESTION 6

- a) Outline any five (5) biological hazards applicable in the biomedical industry. (10 marks)
- b) Describe the five (5) steps involved in emergency response / management. (10 marks)

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