



ZIMBABWE

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

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

BIOMEDICAL ENGINEERING

**MODULE: Biomedical Equipment
Maintenance**

PAPER NO: 450/22/M08

DURATION: 3 Hours

OCTOBER/NOVEMBER 2024 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

1. Answer any four questions.
2. Each question carries 25 marks.
3. Do not write your name and or surname on the answer sheet.

This paper consists of 4 printed pages.

QUESTION 1

- (a) Define the following types of equipment maintenance, giving Biomedical engineering examples
- (i) preventive maintenance (4 marks)
 - (ii) predictive maintenance (4 marks)
 - (iii) emergency maintenance (4 marks)
 - (iv) corrective maintenance (4 marks)
 - (v) routine maintenance (4 marks)
- (b) State the five general steps for biomedical equipment maintenance. (5 marks)

QUESTION 2

- (a) Distinguish between preventive maintenance and predictive maintenance. (6 marks)
- (b) State three types of biomedical equipment. (3 marks)
- (c) A biomedical engineering technician is well aware that there are three classes of biomedical equipment Class I, Class II and III. Describe the classification criteria giving examples (16 marks)

PAPER NO: 450/22/M08 – BIOMEDICAL EQUIPMENT MAINTENANCE

QUESTION 3

Biomedical equipment maintenance plays a pivotal role in any nation's medical industry, discuss factors affecting biomedical equipment maintenance in Zimbabwe, giving authentic examples. (25 marks)

QUESTION 4

- (a) Define the term equipment calibration giving an example. (6 marks)
- (b) After gaining certification for calibration of biomedical equipments you are tasked to propose tools and reliable methodologies for calibration of the following parameters:-
 - (i) Temperature (4 marks)
 - (ii) X ray intensity (4 marks)
 - (iii) Voltage of a defibrillator. (4 marks)
- (c) List seven tools used for equipment disassembly. (7 marks)

QUESTION 5

- (a) State three hazards associated with the following biomedical equipment:-
 - (i) Autoclave machine (3 marks)
 - (ii) Ventilator (3 marks)
 - (iii) Infant warmer (3 marks)
 - (iv) MRI machine (3 marks)
- (b) Outline mitigation strategies for five of the hazards identified in part (a) (5 marks)
- (c) Using sketches illustrate grounding for or insulation requirements for each of the following biomedical equipment classes.
 - (i) Class I (2 marks)
 - (ii) Class II (3 marks)
 - (iii) Class III (3 marks)

QUESTION 6

Give a detailed description for general maintenance of an oxygen tank clearly outlining:-

- | | |
|--------------------------------------|-----------|
| (a) Components | (6 marks) |
| (b) Setup | (5 marks) |
| (c) Consumables | (4 marks) |
| (d) Procedures | (4 marks) |
| (e) Hazards and mitigation thereof | (4 marks) |
| (f) Tests and operation instructions | (2 marks) |

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**NATIONAL CERTIFICATE
IN**

BIOMEDICAL ENGINEERING

**SUBJECT: Drawing and Electrical Circuit PAPER NO: 450/22/M03
Designed**

DURATION: 3 Hours

OCTOBER/NOVEMBER 2024 EXAMINATION

REQUIREMENTS

- 1) Non scientific calculator
- 2) Desktop/computer with CAD softwares, offline
- 3) Blank disk

INSTRUCTIONS TO CANDIDATE

- 1) Question paper consists of six (6) questions.
- 2) Answer only five (5) questions.
- 3) Each question carries 20 marks.
- 4) Identification and distinguishing between "CAD" questions and hand writing questions is strictly examinable and the students task.
- 5) Save files in a folder with your student number as the folder name.
- 6) Print out "CAD" circuits and results saved in PDF format or clear screenshots from your "CAD" software answers.
- 7) Save and transfer your folder to a blank disk provided by the invigilator.
- 8) No foreign hard drives are allowed in the venue.
- 9) Do not write your name or surname on the answer script or any submitted document either in soft or hard copies

This paper consists of 4 printed pages.

