THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

FORM TWO NATIONAL ASSESSMENT

081 ELECTRONICS AND COMMUNICATION ENGINEERING

Time: 2:30 Hours. **ANSWER** **Year: 2024**

Instructions

1. This paper consists of sections **A**, **B** and **C** with a total of **ten (10)** questions.
2. Answer **all** questions.
3. Section A carries **15** marks; section B carries **70** marks and section C carries **15** marks.
4. All writing must be in **black** or **blue** ink and drawings must be in **pencil**.
5. Cellular phones and unauthorized materials are **not allowed** in the examination room.
6. Write your **Assessment Number** at the top-right hand corner of every page.

FOR EXAMINER'S USE ONLY		
QUESTION NUMBER	SCORE	EXAMINER'S INITIALS
1		
2		
3		
4		
5		
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7		
8		
9		
10		
TOTAL		
CHECKER'S INITIALS		

SECTION A (15 Marks)

Answer **all** questions in this section.

1. Choose the correct answer from alternatives (A to D) by writing its letter in the box provided:

   (i) The emitter base of an NPN BJT transistor is normally forward biased and its collector base is reverse biased. How does collector current behave when the base current is increased?

   A It decreases B It increases C It doubles D It remains constant

   Answer: B. It increases.

   Explanation: In an NPN BJT the collector current is largely controlled by the base current through the transistor's current gain. Increasing the base current causes a proportionally larger collector current, assuming the transistor remains in its active region.

   (ii) Identify the parameter, which its value remains the same in a series circuit

   A Voltage B Power C Resistance D Current

   Answer: D. Current.

   Explanation: In a series circuit the same current flows through all components because there is only one path for charge to travel, while voltages and resistances add.

   (iii) Which instrument represent a thin flat piece of plastic containing various cut-out shapes like circles, bolts, and ellipse?

   A Protector B Template C Perforator D Divider

   Answer: B. Template.

   Explanation: A template is a thin flat sheet with cut-outs used to draw standard shapes such as circles, ellipses, and bolt patterns, to ensure accuracy and repeatability in drawing.

   (iv) Some of the electronics devices perform both communication and metrological functions. Identify the device which saves both purposes.

   A Television B Computer C Satellite D Oscilloscope

   Answer: D. Oscilloscope.

   Explanation: An oscilloscope is used for communication system diagnostics and for measuring time-

varying electrical signals, so it serves both communication troubleshooting and metrological (measurement) functions.

(v) How does the conductivity of the intrinsic semiconductor behave when temperature rises?
A Remains constant B Increases C Decreases D Becomes zero

Answer: B. Increases.
Explanation: Raising temperature generates more electron-hole pairs in an intrinsic semiconductor, which increases charge carrier concentration and therefore increases conductivity.

(vi) You are given a task to draw a block diagram of a communication system showing the flow of signals. In which sequence will a signal flow?
A From right to left B From left to right C From top to bottom D From bottom to top

Answer: B. From left to right.
Explanation: Standard block-diagram convention for communication systems is to show signal flow from left (source) to right (destination), so blocks are arranged left to right in sequence.
(vii) Before starting measuring voltage using cathode ray oscilloscope (CRO), beam spot should be located at the correct position on the screen. Which one refers to the correct position?
A Center of the screen B Top right of the screen C Top center of the screen D Top left of the screen

Answer: A. Center of the screen.
Explanation: Positioning the beam at the screen center gives maximum vertical and horizontal adjustment range and a proper reference point for signal measurements.

(viii) Identify the first action to be taken when someone is suffering from electric shock.
A Call for an ambulance B Disconnect from the supply C Run for helping the victim on their back D Lay the victim on their back

Answer: B. Disconnect from the supply.
Explanation: The immediate priority is to remove the electrical hazard so the victim is no longer being energized, either by switching off the supply or using an insulating object to separate them from the source, then proceed with first aid and call for help.

(ix) What will happen when a transformer is supplied with dc source above 30 V
A Transformer will step down the voltage B Transformer will operate with high efficiency C Transformer will be damaged D Transformer will operate with low efficiency

Answer: C. Transformer will be damaged.
Explanation: Transformers require alternating current to operate correctly; a DC supply causes core saturation and large magnetizing currents, which can overheat and damage the transformer.

