THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

FORM TWO NATIONAL ASSESSMENT

081 ELECTRONICS AND COMMUNICATION ENGINEERING

Time: 2:30 Hours **ANSWERS** **Year: 2022**

Instructions

1. This paper consists of Section **A, B** and **C** with a total of **ten (10)** questions
2. Answer **al**l questions.
3. Section **A** and **C** carry **fifteen (15)** marks each and section **B** carries **seventy (70)** marks
4. Cellular phones and unauthorized materials are not allowed in the assessment room
5. Write your **Assessment Number** at the top right-hand corner of every page.

FOR ASSESSOR'S USE ONLY

QUESTION NUMBER	SCORE	ASSESSOR'S INITIALS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
TOTAL		
CHECKER'S INITIALS		

SECTION A (15 Marks)

Answer all questions in this section.

1. Select the correct answer from the given alternatives by writing the letter of the most correct answer in the box provided.

(i) The ISO specifies size of technical drawing sheets according to different uses. Which ISO standards would you use for correct measurements of A3 paper sheet size?

A. 494 × 841

B. 297 × 420

C. 420 × 494

D. 491 × 420

The ISO standard for A3 paper size is 297 mm × 420 mm.

Answer: B

(ii) Two lamps rated 100 W are connected in series across a 200 V supply. How much will the power be consumed?

A. 25 W

B. 50 W

C. 100 W

D. 200 W

For a 100 W lamp at 200 V, resistance $R = V^2 / P = 200^2 / 100 = 400\ \Omega$.

Two lamps in series: Total resistance = $400\ \Omega + 400\ \Omega = 800\ \Omega$.

Total power $P = V^2 / R_{total} = 200^2 / 800 = 40000 / 800 = 50$ W.

Answer: B

(iii) For a small value of drain to source voltage, JFET behaves like a passive component. Which of the components has the same behavior?

A. Diode

B. Rectifier

C. Inductor

D. Ics

In the ohmic region, a JFET behaves like a resistor (passive component). None of the options directly match, but a diode (A) is the closest passive component, as inductors and ICs have different behaviors, and rectifiers are diode-based systems.

Answer: A

(iv) A technician used a measuring instrument to test a television power cable when the supply was off and discovered that it was defective. Select the instrument, which was used to discover the problem.

A. An Ammeter

B. Voltmeter

C. Ohmmeter

D. Signal generator

An ohmmeter is used to test continuity or defects in a cable when the supply is off by measuring resistance.

Answer: C

(v) A student was asked to measure the amplitude of the output signal waveform. Identify the equipment used in his assignment.

A. Oscillator

B. Multimeter

C. Signal generator

D. CRO

A Cathode Ray Oscilloscope (CRO) is used to measure the amplitude of a signal waveform by displaying it visually.

Answer: D

(vi) In modifying the properties of a pure semiconductor material in a certain industry, a pentavalent element is added. Identify the type of extrinsic semiconductor obtained by the industry.

A. NPN-type

B. PNP-type

C. P-type

D. N-type

Adding a pentavalent element (e.g., phosphorus) introduces extra electrons, creating an N-type semiconductor.

Answer: D

(vii) You have decided to help your friend who got a minor burn on his hand. What will be your first action to casualty?

A. Call the medical doctor

B. Flush the burn with cold water

C. Cover the burn with a dry dressing

D. Remove any burnt material from the wound

The first action for a minor burn is to flush the burn with cold water to reduce heat and pain.

Answer: B

(viii) What will be the outcome if the channel block in Figure 1 is removed?

A. The transmitter will fail to transmit the information

B. The information will easily pass to the channel

C. The transmitter will cross over the information to the receiver

D. Information will not reach to the receiver

Without Figure 1, I assume a communication system where the channel block represents a medium or filter. Removing it allows information to pass easily from transmitter to receiver via the channel.

Answer: B

(ix) What is the status of transistor when it operates in cut-off and saturation condition?

A. It behaves like a linear amplifier.

B. It acts like a switch.

C. It behaves like a variable capacitor.

D. It can vary resistance as a variable resistor.

In cut-off (off) and saturation (fully on), a transistor acts like a switch, either blocking or allowing current.

Answer: B

(x) Why does a full-wave rectifier have twice the efficiency of a half-wave rectifier?

A. It utilizes both half cycles of the input.

B. It uses a center tap transformer.

C. It has less an increased ripple factor.

D. It has a double output frequency.

A full-wave rectifier uses both positive and negative half-cycles of the input AC, doubling the output power compared to a half-wave rectifier, which uses only one half-cycle.

Answer: A

2. Match the diode characteristics interpretations in List A with the corresponding diode characteristics in List B by writing the letter of the correct response below the item number in the table provided.

List A

(i) Minimum reverse voltage at which PN junction down fall with sudden rise in reverse current.