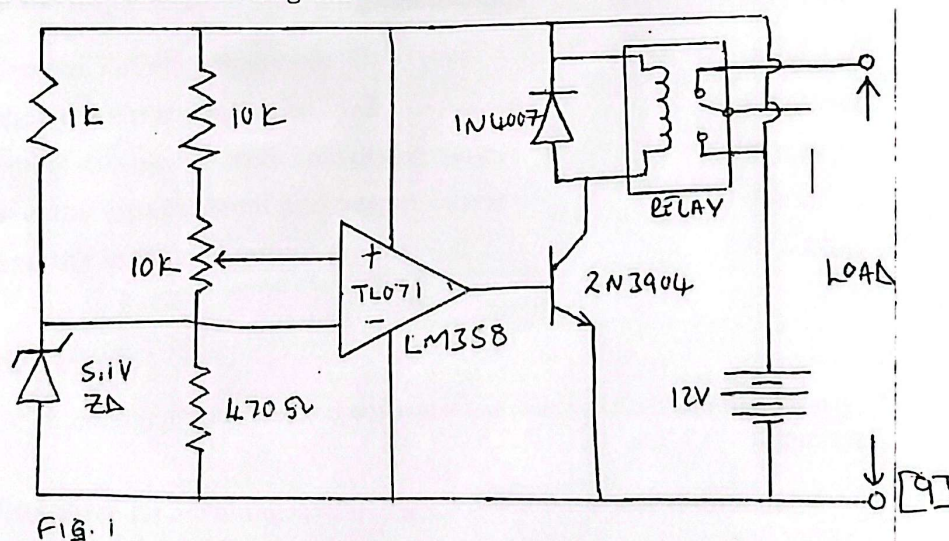
PAPER NO 450/22/M03-DRAWING AND ELECTRICAL CIRCUIT DESIGNED

QUESTION 1

- a) Draw symbols for the following BS3939 components, state their functions and give a use case example for each:
- | | | |
|------|-----------------------------|-----------|
| i) | Iron core transformer | (4 marks) |
| ii) | Electrolytic capacitor | (3 marks) |
| iii) | Resistor | (3 marks) |
| iv) | PNP transistor | (4 marks) |
| v) | AC voltage source component | (3 marks) |
- b) Cite an example of an integrated circuit and its reference part number.
(3 marks)

QUESTION 2

Below is a circuit schematic diagram



- a) Deduce the application of the circuit in fig 1, and give an example application.
(4 marks)
- b) Model the schematic diagram using your bread board design and the fritzing schematic diagram feature interface. Your design must be neat and all connections must be clear, in the fritzing print out. (16 marks)

PAPER NO 450/22/M03-DRAWING AND ELECTRICAL CIRCUIT DESIGNED

QUESTION 3

Using proteous design suit, design a day light control switch making use of a monostable or astable 555-timer circuit

- a) Show the list of components. (4 marks)
- b) Indicate technical specifications. (3 marks)
- c) Show all graphs for input and output wave forms in the design. (8 marks)
- d) Show all working and indicate the time Constance and duty cycle. (5 marks)

QUESTION 4

Design an AC to DC power supply circuit using a CAD software of your choice, the system should convert 220VAC,50Hz to 24VDC where 220VAC is the peak voltage of the input supply: including calculations (1 mark)

- a) Show the list of components (4 marks)
- b) Indicate technical specifications (2 marks)
- c) Display voltages of every conversion state. (4 marks)
- d) Show the input current and output current. (4 marks)
- e) Show the input and output graphs. (5 marks)

QUESTION 5

- a) List three (3) computer aided software used in biomedical engineering. (3 marks)
- b) Write three (3) advantages of using CAD software over traditional methods of drawing. (3 marks)
- c) Describe the importance of block diagrams in circuit design. (3 marks)
- d) Design a block diagram for a pill dispensing instrumentation and control device applying basic components of an instrumentation circuit. (11 marks)

QUESTION 6

- a) With the aid of sketches draw the following PI and D standard symbols and explain their application:

PAPER NO 450/22/M03-DRAWING AND ELECTRICAL CIRCUIT DESIGNED

- i) Hand operated gate valve (2 marks)
 - ii) Motor controlled valve (2 marks)
 - iii) Hydraulic valve (3 marks)
 - iv) Pneumatic (diaphragm) (3 marks)
- b) Name and illustrate three (3) technical drawing lines you know. (6 marks)
- c) State voltage ratings for the following components.
- i) Microcontroller (2 marks)
 - ii) Light emitting diode (2 marks)

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**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

BIOMEDICAL ENGINEERING

**MODULE: Drawing and Electrical Circuit
Designing**

PAPER NO: 450/22/M03

DURATION: 3 hours

MAY/JUNE 2024 EXAMINATION

REQUIREMENTS

- A computer loaded with CAD (Computer aided design) software
- Blank Disc (writeable)

INSTRUCTIONS TO CANDIDATE

1. Question paper contains six (6) questions
2. Candidates are instructed to answer four (4) questions only
3. Each question carries 25 marks

This paper consists of 4 printed pages.