(x) A technician checked a radio receiver and discovered that the rectifier circuit was completely defective. Which combination of components will the technician use to make a new rectifier circuit?
A Transformer, diodes and resistor B Diodes, transformer and capacitor C Inductor, capacitor and resistor D Resistor, transformer and capacitor

Answer: B. Diodes, transformer and capacitor.
Explanation: A practical rectifier uses a transformer to step the AC to desired voltage, diodes to perform rectification, and capacitors to filter the rectified output into smoother DC.

2. Match the functions of measuring instruments in List A with their corresponding instruments in List B by writing a letter of the correct response.

List A	**List B**
(i) An electric current	A. Ohm
(ii) An electric energy	B. Joule
(iii) P.D between two points in an electric circuit	C. Watt
(iv) An electric charge	D. Volt
(v) Electric resistance in one volt per ampere	E. Ampere
	F. Ampere
	G. Farad

	H. Hertz

Answers

(i)	(ii)	(iii)	(iv)	(v)
E	B	D	F	A

3. (a) Transistor operation is based on charge levels made of P-type and N-type semiconductor materials. Draw unbiased P-N junction indicating the following: (i) Depletion layer. (ii) Majority charge carriers in each region. (iii) The direction of junction voltage.

Answer:

In an unbiased P-N junction, the P-type region contains holes as majority charge carriers, while the N-type region contains electrons as majority carriers. At the junction, electrons from the N-region diffuse into the P-region and recombine with holes, creating a depletion layer that has no free charge carriers. This region forms an internal electric field with junction voltage directed from the N-region (negative) to the P-region (positive).

(b) Using diagrams, illustrate three different ways of configuring NPN transistor in amplifier circuit.
(i) Common Base Configuration: The base terminal is common to both input and output. The input is applied between emitter and base, and output is taken between collector and base. It provides low input impedance and high output impedance.

(ii) Common Emitter Configuration: The emitter terminal is common. Input is applied between base and emitter, and output between collector and emitter. It gives high voltage and current gain, and is widely used in amplification.

(iii) Common Collector Configuration: The collector is common. Input is applied between base and collector, and output is taken between emitter and collector. It provides high input impedance and low output impedance, acting as a buffer amplifier.

4. (a) Why are the following measuring instruments needed when troubleshooting a faulty radio receiver?

   (i) Multimeter: It measures voltage, current, and resistance, allowing the technician to check for open circuits, short circuits, or incorrect voltage levels in the radio.

   (ii) Oscilloscope: It displays the waveform of signals in the circuit, helping to identify faults in signal stages such as distortion, noise, or loss of frequency components.

   (b) The CRO display of a pulse waveform indicates that the time/cm switch is on 50 ms/cm and the volts/cm switch is on 0.2 V/cm. Determine:

   (i) Periodic time

   (ii) Frequency

   (iii) Magnitude of the pulse voltage

   (i) Suppose one cycle covers 4 cm on the time axis.

   $T = 4 \text{ cm} \times 50 \text{ ms/cm} = 200 \text{ ms} = 0.2 \text{ s}$

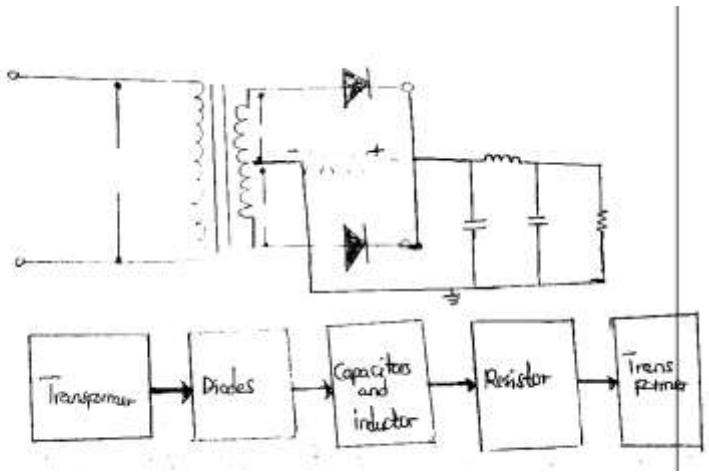
   (ii) Frequency, $f = 1/T = 1/0.2 = 5 \text{ Hz}$

