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: 1999**

Instructions

1. This paper consists of TWELVE questions.

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

1. Figure 1 shows the aerial circuit of a radio receiver. Study it and then answer the following questions.

(a) What will the resistance between A and chassis be when switch S1 is switched to (i) Position M
In position M, S1 connects through the coil L3 to chassis. If L3 is not open, current flows through it, so the resistance between A and chassis is the resistance of coil L3, which is typically very low, close to 0 ohms.

(ii) Position L
In position L, S1 bypasses L3 and directly connects to chassis, meaning there's a direct path from point A to chassis. Therefore, the resistance is zero ohms.

(b) If the resistance was infinity when set to position L, and did not alter when coil L3 was short-circuited, but measured one ohm when it was set to position M, what would you suspect as being wrong?
If resistance is infinite in position L, it means there is no connection between A and chassis. Since L3 is short-circuited and resistance does not change, the path in position L must be open. The one ohm reading in M indicates that the coil L3 is intact. The fault is likely a broken or corroded contact in switch S1 at position L.

(c) If the resistance was zero ohms in the two positions of switch S1, what would you suspect as being wrong?
If resistance is zero in both positions, it indicates that coil L3 is short-circuited. That means the wire in the coil has lost its inductive nature and is simply acting like a wire (no resistance or impedance).

(d) If the resistance was zero ohms when S1 was set to Position L, but read one ohm when set to position M, what would you suspect as being wrong?
This condition is expected for a working circuit. Zero ohms in position L (direct path) and one ohm in position M (through coil L3) suggests that both the switch and coil L3 are functioning normally.

2
(a) Define the term shunt resistance in connection with measuring instruments.
Shunt resistance is a low-value resistor connected in parallel with a measuring instrument like a galvanometer to allow it to measure higher currents. The shunt bypasses excess current around the sensitive meter so that only a small, safe fraction flows through the instrument.

(b) A moving coil galvanometer has 10 ohms resistance. It is rated to measure 100 mV and 10 mA full scale deflection. This galvanometer is to be used as a voltmeter to measure 10 volts full scale deflection. Calculate the value of multiplier resistance required.
Required voltage = 10 V
Galvanometer full scale voltage = 0.1 V
Required drop across multiplier = 10 - 0.1 = 9.9 V Current through galvanometer = 10 mA = 0.01 A
Multiplier resistance = V / I = 9.9 V / 0.01 A = 990 Ω

3. (a) Explain briefly the meaning of the term halfwave rectifier.
A halfwave rectifier is an electronic device or circuit that converts alternating current (AC) into pulsating direct current (DC) by allowing only one half (positive or negative) of the AC cycle to pass through while blocking the other half using a single diode.

(b) Draw a neat and labelled circuit diagram of the bridge rectifier.
(Mchoro wa bridge rectifier utatolewa kama picha ukihitajika. Unahusisha diodes 4 katika mpangilio wa daraja, AC input kati ya jozi mbili, na DC output kati ya pointi za katikati.)

(c) Supposing the input Voltage to the bridge rectifier is sinusoidal, show the waveform of the rectifier output.
(Output waveform ni pulsating DC: mfululizo wa mawimbi ya upande mmoja, bila sehemu hasi. Picha inaweza kutolewa.)

4. (a) Define the term sidebands.
Sidebands are the frequency components produced in amplitude modulation that appear above and below the carrier frequency. They carry the actual information or signal and are called upper sideband (USB) and lower sideband (LSB).

(b) A 500 kHz carrier wave is amplitude modulated by a baseband audio signal ranging from 0 Hz to 5000 Hz. Using a diagram show the following:
(i) the extent of lower and upper sidebands
Lower sideband = 500 kHz - 5 kHz = 495 kHz
Upper sideband = 500 kHz + 5 kHz = 505 kHz
So the sidebands extend from 495 kHz to 505 kHz

(ii) the band width of the modulated wave
Bandwidth = Upper sideband - Lower sideband = 505 kHz - 495 kHz = 10 kHz

5
(a) Two resistors R1 and R2 are connected in parallel. The two resistors are colour coded as follows:
R1: Brown, Green, Red = 1 5 × 10^2 = 1500 Ω
R2: Brown, Black, Red = 1 0 × 10^2 = 1000 Ω

Calculate the total resistance.
1 / R_total = 1 / R1 + 1 / R2
1 / R_total = 1 / 1500 + 1 / 1000 = (2.5 + 1.5) / 1500 = 4 / 3000
R_total = 3000 / 4 = 750 Ω

(b) Suppose the total resistance is connected across a power supply of 60 volts. Calculate (i) total circuit current
V = 60 V, R = 750 Ω

$I = V / R = 60 / 750 = 0.08$ A

(ii) power dissipated in resistor R2
Voltage across R2 = 60 V
Power = $V^2 / R = 60^2 / 1000 = 3600 / 1000 = 3.6$ W

6
Figure 2 is a circuit of an audio frequency amplifier. Explain briefly the functions of the following components:

(a) Resistor R1
R1 provides the base bias for the transistor. It ensures that a small current flows into the base to turn the transistor on and set it into active mode for amplification.

(b) Resistor R2
R2 is used to form a voltage divider with R1 to stabilize the base voltage and keep the transistor operating at a desired Q-point.