QUESTION 1

- a) Show using an illustration the following electronic circuits.
- i) Pull up circuit. (2 marks)
 - ii) Pull down circuit. (2 marks)
 - iii) State any application of the above circuits. (3 marks)
- b) Using CAD design software show your understanding of the 555 timer monostable multivibrator.
- i) Show your schematic illustration. (3 marks)
 - ii) Show a graph for a triggered output. (5 marks)
 - iii) Show input and output illustrations. (5 marks)
 - iv) Describe the difference between astable, bistable and monostable multivibrator. (5 marks)

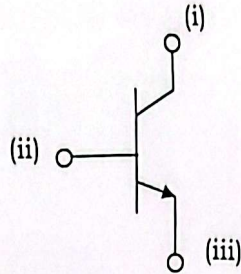
QUESTION 2

- a) With the aid of any design software of your choice implement a 2 way traffic management system.
- i) Bread board. (5 marks)
 - ii) Schematic design. (5 marks)
- b) Using proteous design a 555 timer Astable multivibrator. (15 marks)

QUESTION 3

- a) Draw symbol for the following B53939 Components, state their function and give a use case example for each.
- i) Variable resistor. (3 marks)
 - ii) Light emitting diode. (3 marks)
 - iii) Mosfet (enhancement type). (3 marks)
 - iv) Mosfet depletion type. (3 marks)
 - v) Iron core inductor. (3 marks)
- b) Draw the following lines and explain how they are used with their application.
- i) Centre line. (3 marks)
 - ii) Construction line. (1 mark)
 - iii) Break line. (2 marks)
 - iv) Hidden line. (3 marks)

- c) Below is an NPN transistor symbol.



Clearly label each node.

(1 mark)

QUESTION 4

- a) DTA143EKA
Is a part number of an electrical electronic component. State the meaning of each later/symbol. (16 marks)
- b) List three (3) CAD software used for biomedical engineering drawing. (3 marks)
- c) Design and draw a block diagram for an antitheft electronic system for a table top device. (A device designed to work on a table). (7 marks)

QUESTION 5

- a) With the aid of CAD software design a power supply with input 220V ac, and output 24V dc.
- i) Show all connections and technical specifications of components. (6 marks)
 - ii) Show all input and output voltages at every stage. (5 marks)
 - iii) Show all graphs at every stage. (5 marks)
- b) With aid of neat diagrams, draw 3 valves of your choice from the PI & D standard and explain their application. (9 marks)

QUESTION 6

With the aid of C programming debug the following code.

```
const int ledgreen = 2;
const int ledred = 3;
const int ledyello = 4;
const int temp = AO
const int buzzer = 6

void setup ( )
pinmode (ledgreen, OUTPUT)
pinmode (ledred, OUTPUT);
pinmode (ledyellow OUTPUT);
pinmode (buzzer, OUTPUT)
serial.begin (9600)
}
Void loop {
digital write (ledgreen , low);
digital write (ledred < low);
digital write (ledyellow, low)
int cal = analog red(temp)
if val = < 5.12 {
digitalwrite (buzzer, low)
digitalwrite ledgreen, low);
else
digitalwrite (ledred, HIGH);
digitalwrite (buzzer, high)
}
```

(25 marks)

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IN

BIOMEDICAL ENGINEERING

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

DURATION: 3 Hours

MAY/JUNE 2024 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

Answer ANY FIVE (5) questions.

This paper consists of 2 printed pages.

PAPER NO: 450/22/M04 – HUMAN ANATOMY AND PHYSIOLOGY

QUESTION 1

- (a) Define the following terms
- (i) Anatomy (2 marks)
 - (ii) Physiology (2 marks)
 - (iii) Posterior (2 marks)
 - (iv) Tissue (2 marks)
 - (v) Endocrine (2 marks)
- (b) Distinguish between negative and positive feedback using specific examples. (10 marks)

QUESTION 2

- (a) Describe the various types of tissues giving one example of each. (16 marks)
- (b) Explain the mechanisms of muscle contraction. (4 marks)

QUESTION 3

Draw neat labelled diagrams of the skin giving a function for each structure. (20 marks)