   (iii) If the waveform height covers 3 cm vertically,

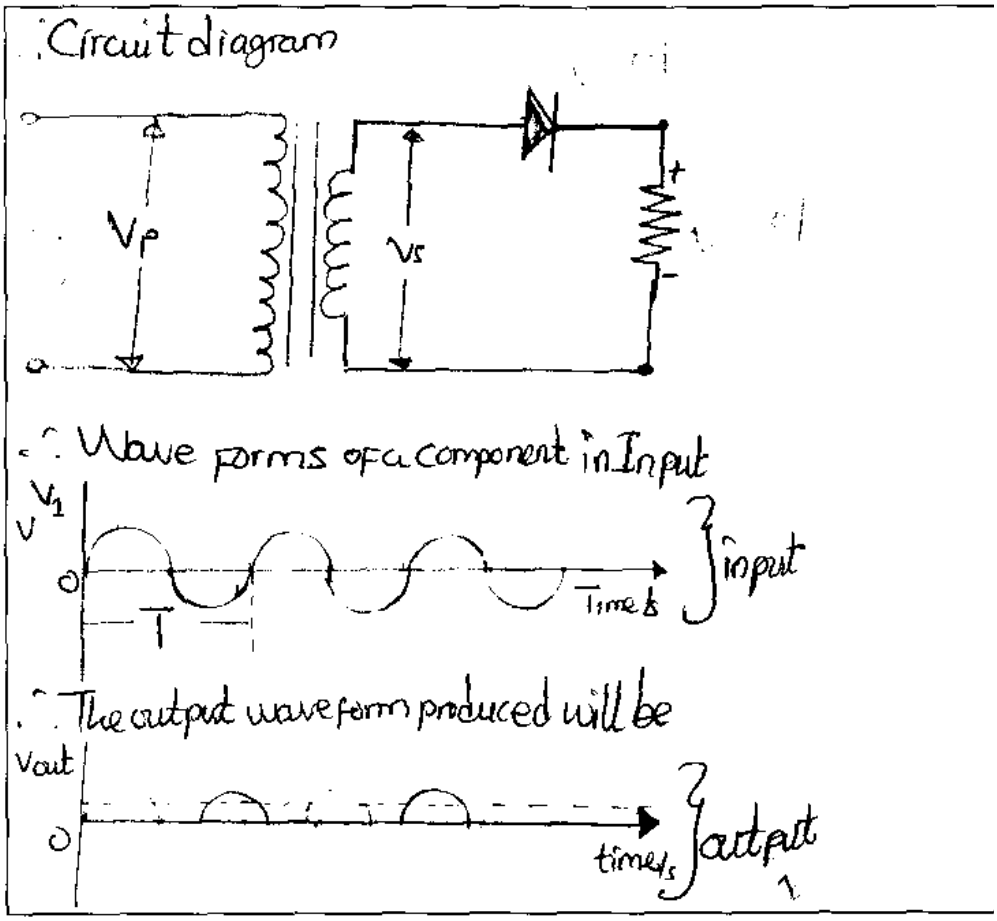
   $V = 3 \text{ cm} \times 0.2 \text{ V/cm} = 0.6 \text{ V}$

   Therefore, the waveform has a period of 0.2 s, frequency of 5 Hz, and voltage of 0.6 V.

5. (a) Figure 1 below is a schematic diagram of an electronic system that converts a.c to d.c signal. Represent the figure with a block diagram showing the sequence of the signal flow.



(b) An a.c source is applied to a circuit which consists of one PN junction diode, a transformer and a load resistor to produce a d.c signal output. Use the given components to construct a circuit diagram and show the produced output waveform.