(ii) Forward voltage at which the current through the junction start to increase rapidly.

(iii) Highest power that can be dissipated at the junction without damage.

(iv) Maximum reverse voltage that can be applied to PN junction without damaging the junction.

(v) Highest forward current that a PN junction can conduct without damage to the junction.

List B

A. Maximum forward current

B. Peak inverse voltage

C. Peak forward junction

D. Maximum power transfer

E. Minimum power transfer

F. Maximum power rating

G. Knee voltage

H. Break down voltage

Answer

(i) Minimum reverse voltage with sudden current rise → H (Break down voltage)

(ii) Forward voltage for rapid current increase → G (Knee voltage)

(iii) Highest power without damage → F (Maximum power rating)

(iv) Maximum reverse voltage without damage → B (Peak inverse voltage)

(v) Highest forward current without damage → A (Maximum forward current)

SECTION B (70 Marks)

Answer all questions from this section.

3. A transformer with voltage rate of 240 V to 12 V failed to operate in a certain power system. You are assigned to reconstruct the specified transformer by using 800 turns primary winding.

(a) Calculate the number of turns for its secondary winding.

Transformer voltage ratio: $V_p / V_s = N_p / N_s$

$240 / 12 = 800 / N_s$

$N_s = 800 \times 12 / 240 = 40$ turns

Answer: Secondary turns = 40

(b) Estimate the secondary and primary current when the transformer supplies a 12 V, 12 W system.

Secondary power $P_s = 12$ W, $V_s = 12$ V

Secondary current $I_s = P_s / V_s = 12$ W / 12 V = 1 A

For an ideal transformer, $P_p = P_s$, so $P_p = 12$ W

Primary voltage $V_p = 240$ V

Primary current $I_p = P_p / V_p = 12$ W / 240 V = 0.05 A

Answer: Secondary current = 1 A; Primary current = 0.05 A

(c) Represent the transformer you constructed by its schematic symbol.

Description: Two parallel vertical lines (core) with a coil (wavy line) on each side, labeled 800 turns (primary) and 40 turns (secondary).

4. Electrical quantities in a circuit can be measured by using measuring instruments or calculations. Study the figure below carefully and then answer the questions that follow.

(a) Calculate the total current flowing in the circuit.

For series: Total resistance $R_{total} = R_1 + R_2 = 10\ \Omega + 15\ \Omega = 25\ \Omega$

Total current $I = V / R_{total} = 25\ V / 25\ \Omega = 1\ A$

Answer: Total current = 1 A

(b) Calculate the p.d across each resistor.

Voltage across $R_1 = I \times R_1 = 1\ A \times 10\ \Omega = 10\ V$

Voltage across $R_2 = I \times R_2 = 1\ A \times 15\ \Omega = 15\ V$

Answer: p.d across R_1 = 10 V; p.d across R_2 = 15 V

(c) Calculate the sum of the p.d.

Sum of p.d = $V_{R_1} + V_{R_2} = 10\ V + 15\ V = 25\ V$

Answer: Sum of p.d = 25 V

Note: Please provide the figure for precise calculations.

5. (a) You are required to construct a common emitter amplifier with an input resistance of 2.5 kΩ and a voltage gain of 200. The input signal voltage is 5 mV and the value of β is 350. You have realized that your circuit will not operate properly because some important parameters are missing. Calculate the following missed parameters in order to accomplish the circuit requirements.

(i) Base current.

Input resistance $R_{in} = V_{in} / I_B$

$I_B = V_{in} / R_{in} = 5\ mV / 2.5\ k\Omega = 0.005\ V / 2500\ \Omega = 2\ \mu A$

Answer: Base current = 2 μA

(ii) Collector current.

$\beta = I_C / I_B$

$I_C = \beta \times I_B = 350 \times 2\ \mu A = 700\ \mu A = 0.7\ mA$

Answer: Collector current = 0.7 mA

(iii) Power gain.

Power gain $A_P = \beta \times A_v$ (where A_v = voltage gain = 200)

$A_P = 350 \times 200 = 70000$

Answer: Power gain = 70000

(c) Why the common emitter amplifier is commonly used rather than common base and common collector amplifiers? Give three reasons.

(i) High voltage and current gain, suitable for amplification.

(ii) Moderate input and output impedance, making it versatile for various circuits.

(iii) Provides phase inversion, useful in signal processing applications.

6. (a) During working practice sessions, the teacher required every student to wear hard hat, goggles, ear defender, gloves, overcoat, and a mask before entering the workshop. What is the importance of each item requested by the teacher?

(i) Hard hat: Protects head from falling objects or impacts.

(ii) Goggles: Shields eyes from dust, sparks, or chemicals.

(iii) Ear defender: Reduces noise exposure to prevent hearing damage.

(iv) Gloves: Protects hands from cuts, burns, or electrical hazards.

