THE UNINTED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

FORM TWO SECONDARY EDUCATION EXAMINATION

080 ELECTRICAL ENGINEERING

Time: 2:30 Hours **ANSWERS** **Year: 2003**

Instructios:

1. this paper consists of sections A and B with total of eleven questions
2. answer all questions in section A. In section B answer all questions in either part I or part II depending on the area of your specialization.
3. All answers must be written in spaces provided.

(i) Crystals of certain materials produce electricity when subjected to:
A. Light
B. Magnetism
C. Heat
D. Pressure
Answer: D. Pressure
Reason: This phenomenon is called the piezoelectric effect, where certain materials generate an electric charge in response to mechanical stress.

(ii) Matter retains its chemical properties when broken down into:
A. Electrons
B. Molecules
C. Ions
D. Atoms
Answer: D. Atoms
Reason: Atoms are the smallest units of matter that retain the chemical properties of an element.

(iii) The capacity of a cell or battery is measured in:
A. Ampere-hours
B. Litres
C. Volts
D. Watts
Answer: A. Ampere-hours
Reason: Battery capacity is measured in ampere-hours (Ah), which indicates the amount of current a battery can supply over time.

(iv) Electromagnetism is the study of:
A. Behaviour of a conductor in a magnetic field
B. Magnetic field set up by a conductor
C. Magnetic field set up by a current-carrying conductor
D. Interaction of two magnetic fields
Answer: C. Magnetic field set up by a current-carrying conductor
Reason: Electromagnetism explores how electric currents create magnetic fields and how these fields interact with other charges.

(v) The movement of electrons through a conductor in one direction is caused by:
A. Equal potentials
B. Inductance
C. A resistance
D. An e.m.f.
Answer: D. An e.m.f.
Reason: Electromotive force (e.m.f.) provides the energy required to move electrons through a conductor.

(vi) The two main defects of a primary cell are:
A. Polarization and sulphation
B. Local action and polarization
C. Buckling and polarization
D. Sulphation and buckling
Answer: B. Local action and polarization
Reason: Primary cells face issues like local action (unwanted chemical reactions) and polarization (buildup of hydrogen gas), reducing their efficiency.

(vii) In a step-down transformer, the number of turns in the secondary as compared to the primary turns would be:
A. Fewer
B. The same
C. Greater
D. One turn less
Answer: A. Fewer
Reason: A step-down transformer reduces voltage by having fewer turns in the secondary winding compared to the primary winding.

(viii) The value of capacitance depends upon:
A. The product of charge and voltage
B. The product of charge and current
C. Charge divided by voltage
D. Voltage divided by charge
Answer: C. Charge divided by voltage
Reason: Capacitance is defined as the ratio of the charge stored to the voltage across the capacitor, $C = Q/V$.

(ix) The unit of electrical energy as commercially used is:
A. Kilowatt-hour
B. Kilowatt
C. Kilovolt
D. Kiloamperes
Answer: A. Kilowatt-hour
Reason: Kilowatt-hour (kWh) is the standard unit of electrical energy used commercially to measure power consumption.
(x) When the temperature of an electric conductor is increased, its resistance will:
A. Remain the same
B. Decrease
C. Increase
D. None of the above
Answer: C. Increase
Reason: As the temperature increases, the atoms in a conductor vibrate more, increasing resistance by obstructing the flow of electrons.

2. (a) When measuring electric current and voltage passing across the load respectively, the ammeter and voltmeter should be connected:
Answer:
- Ammeter: In series with the circuit to measure the current flowing through the load.
- Voltmeter: In parallel with the circuit to measure the voltage drop across the load.

(b) The two major losses in the transformer are:
Answer:
(i) Cu loss (Copper loss): These are losses due to the resistance of the winding conductors, caused by the current flowing through them (I^2R losses).
(ii) Fe loss (Iron loss): These are losses due to eddy currents and hysteresis in the core of the transformer.

(c) Electromagnetism is:
Answer: The study of the magnetic field set up by the passage of electric current through a system or conductor.

(d) State Ohm's Law in words and by using the formula.
Answer: Ohm's Law states that the current flowing in a circuit is directly proportional to the voltage applied and inversely proportional to the resistance, provided the temperature remains constant.

Formula:
$I = V / R$
Where:
I = Current (in amperes)
V = Voltage (in volts)
R = Resistance (in ohms)

(e) In an analogy instrument, "damping" means:
Answer: Damping refers to the process of reducing oscillations or vibrations in the pointer of an instrument, allowing it to quickly settle at its final reading.

3. (a) The resistance of the relay coil used in a cold room test was 20 ohms at 0°C. What would be its resistance when operating at a mean temperature of 20°C, if the temperature coefficient of resistance of the coil winding is 0.0043/°C?

