THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

181 ELECTRONICS AND RADIO REPAIR

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 1991**

Instructions

1. This paper consists of TWELVE questions.

2. Answer SIX questions in section A and FOUR questions from section B.

1. (a) Why is modulation necessary for transmission of intelligence?
Modulation is necessary to superimpose low-frequency intelligence signals such as audio or data onto high-frequency carrier waves. This allows the signals to be transmitted over long distances efficiently, with reduced antenna size, minimized noise interference, and allows multiplexing of signals on different frequencies without overlap.

(b) What frequencies in the amplitude modulated wave contain intelligence?
The intelligence is carried by the upper and lower sidebands of the AM wave. These sidebands are located at frequencies slightly above and below the carrier frequency, specifically at (carrier ± modulating frequency). The carrier itself contains no information.

2
(a) In Fig. 1, the lamp L1 will illuminate when S is set to one position and not illuminate when S is set to another position. On which position of S will the lamp:
(i) Illuminate
The lamp will illuminate when S is in position A. In this position, the base of the transistor is connected through R2 to the positive terminal, providing base current to turn the transistor on, allowing current to flow from collector to emitter and lighting L1.

(ii) Not illuminate
The lamp will not illuminate when S is in position B. In this position, the base of the transistor is grounded through R3, preventing any base current from flowing. The transistor stays off, and no current flows through L1, so it remains off.

(b) What is the function of R4?
R4 is the collector resistor. It limits the current through the lamp L1 and the transistor, protecting both from excessive current. It also helps develop voltage across the collector which is necessary for the transistor's operation.

3
(a) Distinguish audio signals from radio signals.
Audio signals are low-frequency signals (typically 20 Hz to 20 kHz) that represent sound waves. Radio signals are high-frequency electromagnetic waves (typically from 3 kHz to several GHz) used for transmitting data or audio over distances via antennas.

(b) What two factors make up a radio wave?
A radio wave is made up of an electric field and a magnetic field, both oscillating perpendicular to each other and to the direction of propagation.

(c) Name three applications of radio waves.
Radio broadcasting, mobile communication, and radar systems.

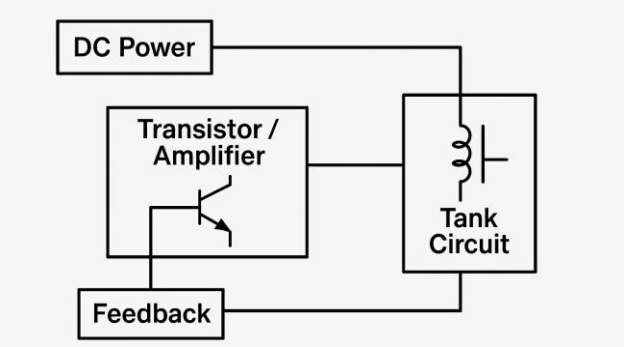
(d) A sinewave has a periodic time of 5 μs (microseconds) at a peak value of 5 mV (millivolts). What is its frequency and r.m.s. value?
Frequency $f = 1 / T = 1 / 5 \times 10^{-6} = 200000$ Hz = 200 kHz
RMS value = peak / $\sqrt{2}$ = 5 mV / 1.414 ≈ 3.54 mV

4
(i) What is an electronic oscillator?
An electronic oscillator is a circuit that generates a continuous and repetitive waveform, usually sinusoidal or square wave, without an input signal. It converts DC power into AC signal at a specific frequency.

(ii) Name two types of L.C. oscillators
Hartley oscillator and Colpitts oscillator

(iii) Where is the oscillator positioned in a superhet receiver?
The oscillator is located just before the mixer stage in the superhet receiver. It generates a signal that mixes with the incoming RF signal to produce the intermediate frequency (IF).

(iv) Draw a well labelled block-diagram of an oscillator.
(The diagram includes: DC power source, transistor/amplifier, tank circuit with inductor and capacitor in parallel, feedback path.)



5
(a) Two resistors R1 and R2 are connected in series. Calculate the total resistance when the value of R1 and R2 are given in colour codes as shown in table 1.

R1: Red, Violet, Orange
Red = 2, Violet = 7, Orange = ×1000
R1 = 27 × 1000 = 27000 Ω = 27 kΩ

R2: Yellow, Grey, Red
Yellow = 4, Grey = 8, Red = ×100
R2 = 48 × 100 = 4800 Ω = 4.8 kΩ

Total resistance = R1 + R2 = 27000 + 4800 = 31800 Ω = 31.8 kΩ

(b) Two values of some resistors printed on the body are shown below. Determine the value of each resistor:
(i) 5.6 K = 5.6 × 1000 = 5600 Ω
(ii) 2 K2 = 2.2 × 1000 = 2200 Ω
(iii) 4 M7 = 4.7 × 1000000 = 4700000 Ω

(c) Briefly explain the meaning of Power rating in resistors.
Power rating of a resistor is the maximum amount of power it can safely dissipate without overheating or getting damaged. It depends on the resistor's size and material. If the resistor dissipates more than its rated power, it may burn out or fail.