QUESTION 4

- (a) Outline the process of the formation of urine in the kidneys. (16 marks)
- (b) State the role of the accessory organs in digestion. (4 marks)

QUESTION 5

- (a) State the composition of blood. (5 marks)
- (b) Describe the cardiac cycle. (15 marks)

QUESTION 6

- (a) Outline the events that occur at the neuromuscular junction. (10 marks)
- (b) Describe the process of gaseous exchange. (10 marks)

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IN

BIOMEDICAL ENGINEERING

**MODULE: Electrical and Electronic
Principles 1**

PAPER NO: 450/22/M05/1

DURATION: 3 Hours

OCTOBER/NOVEMBER 2024 EXAMINATION

REQUIREMENTS

Use a non programmable scientific calculator.

INSTRUCTIONS TO CANDIDATE

- 1. Question paper contains seven (7) questions.**
- 2. Section A : Questions 1 and 2 carry ten (10) marks each.**
- 3. Section B: Questions 3 and 4 carry twenty (20) marks.**
- 4. Each question in Section B carries twenty (20) marks.**
- 5. Answer all questions in Section A, choose two (2) questions from section B.**

This paper consists of 4 printed pages.



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BIOMEDICAL ENGINEERING

**MODULE: Electrical and Electronic
Principles 1**

PAPER NO: 450/22/M05/1

DURATION: 3 Hours

OCTOBER/NOVEMBER 2024 EXAMINATION

REQUIREMENTS

Use a non programmable scientific calculator.

INSTRUCTIONS TO CANDIDATE

- 1. Question paper contains seven (7) questions.**
- 2. Section A : Questions 1 and 2 carry ten (10) marks each.**
- 3. Section B: Questions 3 and 4 carry twenty (20) marks.**
- 4. Each question in Section B carries twenty (20) marks.**
- 5. Answer all questions in Section A, choose two (2) questions from section B.**

This paper consists of 4 printed pages.

SECTION A

QUESTION 1

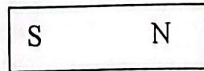
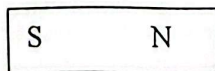
- a) Name any four (4) alternative renewable energy sources. (4 marks)
- b) State any four (4) basic quantities and their units. (4 marks)
- c) Define the value of the resistors with the following codes
 - i) Orange – orange- black – blue – green. (1 mark)
 - ii) Resistor marked as 47kk (1 mark)

QUESTION 2

- a) An ECG machine consumes 1.8MJ of energy when connected to a 250V power supply for 30 minutes; find
 - i) Power rating of the ECG (2 marks)
 - ii) Current drawn from the supply (2 marks)
- b) Give three (3) differences between a voltmeter and an ammeter. (3 marks)
- c)
- d) Using sketches illustrate how both instruments in part 2b are used. (3 marks)

QUESTION 3

- a) In magnetic circuits, define the following terms:
 - i) Magnetic flux (2 marks)
 - ii) Magnetic flux density (2 marks)
- b) Two permanent magnets of equal size are placed such that their fields interact as shown



Re- draw the setup showing how the lines of flux are imagined.

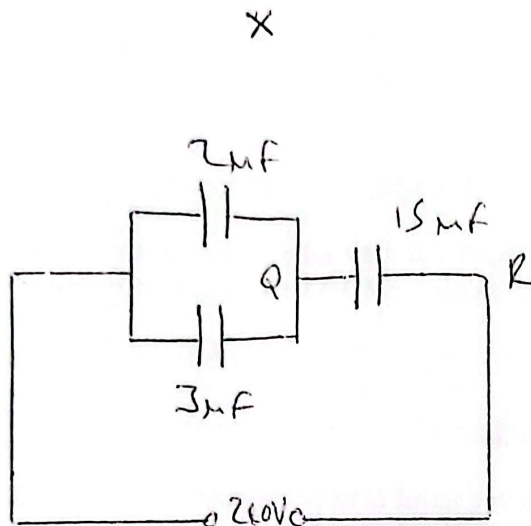
(6 marks)

- c) Two parallel plates having a p.d of 200V between them are spaced 0.8mm apart what is the flux density when the dielectric between the plates is polyethene of relative permittivity $\epsilon_r = 2.3$ and $\epsilon_0 = 8.85 \times 10^{-12}$

(10 marks)

QUESTION 4

- a) For the parallel – series arrangement below find:



- i) Equivalent circuit capacitance. (3 marks)
 - ii) Voltage across QR (3 marks)
 - iii) Charge on each capacitor (3 marks)
 - iv) Energy stored by $15\mu F$ capacitor (3 marks)
- b) The resistance of an electrical conductor depends on four (4) factors. State the four (4) factors and how each factor affects resistance. (8 marks)

SECTION B

QUESTION 5

- a) Transistors can be used as amplifiers when connected in three (3) basic modes; collector and common base. Draw a well labelled transistor diagrams to show these modes. (12 marks)
- b) A transistor operates with a collector current of 100mA and an emitter current of 102mA. Determine the value of the base current. (2 marks)

PAPER NO: 450/22/M05/1 – ELECTRONIC AND ELECTRONIC PRINCIPLES 1

- c) Bipolar transistors (BJTs) comprise of npn or pnp junctions. Draw a cross section of a typical p-n-p transistor, clearly labelling the base, emitter and collector. (6 marks)

QUESTION 6

- a) Define Faraday's law and lenz law of electromagnetic induction. (6 marks)
- b) A rectangular coil of sides 12cm and 8cm is rotated in a magnetic field of flux density 1.4T, the longer side of the coil actually cutting this flux. The coil is made up of 80 turns and rotates of 1200 rev/min.
Calculate the maximum generated e.m.f (5 marks)
- c) A flux of 25mWb links with a 1500 turn coil when a current of 3. A passes through the coil. Calculate:
- i) The inductance of the coil. (3 marks)
- ii) The energy stored in the magnetic field. (3 marks)
- d) Illustrate the magnetic field lines pattern around a around a conductor passing current at 90° to the page downwards. (3 marks)

QUESTION 7

- a) Field effect transistors are available in two basic forms. What are two forms and how do they differ. (4 marks)
- b) A typical n- channel JFET consist of three (3) terminals, the p-gate and n^+ source and drain. Draw the basic construction of an n-channel JFET, Clearly labelling all the components. (8 marks)
- c) Sketch a circuit to show how a thyristor can be used as a controlled rectifier. (8 marks)



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NATIONAL CERTIFICATE

IN

BIOMEDICAL ENGINEERING

MODULE: Decomission Biomedical Equipment and Inventory Maintenance PAPER NO: 450/22/M10

DURATION: 3 Hours

OCTOBER / NOVEMBER 2024 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

1. Question paper contains four (4) questions.
2. Candidate instructed to answer four (4) questions.
3. Each question carries 25 marks.
4. Do not write your name and/or surname on the answer sheet.

This paper consists of 3 printed pages.

PAPER NO: 450/22/M10 – DECOMISSION BIOMEDICAL EQUIPMENT AND INVENTORY MAINTENANCE

QUESTION 1

- a) State and explain three (3) properties that are associated with ideal cleaning agents. (6 marks)
- b) Distinguish between industrial and clinical sterilization. (4 marks)
- c) Define the term stock taking in the context of biomedical equipment. (2 marks)
- d) Explain the importance of stores accounting. (4 marks)
- e) Describe any two (2) methods of recording inventory data. (4 marks)
- f) Explain the importance and purpose of recording inventory data. (5 marks)

QUESTION 2

- a) Outline any three (3) common issues that usually arise during safety inspections of medical equipment. (6 marks)
- b) Explain the importance of proper documentation during safety inspections. (3 marks)
- c) Define a leakage current in biomedical equipment. (6 marks)
- d) Describe the causes of leakage current in biomedical equipment. (6 marks)
- e) Explain how a safety inspection can be conducted for a pulse oximeter. (8 marks)

PAPER NO: 450/22/M10 – DECOMMISSION BIOMEDICAL EQUIPMENT AND INVENTORY MAINTENANCE

QUESTION 3

- a) Define the term medical equipment inventory. (2 marks)
- b) Describe any three (3) essential data elements that must be included in inventory records. (6 marks)
- c) Explain three (3) stages of inventory management. (6 marks)
- d) Explain how inventory management can serve as a strategic tool to optimize operation and enhance efficiency in a health care facility. (6 marks)
- e) Explain the LIFO and FIFO stores accounting methods. (5 marks)

QUESTION 4

- a) Define the term medical waste. (2 marks)
- b) State any three (3) classes of medical waste and give an example for each. (6 marks)
- c) State the advantages and disadvantages of treating medical waste by incineration. (4 marks)
- d) Explain any three (3) ways that can be used to minimise medical waste. (9 marks)
- e) Describe how cultural acceptance of treatment methods affects how medical waste is treated. (4 marks)

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