Answer:
Using the formula:
$R = R_0(1 + \alpha\Delta T)$
Where:
R_0 = Resistance at 0°C = 20 Ω
α = Temperature coefficient = 0.0043/°C
ΔT = 20°C - 0°C = 20°C

$R = 20(1 + 0.0043 \times 20)$
$R = 20(1 + 0.086)$
$R = 20 \times 1.086$
$R = 21.72\ \Omega$
The resistance at 20°C is 21.72 Ω

(b) A carbon resistor has a resistance of 100 ohms at 30°C and 98.95 ohms at 70°C. Determine the average temperature coefficient of resistance of carbon over this temperature range.

Answer:
Using the formula:
$\alpha = (R_2 - R_1) / (R_1 \times \Delta T)$
Where:
$R_1 = 100\ \Omega$ at 30°C
$R_2 = 98.95\ \Omega$ at 70°C
$\Delta T = 70°C - 30°C = 40°C$

$\alpha = (98.95 - 100) / (100 \times 40)$
$\alpha = -1.05 / 4000$
$\alpha = -0.0002625/°C$

The average temperature coefficient is -0.0002625/°C

(c) A P.V.C. twin copper cable 50 m long has a total voltage drop of 8V when it is carrying a current of 40A. Calculate the cross-sectional area of the cable and the power lost in the cable when this current is flowing.

Answer:
Voltage drop (V) = I × R
$R = V / I = 8 / 40 = 0.2\ \Omega$

Resistance of the cable:
$R = \rho L / A$
$0.2 = (1.7 \times 10^{-8} \times 2 \times 50) / A$
$A = (1.7 \times 10^{-8} \times 100) / 0.2$
$A = 8.5 \times 10^{-8} / 0.2$
$A = 4.25 \times 10^{-7}\ m^2 = 4.25\ mm^2$

Power lost:
$P = I^2R$
$P = 40^2 \times 0.2$
$P = 1600 \times 0.2$

P = 320 W
The cross-sectional area is 4.25 mm², and the power lost is 320 W

(d) Write down the various ranges of voltage which are defined in the electricity supply act of the following:
Answer:
(i) Extra-low voltage: Up to 50 V
(ii) Medium voltage: 1000 V to 35 kV
(iii) Low voltage: 50 V to 1000 V
(iv) High voltage: Above 35 kV
(v) Extra high voltage: Above 230 kV
(e) What will be the power dissipated in the resistor if a current of 15 mA flows in a resistor of 20 kilo ohms?

Answer:
$P = I^2R$
I = 15 mA = 0.015 A
R = 20 kΩ = 20000 Ω

$P = (0.015)^2 \times 20000$
$P = 0.000225 \times 20000$
P = 4.5 W

The power dissipated is 5.5 W

4. (a) Write three measures which should be taken in the case of an electric fire.
Answer:
- Disconnect the power supply immediately.
- Use a fire extinguisher rated for electrical fires (Class C or CO2).
- Avoid using water to extinguish the fire, as it conducts electricity.

(b)(i) What is the maximum permissible voltage drop in installation as recommended by the I.E.E. Regulations?
Answer: 4% of the supply voltage.

(ii) Calculate the resistivity of aluminum wire if a 100m length of conductor with a cross-sectional area 4mm² has a measured resistance of 0.7 ohms.

Answer:
Using the formula:
$\rho = R \times A / L$
R = 0.7 Ω
$A = 4 \times 10^{-6}$ m²
L = 100 m

$\rho = (0.7 \times 4 \times 10^{-6}) / 100$
$\rho = 2.8 \times 10^{-6} / 100$
$\rho = 2.8 \times 10^{-8}\ \Omega m$
The resistivity is $2.8 \times 10^{-8}\ \Omega m$

(c) Write the components which are used to make a simple circuit and draw the simple circuit.
Answer:
Components:
Power source (e.g., battery)
Conductors (wires)
Load (e.g., bulb)
Switch

5. (a) Draw symbols for the following electrical accessories:

(i) Socket outlet
Answer: The symbol for a socket outlet is a rectangle with two parallel vertical lines inside, indicating the live and neutral terminals.
(ii) Lighting outlet
Answer: The symbol for a lighting outlet is a circle with an "X" inside, representing a connection for a bulb.

(iii) Earth
Answer: The symbol for earth is a series of three horizontal lines decreasing in length from top to bottom, stacked vertically.

(b)(i) What is a fuse?
Answer: A fuse is a safety device used in electrical circuits to protect equipment and wiring from damage caused by excessive current. It contains a thin wire that melts when the current exceeds a specific limit, interrupting the circuit.

