

**THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATION COUNCIL
CERTIFICATE OF SECONDARY EDUCATION EXAMINATION**

083

RADIO AND TV SERVICING

(For Both School and Private Candidates)

Time: 3 Hours.

SOLUTIONS

Year: 2022

Instructions

1. This paper consists of section A, B and C with total of fourteen (14) questions.
2. Answer all questions in section A and B, and three (3) questions from section C.
3. Section A carries ten (10) marks, section B and C carry forty five (45) marks each.
4. Cellular phones, and any unauthorized materials are not allowed in the examination room.
5. Write your Examination Number on every page of your answer booklet (s).

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SECTION A (10 marks)
Answer all questions in the section

1. Choose the correct answer for each item (i) to (x) and write its letter in the answer booklet provided:

i) What does the term “retrace” referred to as used in TV technology?

- A. Synchronizing pulse
- B. Field scanning
- C. Back porch
- D. Interlaced scanning
- E. Fly back.

Correct answer: E.

Retrace in TV technology refers to the rapid return of the electron beam from the end of one scan line or field back to the starting position. This return motion is known as flyback, during which the beam is blanked so that no visible trace appears on the screen.

ii) What is the value of the potential barrier for Germanium diode?

- A. 3V
- B. 6V
- C. 0.3V
- D. 0.6V
- E. 0.7V

Correct answer: C.

A germanium diode has a low potential barrier voltage due to its smaller band gap energy. This barrier is approximately 0.3 V, which allows current to flow at relatively low forward bias compared to silicon diodes.

iii) Which one is an oscillator which utilizes capacitive voltage divider in providing feedback?

- A. Hartley
- B. Colpitts
- C. Armstrong
- D. Multivibrator
- E. Wien

Correct answer: B.

The Colpitts oscillator uses two capacitors connected in series to form a capacitive voltage divider. This divider provides the required feedback voltage to sustain oscillations.

iv) In what type of wave is UHF signal range propagated?

- A. Ground wave
- B. Sinusoidal wave
- C. Sky wave
- D. Surface wave
- E. Space wave.

Correct answer: E.

UHF signals propagate mainly as space waves, which travel in straight lines through the atmosphere. These waves are suitable for line-of-sight communication such as television and satellite links.

v) Which of the following diodes possess negative resistance characteristics?

- A. Zener diode
- B. Schottky diode
- C. Tunnel diode
- D. PN junction diode
- E. Varactor diode.

Correct answer: C.

A tunnel diode exhibits negative resistance due to quantum tunneling. In a certain region of its V–I characteristic, an increase in voltage causes a decrease in current.

vi) Which stage of a d.c power supply use a zener diode as a main component?

- A. Rectifier
- B. Voltage divider
- C. Regulator
- D. Filter
- E. Load.

Correct answer: C.

A zener diode is used in the voltage regulator stage of a DC power supply. It maintains a constant output voltage despite variations in input voltage or load current.

vii) Which type of instrument is recommended for measuring A.C current?

- A. Induction type ammeter
- B. Moving iron type ammeter

- C. Moving iron voltmeter
- D. Permanent magnet type ammeter
- E. Hot wire type ammeter.

Correct answer: B.

A moving iron ammeter is suitable for measuring AC current because its operation depends on the magnetic effect of current, which works for both AC and DC.

viii) What will be the effect to the image produced, if the picture tube operates under poor convergence?

- A. The image will have chroma phase shift
- B. The image will have random interference
- C. The image will have colour fringing
- D. The image will have unstable sync lock
- E. The image will have mutual interference

Correct answer: C.

Poor convergence in a colour picture tube causes the red, green, and blue electron beams not to meet at the same point. This results in colour fringing around objects on the screen.

ix) What are the factors that determine the amount of the current flowing in a capacitor?

- A. Area, distance between plates and material used.
- B. Capacitance, area and material used.
- C. Distance between plates, dielectric and material used.
- D. Capacitance, distance between plates and area.
- E. Capacitance, distance between plates and material used.

Correct answer: D.

The current in a capacitor depends on its capacitance, which is determined by the plate area and the distance between the plates. These factors directly influence how much charge can be stored and released.

x) Which one is true about an amplitude modulated wave in radio communication systems?

- A. Is the sum of carrier and the modulating signal.
- B. Is the difference between the carrier and the modulating wave.
- C. Is the product of the carrier and the modulating signal.
- D. Is the sum of the carrier and its product with modulating signal.
- E. Is the suppressed carrier signal and modulating wave?

Correct answer: D.

In amplitude modulation, the carrier wave is combined with the modulating signal such that the carrier amplitude varies in proportion to the modulating signal. Mathematically, it is the sum of the carrier and its product with the modulating signal.

SECTION B (45 Marks)

Answer all questions from this section

2.(a) State the safety factors to be considered in any electronics and electrical workshop.

One important safety factor is proper insulation of all electrical connections and equipment. This prevents electric shock by ensuring that live conductors are not exposed during normal operation.

Another safety factor is adequate ventilation in the workshop. Good ventilation prevents overheating of equipment and reduces the accumulation of harmful fumes from soldering and other processes.

Proper earthing of equipment is also essential. Earthing provides a low-resistance path for fault current, reducing the risk of electric shock and equipment damage.

The use of appropriate personal protective equipment such as gloves, goggles, and insulated tools is another key factor. These protect workers from burns, sparks, and accidental contact with live parts.

Clear labeling and proper arrangement of tools and components is also important. This reduces confusion and minimizes accidental misuse of equipment.

(b) Give four causes of accidents in electronics and electrical workshops.

One major cause of accidents is careless handling of electrical equipment, especially when working on live circuits without proper precautions.

Another cause is faulty or damaged tools and cables. Broken insulation and loose connections can easily lead to electric shock or fire hazards.

