THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

083   **RADIO AND TV SERVICING**

(For Both School and Private Candidates)

Time: 3 Hours   **ANSWERS**   **Year: 2016**

Instructions

1. This paper consists of SIXTEEN questions.

2. Answer all questions in section A and B and two questions from section C.

I. For each of the items (i) – (x), choose the correct answer from among the given alternatives and write its letter beside the item number in the answer booklet provided.

(i) The typical operating voltage for LED's ranges from
A 6 V to 10 V
B 1.5 V to 2.5 V
C 0.2 V to 0.7 V
D 9 V to 12 V

Answer: B 1.5 V to 2.5 V
Reason: LEDs typically operate at low forward voltages in the range of 1.5 to 2.5 V depending on the color.

(ii) The cut off voltage of a silicon diode is
A 0.1 V
B 0.2 V
C 0.6 V
D 0.3 V

Answer: C 0.6 V
Reason: Silicon diodes typically start conducting at about 0.6 to 0.7 V, known as the cut-in or threshold voltage.

(iii) Through which mode are medium wave signals received?
A Ionospheric layers
B Ground wave
C Short wave
D Space wave
E Medium wave

Answer: B Ground wave
Reason: Medium wave signals are primarily received by ground wave propagation during the day.

(iv) How many electron guns are present in a colour TV picture tube?
A One
B Three
C Two
D Five

Answer: B Three
Reason: A color TV uses three electron guns for red, green, and blue phosphor dots on the screen.

(v) What is the colour coding of a 47 kΩ ± 20% resistor?
A Orange, Blue, Yellow, Silver

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B Yellow, Violet, Orange
C Yellow, Violet, Orange, Silver
D Yellow, Violet, Orange, Gold
E Black, Green, Black

Answer: C Yellow, Violet, Orange, Silver
Reason: Yellow (4), Violet (7), Orange (×1000), Silver (±20% tolerance)

(vi) Which of the following current directions is represented by an arrow in the transistor symbol?
A Electron current in the emitter
B Electron current in the collector
C Hole current in the emitter
D Donor ion current

Answer: C Hole current in the emitter
Reason: The arrow in the transistor symbol indicates the direction of conventional current (i.e., hole flow) in the emitter.

(vii) What is the impact of applying forward bias to a p-n junction diode?
A Minority charge carrier reduced
B Electron current in collector
C Potential barrier increased
D Majority charge carrier reduced
E Depletion layer widened

Answer: B Electron current in collector
Correction: The correct effect of forward bias is that the potential barrier is reduced and current flows.
So correct answer is: None of the options are precisely worded. However, among them, the most relevant correct choice based on context is:
Answer: B Electron current in collector (although it's more valid for a transistor context).

(viii) Which of the following is the result of increasing the height of the TV receiving antenna?
A The range of TV broadcast decreases
B Signal noise increases
C Antenna may fail to receive the signal
D The range of TV broadcast increases
E Image frequencies are doubled

Answer: D The range of TV broadcast increases
Reason: Increasing antenna height increases line-of-sight distance, improving reception range.

(ix) The main purpose of applying blanking pulse in TV signal is
A to avoid flickering effect

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B to make the retraces invisible
C to ensure a uniform scanning rate
D to reduce the width of the picture
E to make synchronization

Answer: B to make the retraces invisible
Reason: Blanking pulses prevent the retrace (return of electron beam) from appearing on the screen.

(x) Which type of transistor biasing provides good stability using negative feedback?
A Base-feedback bias
B Collector-feedback bias
C Voltage divider-feedback bias
D Emitter-feedback bias

Answer: C Voltage divider-feedback bias
Reason: Voltage divider biasing provides good stability as it applies negative feedback to stabilize operating point.
2. Define the following terms as applied in electronic amplifiers circuits:
(a) Feedback.
(b) Negative feedback.
(c) Positive feedback.

(a) Feedback is the process of taking a portion of the output signal of an amplifier and feeding it back to the input.

(b) Negative feedback is when the feedback signal opposes the input signal, resulting in reduced gain but improved stability, bandwidth, and linearity.

(c) Positive feedback is when the feedback signal adds to the input signal, increasing the gain and possibly causing oscillations.

3. (a) Draw a symbol of variable capacitor.

[The symbol consists of two parallel lines (like a normal capacitor) with a diagonal arrow crossing it, indicating variability.]

(b) A tuned circuit with 40 µH inductor and 1 nF capacitor is used as a source of frequency in a radio receiver. What value of frequency will be produced?

Given: $L = 40\ \mu H = 40 \times 10^{-6}$ H, $C = 1$ nF $= 1 \times 10^{-9}$ F
$f = 1 / (2\pi\sqrt{(LC)})$
$f = 1 / (2 \times 3.1416 \times \sqrt{(40 \times 10^{-6} \times 1 \times 10^{-9})})$
$= 1 / (6.2832 \times \sqrt{4} \times 10^{-14})$

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= 1 / (6.2832 × 2 × 10⁻⁷)
= 1 / 1.2566 × 10⁻⁶
$= 7.96 \times 10^5$ Hz = 796 kHz

Answer: 796 kHz

4. Give the meaning of each of the following terms used in TV systems:
(a) Chrominance.
(b) Line frequency.
(c) Picture element.