6. (a) (i) Classify resistors according to their voltage-current (V-I) characteristics.
   Resistors are classified as linear and non-linear. Linear resistors obey Ohm's law, meaning the voltage is directly proportional to current. Non-linear resistors do not obey Ohm's law; examples include thermistors and varistors whose resistance changes with temperature or voltage.

(ii) Determine the maximum and minimum resistance range of a resistor with yellow, violet, orange and gold colour codes.

The colour code corresponds to:

Yellow = 4, Violet = 7, Orange = multiplier ×1000, Gold = ±5% tolerance

Nominal value = 47 × 1000 = 47,000 Ω = 47 kΩ

Tolerance range = ±5%

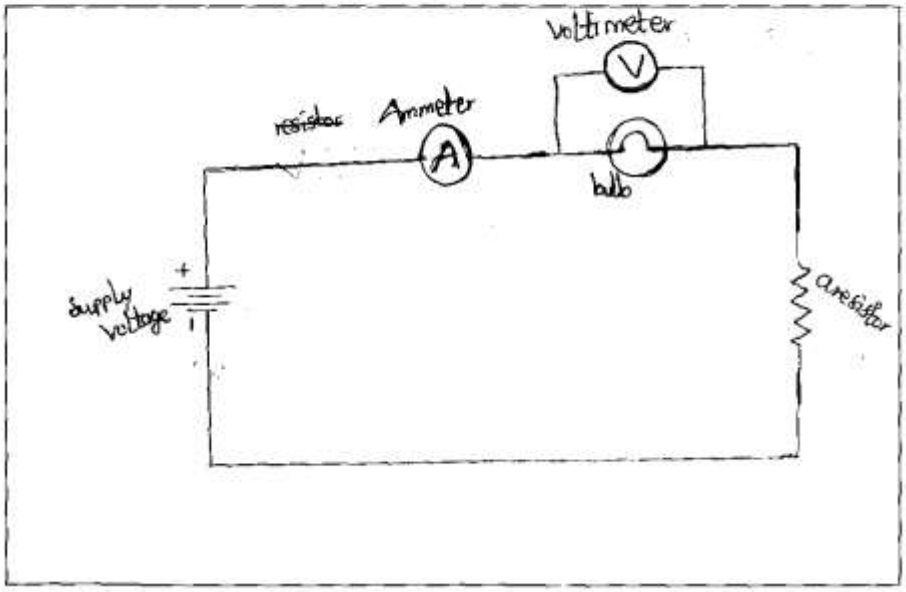
Maximum resistance = 47,000 × 1.05 = 49,350 Ω

Minimum resistance = 47,000 × 0.95 = 44,650 Ω

(iii) Suggest an instrument which can be used to measure the resistance of a resistor.

An ohmmeter or a multimeter in resistance mode can be used to measure the resistance of a resistor accurately.

(b) A resistor in part (a)(ii) is needed to be tested. You are given a supply voltage, a voltmeter, an ammeter and a bulb. Draw the circuit to show the connection of the ammeter and voltmeter to measure the circuit current and potential difference across the resistor under test when connected in series with the bulb.



7. (a) In a performance test of a transistor amplifier, a change of 200 mV in base-emitter voltage caused a change of 100 μA in the base current. Calculate its input resistance.

Input resistance = $\Delta VBE / \Delta IB$

$= (200 \times 10^{-3}) / (100 \times 10^{-6})$

$= 2000\ \Omega$

Therefore, the transistor amplifier has an input resistance of 2 kΩ.

(b) The NPN transistor circuit in figure below is required to replace the faulty one in a certain electronic system. To ensure better performance of the circuit in above before replacement, calculate the following parameters (Neglect VBE):

(i) IB

(ii) IC

(iii) IE

(iv) VCE

Answer:

Let's assume the transistor is biased with a supply voltage VCC, base resistor RB, and collector resistor RC.

(i) $IB = (VCC - VBE) / RB$

Since VBE is neglected, $IB = VCC / RB$.

(ii) $IC = \beta \times IB$ (where β is the current gain of the transistor).

(iii) $IE = IC + IB$.

(iv) $VCE = VCC - (IC \times RC)$.

These equations define the transistor's DC operating parameters and are used to verify correct biasing before replacing the device.