(ii) Write three types of fuses:
Answer:

- Cartridge fuse
- Resettable fuse
- High rupturing capacity (HRC) fuse

(c) What is the resistance of an electric lamp filament if it draws a current of 0.5 A from a 240 V supply?
Answer:
Using Ohm's Law:
$R = V / I$
$R = 240 / 0.5$
$R = 480\ \Omega$
The resistance of the lamp filament is $480\ \Omega$

6. (a) The seriousness of electric shock will depend on:
Answer:
(i) The magnitude of the current flowing through the body.
(ii) The duration of contact with the electrical source.
(iii) The pathway of the current through the body.
(iv) The voltage of the source and skin resistance.

(b) Write the long form of the following abbreviations of cables:
(i) MICS - Mineral Insulated Copper Sheathed
(ii) S.W.A - Steel Wire Armoured
(iii) P.V.C - Polyvinyl Chloride
(iv) T.R.S - Tough Rubber Sheathed
(v) M.I.A.S - Mineral Insulated Aluminium Sheathed

(c) Explain the uses of running couples.
Answer: Running couples are used to connect or extend electrical wiring in installations where flexibility and durability are needed. They allow for easy connection of wires and can be used to prevent tension or stress in cables.

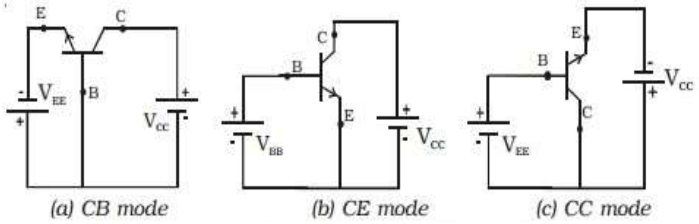
7. (a) In n-type semiconductor, name:

(i) The majority charge carriers: Electrons
(ii) The minority charge carriers: Holes

(b) Name a doping agent used to obtain:

(i) P-type semiconductor: Boron
(ii) N-type semiconductor with germanium and silicon: Phosphorus or Arsenic

(c) Draw three configurations of a PNP Bipolar transistor:



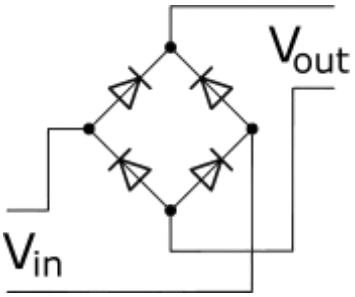
8. (a) Write the values of the following resistors color-coded as:

(i) R1: Blue, Red, Brown, and Gold
Answer: Blue = 6, Red = 2, Brown = multiplier (10), Gold = ±5%
Value = 62 × 10 = 620 Ω ± 5%

(ii) R2: Red, Black, Red, and Silver
Answer: Red = 2, Black = 0, Red = multiplier (100), Silver = ±10%
Value = 20 × 100 = 2000 Ω ± 10%

(b) Explain the peak inverse voltage.
Answer: The peak inverse voltage (PIV) is the maximum voltage a diode can withstand in the reverse-biased condition without breaking down. It is a critical parameter in rectifier circuits to ensure the diode operates safely.
(c) Distinguish between extrinsic and intrinsic in connection to semiconductors.
Answer:
- Intrinsic semiconductors are pure and have no impurities, with equal numbers of electrons and holes.
- Extrinsic semiconductors are doped with impurities to increase conductivity by introducing more free electrons (n-type) or holes (p-type).

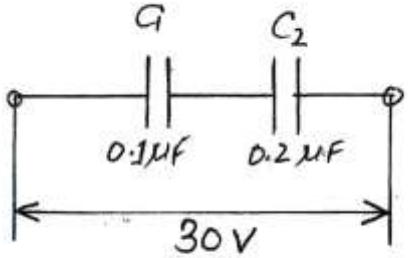
9. (a) Draw a neat circuit diagram of a simple bridge rectifier and sketch its waveforms at the input and output.



Answer: A simple bridge rectifier circuit includes four diodes arranged in a bridge configuration, connected to an AC input and a load resistor. The waveform at the input is an AC sine wave, while the output is a pulsating DC wave.

(b) Explain the uses of flux as applied in soldering electronic components.
Answer: Flux is used to remove oxidation from metal surfaces, improve solder flow, and create better electrical and mechanical connections during soldering.

10. (a) In the figure below, calculate the voltage across capacitor C1.



Answer:
Capacitors in series share voltage inversely proportional to their capacitances:
V1 / V2 = C2 / C1
Given:

C1 = 0.1 μF, C2 = 0.2 μF, Total Voltage = 30 V
V1 = (C2 / (C1 + C2)) × Total Voltage
V1 = (0.2 / (0.1 + 0.2)) × 30
V1 = (0.2 / 0.3) × 30
V1 = 20 V The voltage across capacitor C1 is 20 V.