(a) Chrominance is the part of a video signal that carries color information, usually including hue and saturation.

(b) Line frequency refers to the number of horizontal scanning lines per second used in displaying a video image.

(c) Picture element or pixel is the smallest unit of a digital image or video display which carries image information.

5. (a) What is the meaning of a term transducer as used in telecommunication systems?

A transducer is a device that converts one form of energy into another. In telecommunication, it often converts sound (acoustic energy) into electrical signals and vice versa.

(b) Mention two transducers used in a radio receiver.

Microphone
Speaker

6. Define the following terms as used in radio and television systems:
(a) Adjacent Channels.
(b) Adjacent channel Interference.
(c) Automatic Gain Control.

(a) Adjacent channels are frequency bands that are next to each other in a broadcast spectrum.

(b) Adjacent channel interference is the undesired signal spillover from one channel into its neighboring channel, causing distortion or loss of quality.

(c) Automatic Gain Control (AGC) is a system in receivers that automatically adjusts the amplifier gain to maintain a constant output despite varying signal strengths.

7. Mention three commonly used modes of transistor configurations.

Common Emitter (CE)
Common Base (CB)
Common Collector (CC)

8. A 6.8 V zener diode has resistance of 5 Ω. With reference to Figure 1, calculate the actual voltage across its terminals when the current is 20 mA.

Given: V_z = 6.8 V (zener breakdown voltage), r_z = 5 Ω, I = 20 mA
Voltage drop due to resistance = I × r_z = 0.02 A × 5 Ω = 0.1 V
Total voltage = V_z + drop = 6.8 V + 0.1 V = 6.9 V

Answer: 6.9 V

9. Give one application for each of the following measuring instruments:
(a) Ammeter
(b) Voltmeter
(c) Ohmmeter

(a) Ammeter: Used to measure current in an electric circuit.
(b) Voltmeter: Used to measure voltage between two points in a circuit.
(c) Ohmmeter: Used to measure electrical resistance of a component or circuit.

10. (a) Define the term modulation as used in radio systems.

Modulation is the process of varying a carrier signal's properties (amplitude, frequency, or phase) in accordance with the information (audio, video, or data) being transmitted.

(b) Give a frequency range for the following:
(i) Audio Frequency (AF)
(ii) Ultra High Frequency (UHF)

(i) Audio Frequency (AF): 20 Hz to 20 kHz
(ii) Ultra High Frequency (UHF): 300 MHz to 3 GHz

11. The following table shows the color codes for three resistors, R1, R2 and R3. Complete the table by filling in the columns for values and tolerance of the three resistors.

Band:	1	2	3	4	Value	Tolerance
R1:	Orange	Orange	Brown	Silver	330 Ω	±10%
R2:	Brown	Black	Orange	Gold	10 kΩ	±5%
R3:	Green	Blue	Yellow	None	560 kΩ	±20%

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12. Answer three (3) questions from this section.

(a) Draw a well labeled circuit diagram for AM diode detector.

[Diagram should include: antenna feeding into tuned circuit, then a diode connected to a load resistor and a capacitor in parallel, which delivers detected audio signal.]

(b) A communication receiver has an intermediate frequency (IF) of 9 MHz. Calculate the frequency of its oscillator when it is tuned to 15 MHz.

Oscillator frequency = Signal frequency + IF = 15 MHz + 9 MHz = 24 MHz

Answer: 24 MHz

(c) A carrier of 1 MHz frequency is amplitude modulated by a frequency of 1000 Hz:
(i) Determine the frequency components of the modulated signal.
(ii) Draw the frequency spectrum of the modulated wave.
(iii) Find the bandwidth occupied by the modulated wave.

(i) Frequency components: 1 MHz (carrier), 1 MHz ± 1 kHz = 999 kHz and 1.001 MHz (sidebands)
(ii) Spectrum: should show three spikes at 999 kHz, 1 MHz, and 1.001 MHz
(iii) Bandwidth = 2 × modulating frequency = 2 × 1 kHz = 2 kHz

(d) Give four advantages of a diode detector that is used for extraction of intelligence signal in AM radio receivers.

Simple circuit and easy to construct
Requires few components and low cost
Efficient for detection of AM signals
Provides acceptable demodulation for strong signals

13. (a) Which part of a super heterodyne receiver is referred to as the first detector?

The first detector is the mixer. It combines the incoming radio frequency signal with the oscillator signal to produce the intermediate frequency (IF).

(b) Give four factors that govern the selection of the intermediate frequency (IF) of a radio receiver.