8. (a) Although a pure germanium has more free electrons and higher conductivity than silicon, it was observed that silicon is more widely used in semiconductor devices than germanium. Give a reason for this observation.

Silicon is more thermally stable and has a higher operating temperature range than germanium. Germanium devices suffer from high leakage currents at moderate temperatures, whereas silicon devices maintain performance up to about 150°C. Silicon is also more abundant and easier to process into high-quality crystals.

(b) Use well labelled diagrams to differentiate the energy levels of the following materials: (i) Insulator (ii) Semiconductor (iii) Conductor

Answer:

In an insulator, the valence band is full and separated from the conduction band by a large energy gap (about 6 eV), preventing electron flow.

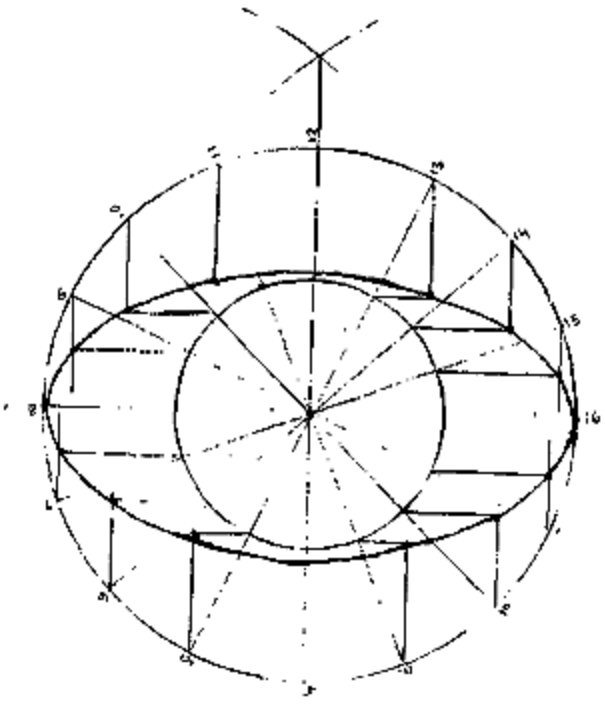
In a semiconductor, the energy gap is smaller (about 1 eV), allowing some electrons to jump from the valence band to the conduction band when heated.

In a conductor, the valence and conduction bands overlap, meaning electrons move freely, allowing high conductivity.

9. You have been given 2 circles with 90 mm diameter and 45 mm diameter. Using concentric circle method, draw an ellipse by using a compass, a ruler and a protractor only.

Answer:

Draw two concentric circles, one with 90 mm diameter (major axis) and another with 45 mm (minor axis). Divide both circles into equal parts using a protractor. Draw verticals and horizontals through corresponding points on both circles, and where these lines intersect mark points of the ellipse. Join all intersection points smoothly to form the ellipse.



10. The figure below represents a measuring instrument used in the electronics workshop. Study it and answer the questions that follow.

(i) Identify the names of the instruments labelled by letters G, H, J, I and K with its function according to the positions to which they are connected. Calculate the total resistance of the circuit.
Answer:
Without the diagram, general interpretation applies. G, H, and J could be voltmeters or ammeters depending on their positions, while I and K might represent resistors or power sources. The total resistance can be found using series or parallel formulas as appropriate:
RT = R1 + R2 + R3 (for series) or 1/RT = 1/R1 + 1/R2 + 1/R3 (for parallel).

(ii) Calculate the value measured by the instruments labelled by letter G, H and J.
Assume these measure voltage or current. Use Ohm's law, V = IR, for each circuit branch to determine their readings.

(iii) Find the value measured by the instruments labelled by letter I and K.
If they represent resistors, calculate their voltage drops or currents using the same principle.

(b) Do you agree that, data in analogue measuring instruments are more likely to be read wrongly than digital instruments? Give two reasons to support your answer.

Yes, analogue instruments are more likely to have reading errors because

(a) they rely on needle deflection which can be affected by parallax error if viewed at an angle.

(b) the scale divisions in analogue meters are less precise than digital displays, making it harder to read small changes accurately.