(c) Resistor R3
R3 is the collector load resistor. It converts the amplified current from the collector into a voltage output. It helps develop the output voltage signal across it.

(d) Capacitor C1
C1 is a coupling capacitor. It blocks any DC component from the previous stage while allowing AC signals (audio frequencies) to pass into the base of the transistor.

(e) Capacitor C2
C2 is the emitter bypass capacitor. It bypasses AC signals to ground, increasing the gain of the amplifier by reducing the AC impedance in the emitter leg.

7
(a) Explain the meaning of auto-transformer.
An auto-transformer is a type of transformer that uses a single winding for both the primary and secondary sides. The winding has at least three taps where a portion of the winding acts as the primary, and another portion acts as the secondary. It is used when voltage transformation ratio is small and is more economical due to fewer turns of wire.

(b) A transformer has 240 volts on the Primary Windings and 20 volts on the Secondary Windings. Calculate:

(i) Primary current when Secondary current is 2 Amperes Using the transformer equation:
$V_1I_1 = V_2I_2$

$240 \times I_1 = 20 \times 2 = 40$
$I_1 = 40 / 240 = 0.167$ A

(ii) Secondary turns when the Primary turns are 48000

$V_1 / V_2 = N_1 / N_2$

$240 / 20 = 48000 / N_2$

$12 = 48000 / N_2$

$N_2 = 48000 / 12 = 4000$ turns

(iii) Transformer's turns ratio between the Primary and Secondary Turns ratio = $N_1 / N_2 = 48000 / 4000 = 12:1$

8

Draw a block diagram of Superhet Radio receiver suitable for AM reception. Label each stage and show the signal waveform at each stage of the block diagram.

The block diagram includes the following stages in order:

1. Antenna – Captures incoming AM radio signals from the air.
Waveform: Weak amplitude modulated (AM) signal

2. RF Amplifier – Amplifies the incoming AM signal without changing its frequency. Waveform: Stronger AM signal (same frequency)

3. Mixer – Combines the amplified AM signal with a locally generated signal from the local oscillator. This creates an intermediate frequency (IF) signal.
Waveform: IF signal with same modulation as original AM but fixed frequency (typically 455 kHz)

4. Local Oscillator – Generates a signal of frequency different from the incoming signal, to aid frequency conversion.
Waveform: Pure sine wave

5. IF Amplifier – Amplifies the intermediate frequency signal for further processing. Waveform: Strong IF signal with clear modulation

6. Detector or Demodulator – Extracts the original audio signal from the modulated carrier.
Waveform: Audio signal waveform

7. Audio Amplifier – Boosts the audio signal to drive a speaker or headphones. Waveform: Amplified audio signal

8. Loudspeaker – Converts the audio signal into sound.

Output: Audible sound

9
A camera tube and picture tube are transducers which are used in television systems. Explain briefly the functions of each device.

Camera Tube
This is an input transducer that converts light from the scene being televised into an electrical video signal. It works by focusing light onto a photosensitive surface, generating electrical charges that correspond to the brightness of each part of the image. The scanning process converts these charges into a continuous video signal for transmission.

Picture Tube (Cathode Ray Tube - CRT)
This is an output transducer that converts the incoming video signal back into light to recreate the original image on the screen. The electron beam inside the CRT is directed and focused onto a phosphorescent screen, and as it scans line by line, it lights up to form a visible picture corresponding to the transmitted video signal.

10
Explain briefly the differences between the following systems:
(i) Television Broadcasting
Television broadcasting involves sending television signals from a central broadcasting station via radio waves or satellites to the public. It is one-way communication intended for mass reception, where viewers use antennas or satellite dishes to receive the content.

(ii) Cable Television
Cable television delivers TV signals through coaxial or fiber-optic cables directly to subscribers. It offers a wider variety of channels, improved quality, and is less affected by atmospheric conditions. Cable TV is usually subscription-based and more secure against interference.

11. (a) Define the term Scanning in connection with television.
Scanning is the process of converting a visual image into a sequence of electrical signals by sweeping an electron beam across the image area line by line and frame by frame. In television, scanning is used both at the transmitter to convert images to signals and at the receiver to reconstruct the image.

(b) In television transmission, each picture before being transmitted, is divided into a number of lines. List three television line systems used.
525-line system (used in NTSC systems)
625-line system (used in PAL systems)
1125-line system (used in HDTV systems)

(c) A television system transmits 15625 lines per second. What is the time duration required to transmit one line?

Time per line = 1 / number of lines per second = 1 / 15625 = 0.000064 seconds = 64 microseconds

12. (a) Define the term television channel.
A television channel is a specific range of frequencies allocated for the transmission of a TV signal. It includes both video and audio information, typically occupying a bandwidth of about 6 to 8 MHz depending on the region and standard used.

(b).A television wave propagated from the transmitting antenna towards the receiving antenna is said to contain three different pieces of information. List them down.
1. Video signal (picture information)
2. Audio signal (sound information)
3. Synchronizing pulses (to maintain timing between transmitter and receiver)

(c) Explain briefly the meaning of monochrome television.
Monochrome television refers to black-and-white television, where images are transmitted and displayed in shades of gray. It uses a single brightness signal (luminance) without any color information and was the standard before the introduction of color TV.