Stability of frequency
Selectivity of the receiver
Image frequency rejection
Bandwidth requirements of the signal

(c) A radio receiver uses a series resonant circuit which has the following circuit elements: L = 200 µH, C = 300 pF and R = 12 Ω. The source voltage is 9 V. Calculate:
(i) the resonant frequency
(ii) the impedance at resonance
(iii) the source current at resonance
(iv) the voltage across each element
(v) the Q-factor of the circuit

(i) $f = 1 / (2\pi\sqrt{(LC)})$
$L = 200 \times 10^{-6}$ H, $C = 300 \times 10^{-12}$ F
$f = 1 / (2 \times 3.1416 \times \sqrt{(200 \times 10^{-6} \times 300 \times 10^{-12})})$
$= 1 / (6.2832 \times \sqrt{6} \times 10^{-14})$
$= 1 / (6.2832 \times 7.746 \times 10^{-7})$
$= 1 / 4.867 \times 10^{-6}$
$= 2.055 \times 10^{5}$ Hz $= 205.5$ kHz

(ii) At resonance, impedance Z = R = 12 Ω

(iii) I = V / R = 9 V / 12 Ω = 0.75 A

(iv) Voltage across L or C = I × X
$X = 2\pi fL = 2 \times 3.1416 \times 2.055 \times 10^{5} \times 200 \times 10^{-6} = 258$ Ω
$V\_L = V\_C = 0.75 \times 258 = 193.5$ V

(v) Q = X_L / R = 258 / 12 = 21.5

14. (a) Define the following terms as used in transistor amplifiers:
(i) Voltage gain
(ii) Current gain
(iii) Power gain

(i) Voltage gain is the ratio of output voltage to input voltage in an amplifier.
(ii) Current gain is the ratio of output current to input current.
(iii) Power gain is the ratio of output power to input power, and equals voltage gain × current gain.

(b) The voltage gain of the individual stages of a three stage amplifier are 90, 70 and 40. Calculate the overall voltage gain in dB.

Overall gain = 90 × 70 × 40 = 252000
Gain in dB = 20 log(252000) = 20 × 5.401 = 108.02 dB

(c) A transistor draws a base current of 150 µA when the collector current is 20 mA. Calculate its α and β.

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$I\_B = 150 \times 10^{-6}$ A, $I\_C = 20 \times 10^{-3}$ A
$I\_E = I\_C + I\_B = 20.15$ mA
$\alpha = I\_C / I\_E = 20 / 20.15 = 0.993$
$\beta = \alpha / (1 - \alpha) = 0.993 / (1 - 0.993) = 0.993 / 0.007 = 141.86$

(d) The d.c alpha (α) of the transistor in Figure 2 is 0.96. The voltage drop across 2 kΩ resistor is 4 V. Determine the base current.

$I\_C = V / R = 4 / 2000 = 0.002$ A
$\alpha = I\_C / I\_E \rightarrow I\_E = I\_C / \alpha = 0.002 / 0.96 = 0.002083$ A
$I\_B = I\_E - I\_C = 0.002083 - 0.002 = 8.3 \times 10^{-5}$ A $= 83$ µA

15. (a) List two uses of each of the following equipment in radio works:
(i) Cathode ray oscilloscope (CRO)
(ii) RF Generator

(i) CRO:
To display waveform signals in time domain
To measure voltage, frequency and phase difference

(ii) RF Generator:
To produce test RF signals for tuning and testing circuits
To simulate broadcast signals during development

(b) (i) Give the name of the transducer found at the output part of a radio receiver.
(ii) Draw the symbol for the transducer you named in b(i) above.

(i) Loudspeaker
(ii) [Symbol: circle with two lines coming out; inside the circle, a small cone or triangle indicating sound projection.]

16. (a) Give the main function of each of the following electronic transducers:
(i) Light emitting diode
(ii) Electric motor

(i) Light Emitting Diode (LED): Converts electrical energy into light energy.
(ii) Electric Motor: Converts electrical energy into mechanical energy.

(b) List five transducers that are found in a television system.

Microphone
Speaker

Camera tube
CRT (Cathode Ray Tube)
Remote sensor

(c) Define the following terms as used in electronic systems:
(i) Rectification
(ii) Filter circuit

16.(a) (i) Rectification is the process of converting alternating current (AC) to direct current (DC).
(ii) A filter circuit removes the AC components from a rectified signal, leaving smooth DC output.

(b) Mention three most commonly used filter circuits in d.c. power supplies.

Capacitor input filter
Inductor input filter
Pi (π) section filter

(c) You have been provided with the following components; two semiconductor diodes, a transformer with center tapped secondary, a choke and two fixed capacitors. Design a d.c power supply circuit diagram.

(d) In a half-wave rectifier, the turns ratio of the transformer is $N1/N2 = 31:2$. The primary of the transformer is connected to power mains of 220 V, 50 Hz. The average dynamic forward resistance of the diode used is 20 Ω and the load resistance is 1 kΩ. If the threshold voltage of the diode is 0.6 V, determine:
(i) the dc current through the load
(ii) the peak inverse voltage

(i) Secondary voltage = $(2/31) \times 220 = 14.19$ V
V_peak = 14.19 V − 0.6 V = 13.59 V
I_dc = V_peak / (R + r_diode) = 13.59 / (1000 + 20) = 13.59 / 1020 = 0.0133 A = 13.3 mA

(ii) Peak Inverse Voltage (PIV) = V_peak = 13.59 V