6

Resistors used for volume and tone controls are either logarithmic or linear. Use characteristic curves to explain what these terms mean. What are the resistors usually called?
Logarithmic resistors vary their resistance according to a logarithmic scale, meaning a small rotation causes a large change in resistance at one end and small change at the other. They are used to match the logarithmic nature of human hearing in audio controls. Linear resistors change resistance uniformly with the rotation of the control. These resistors are commonly called potentiometers or variable resistors.

7

A radio receiver is brought to you with incorrect dial indication problem. Name five possible causes of the problem.
1. Loose or misaligned tuning dial mechanism
2. Faulty or misaligned tuning capacitor
3. Defective or worn-out pointer cord or string
4. Mechanical obstruction in the dial movement
5. Calibration error in the frequency scale

8

(a) Draw a bridge rectifier with a capacitor input filter circuit.
(The diagram includes four diodes in bridge arrangement with AC input on opposite corners and output on the other two corners. A capacitor is connected across the output terminals. Can be generated as image if needed.)

(b) Show by arrow heads the current flow around the bridge.
Current flows through two diodes in the conducting half-cycle, forming a loop through the load and back via the other two diodes in the opposite half-cycle. Arrow heads on diodes indicate this alternating path.

9

What do the following terms mean?
(i) Fidelity
Fidelity is the ability of a communication system to reproduce the input signal accurately at the output without distortion. High fidelity means better sound or signal reproduction.

(ii) Sensitivity
Sensitivity is the minimum input signal strength required for a receiver to produce a usable output. Higher sensitivity means the receiver can detect very weak signals.

(iii) Selectivity
Selectivity is the ability of a receiver to select the desired signal frequency from among many close frequencies. A selective receiver can reject adjacent channel interference effectively.

10
(a) State the functions of the ignition system used in cars.
The ignition system generates high-voltage sparks at the right moment to ignite the air-fuel mixture in the engine's combustion chamber. It ensures engine starts smoothly and runs efficiently.

(b) Sketch a labelled circuit diagram of the ignition coil.
(The diagram includes primary coil, secondary coil, battery, contact breaker, condenser, and spark plug. Image can be generated.)

(c) Estimate the range of voltages produced by the ignition coil.
The ignition coil steps up 12 V from the battery to between 10000 V and 40000 V depending on the system design.

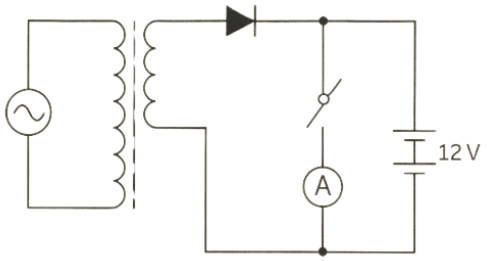
(d) What is the standard number of turns on the secondary and primary sides of the ignition coil?
The primary coil has about 100 to 200 turns, while the secondary coil has between 15000 and 25000 turns.

11
(a) What type of motor is used as the starter motor in cars?
A DC series motor is typically used because it provides high starting torque.

(b) Sketch a circuit diagram of the starter motor. In your diagram show the armature and the field windings.
(The diagram includes battery, switch, series connection of field winding and armature. Can be generated.)

(c) What are the functions of a starter motor in a motor vehicle?
The starter motor converts electrical energy from the battery into mechanical energy to crank the engine and initiate the combustion process. It turns the engine flywheel until the engine starts running on its own.

12
(a) Draw a circuit diagram of a simple 12 volt battery charger using a half-wave rectifier. In your diagram include a switch and an ammeter to measure the charging current.



(The diagram includes transformer, single diode, battery, switch, ammeter in series, and AC input. Image can be generated.)

(b) A 12 volts battery has 6 cells. Each cell has an internal resistance of 0.01 ohms. If the charger output voltage is 12.6 volts, calculate the initial charging current.
Battery voltage = 12 V, Charger voltage = 12.6 V
Voltage difference = 0.6 V
Total internal resistance = $6 \times 0.01 = 0.06\ \Omega$
Charging current = V / R = 0.6 / 0.06 = 10 A

13
(a) The lead acid battery uses dilute sulphuric acid as the electrolyte. Give the chemical equation when the battery is
(i) fully charged
$PbO_2 + Pb + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$ (during discharge, reverse during charging)

(ii) completely discharged
Both electrodes are lead sulphate:
$PbSO_4 + PbSO_4 + 2H_2O \rightarrow PbO_2 + Pb + 2H_2SO_4$ (this is the recharging reaction)

(b) A 12 volts car battery is supplying two lamps. Each lamp is rated at 30 watts. Calculate the:
(i) Current drawn from the battery when the lamps are in parallel
Total power = $2 \times 30 = 60$ W
V = 12 V
I = P / V = 60 / 12 = 5 A

(ii) Resistance of each lamp
$P = V^2 / R \rightarrow R = V^2 / P = 12^2 / 30 = 144 / 30 = 4.8\ \Omega$