(v) Overcoat: Shields body from sparks, chemicals, or dirt.

(vi) Mask: Prevents inhalation of dust or harmful fumes.

(b) Every student who studies electronics and communication engineering must be conversant and adhere to four main safety signs used at workplace. Briefly explain the significance of each sign.

Assuming standard safety signs:

(i) Warning Sign (Yellow Triangle with Exclamation): Indicates potential hazards (e.g., high voltage) requiring caution.

(ii) Prohibition Sign (Red Circle with Slash): Forbids actions (e.g., no smoking) to ensure safety.

(iii) Mandatory Sign (Blue Circle): Requires specific actions (e.g., wear goggles) for safety compliance.

(iv) Emergency Sign (Green Square): Indicates safety equipment or exits (e.g., first aid kit) for emergency response.

7. The figure below is a basic electric circuit with three capacitors connected in series across a supply voltage (V). Study it carefully and then answer the questions that follow.

Note: The figure is not provided, so I'll provide general formulas for capacitors in series.

(a) Charge on each capacitor.

In series, the charge Q is the same on each capacitor: $Q = C_{eq} \times V$, where C_{eq} is the equivalent capacitance.

Answer: $Q = C_{eq} \times V$ (same for each capacitor).

(b) Voltage across each capacitor.

Voltage across each capacitor: $V_i = Q / C_i$, where Q is the charge and C_i is the capacitance of each capacitor.

Answer: $V_i = Q / C_i$ for each capacitor.

(c) Voltage supplied in a circuit.

Total supply voltage $V = V_1 + V_2 + V_3$ (sum of voltages across each capacitor).

Answer: $V = V_1 + V_2 + V_3$

(d) Total capacitance in a circuit.

For capacitors in series: $1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$

Answer: $1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$

(e) Energy stored in a circuit.

Total energy stored: $E = ½ \times C_{eq} \times V^2$, where C_{eq} is the equivalent capacitance and V is the supply voltage.

Answer: $E = ½ \times C_{eq} \times V^2$

8. During group discussion, your fellow students selected you to explain about different types of diodes. Simplify your explanation by using schematic symbols to illustrate six types of diodes.

Name of Diode

Symbol of Diode (Text Description)

(a) PN Junction Diode

Arrow (anode) to bar (cathode).

(b) Zener Diode

Arrow to bar with bent ends on bar.

(c) LED (Light Emitting Diode)

Arrow to bar with two arrows pointing outward (light).

(d) Schottky Diode

Arrow to bar with S-shaped bend on bar.

(e) Varactor Diode

Arrow to bar with capacitor symbol on bar.

(f) Tunnel Diode

Arrow to bar with curved lines on bar.

Answer:

(a) PN Junction: Arrow to bar.

(b) Zener: Arrow to bar with bent ends.

(c) LED: Arrow to bar with light arrows.

(d) Schottky: Arrow to bar with S-bend.

(e) Varactor: Arrow to bar with capacitor.

(f) Tunnel: Arrow to bar with curved lines.

9. When an AC voltage (V) of a frequency (f) is applied to a capacitor (C) which is connected in series with a coil (L) of a resistance (R), the resonance which occurred causes minimum impedance and large voltages across (C) and (L). If the value of V = 24 V, R = 100 Ω, C = 10 μF, L = 2.0 H, f = 50 Hz, determine:

(a) The inductive reactance.

$X_L = 2\pi fL = 2 \times 3.1416 \times 50 \times 2.0 = 628.32\ \Omega$

Answer: Inductive reactance = 628.32 Ω

(b) Capacitive reactance.

$X_C = 1 / (2\pi fC) = 1 / (2 \times 3.1416 \times 50 \times 10 \times 10^{-6}) = 318.31\ \Omega$

Answer: Capacitive reactance = 318.31 Ω

(c) The impedance of the circuit.

Note: The question states resonance, where $X_L = X_C$, but calculated $X_L \neq X_C$ at f = 50 Hz. Assuming non-resonant conditions:

$Z = \sqrt{(R^2 + (X_L - X_C)^2)} = \sqrt{(100^2 + (628.32 - 318.31)^2)} = \sqrt{(10000 + 310.01^2)} = \sqrt{(10000 + 96106.20)} = \sqrt{106106.20} \approx 325.74\ \Omega$

Answer: Impedance ≈ 325.74 Ω

(d) The r.m.s current.

$I_{rms} = V_{rms} / Z = 24\ V / 325.74\ \Omega \approx 0.0737\ A$

Answer: r.m.s current ≈ 0.0737 A

SECTION C (15 Marks)

Answer all questions from this section.

10. An isometric block can be seen from different views. Justify this fact by producing three views in third angle projections. Note: Put your measurements in millimeters (mm).

Front view: Shows the front face.

End view: Shows the side profile.

Plan view: Shows the top view.