Poor housekeeping is also a common cause of accidents. Scattered wires, components, and tools can cause trips, falls, or accidental short circuits.

Lack of proper training and supervision contributes significantly to accidents. Workers who do not fully understand safety procedures are more likely to make dangerous mistakes.

(c) State the importance for having a first aid kit in a workshop.

A first aid kit is important because it allows immediate treatment of minor injuries such as cuts, burns, and electric shocks before medical help arrives.

It also helps to reduce the severity of injuries by providing quick response, which can prevent complications and promote faster recovery.

Having a first aid kit improves overall safety awareness in the workshop and ensures preparedness for emergencies, thereby protecting both workers and visitors.

3.(a) Explain the main purpose of communication engineering systems.

The main purpose of communication engineering systems is to transmit information accurately and efficiently from one point to another. This includes voice, data, images, and video signals.

These systems are designed to overcome noise, interference, and signal loss so that the received information closely matches the original message.

Communication engineering systems also aim to maximize the use of available bandwidth and power, ensuring reliable communication over long distances.

(b) Calculate the wavelength of electromagnetic wave propagated at a frequency of 300 MHz.

Frequency $f = 300 \text{ MHz}$

$$f = 300 \times 10^6 \text{ Hz}$$

Speed of light $c = 3 \times 10^8 \text{ m/s}$

Wavelength $\lambda = c \div f$

$$\lambda = (3 \times 10^8) \div (300 \times 10^6)$$

$$\lambda = 1 \text{ m}$$

4.(a) Why interlacing scanning is used in TV signal transmission?

Interlaced scanning is used to reduce flicker in television pictures without increasing the transmission bandwidth. By dividing each frame into two fields, the screen is refreshed more frequently.

This method improves picture stability and smoothness while keeping the required channel bandwidth within practical limits.

(b) If the number of lines per field in a TV system is $262\frac{1}{2}$ and the number of frames per second is 30, determine the number of lines per second.

Number of fields per second
= $2 \times$ frames per second
= 2×30
= 60 fields per second

Lines per second
= lines per field \times fields per second

Lines per second
= 262.5×60

Lines per second
= 15750 lines/s

5.(a) State what will happen if a superhet radio receiver operates without a loudspeaker.

If a superheterodyne radio receiver operates without a loudspeaker, the electrical audio signal will still be produced in the output stage but no sound will be heard.

The receiver will function internally, but the absence of a loudspeaker prevents conversion of the electrical signal into audible sound.

(b) Draw a cross-over network that employs only a tweeter and woofer.

A simple crossover network consists of a capacitor connected in series with the tweeter to block low-frequency signals, and an inductor connected in series with the woofer to block high-frequency signals. This ensures that each speaker receives only the frequency range it is designed to reproduce.

6.(a) How are transistor junctions biased in order to operate in the following regions?

(i) Active region

In the active region, the emitter–base junction is forward biased while the collector–base junction is reverse biased. This condition allows the transistor to amplify signals.

(ii) Saturation region

In the saturation region, both the emitter–base and collector–base junctions are forward biased. This causes the transistor to conduct maximum current and behave like a closed switch.

(b) What are the two features that must be possessed by a good amplifier?

A good amplifier must have high gain so that it can significantly increase the amplitude of the input signal without distortion.

It must also have good fidelity, meaning it reproduces the input signal accurately at the output without altering its waveform or introducing unwanted noise.

7.(a) What is the function of a diode in detector circuit of an AM radio receiver?

The diode in an AM detector circuit is used to rectify the incoming amplitude modulated radio frequency signal. By allowing current to pass in only one direction, the diode removes one half of the carrier waveform so that the envelope of the signal remains. This envelope corresponds to the original audio signal, which can then be filtered and amplified to drive a loudspeaker.

7.(b) Study the figure below and sketch the waveform that would be observed at point Y and Z when point A and B are connected by a conducting wire.

At point Y, the waveform is a half-wave rectified signal. Only the positive half cycles of the input sinusoidal waveform appear because the diode conducts during positive cycles and blocks during negative cycles.

At point Z, the waveform is a pulsating direct voltage with respect to the reference line. When A and B are connected, the resistor provides a load, and the output across Y and Z follows the positive half cycles while remaining at zero during negative half cycles.

8. Study the given circuit and calculate the impedance of the circuit when its operating frequency (f) = 12 kHz.

Given

$$R = 30 \text{ ohms}$$

$$L = 3 \text{ mH}$$

$$C = 0.1 \text{ microfarad}$$

$$f = 12000 \text{ Hz}$$

Inductive reactance

$$X_L = 2\pi fL$$

$$X_L = 2 \times 3.142 \times 12000 \times 0.003$$

$$X_L \approx 226 \text{ ohms}$$

Capacitive reactance

$$X_C = 1 \div (2\pi fC)$$

$$X_C = 1 \div (2 \times 3.142 \times 12000 \times 0.1 \times 10^{-6})$$

$$X_C \approx 133 \text{ ohms}$$

Net reactance

$$X = X_L - X_C$$

$$X = 226 - 133$$

$$X = 93 \text{ ohms}$$

Impedance

$$Z = \sqrt{R^2 + X^2}$$

$$Z = \sqrt{30^2 + 93^2}$$

$$Z = \sqrt{900 + 8649}$$

$$Z = \sqrt{9549}$$

$$Z \approx 97.7 \text{ ohms}$$

9.(a) Why RF amplifier is a sensitive stage in a radio receiver?

The RF amplifier is sensitive because it handles very weak signals picked up by the antenna. Any noise, interference, or improper tuning at this stage can significantly degrade the quality of the received signal. Since it determines selectivity and sensitivity of the receiver, small disturbances at this stage greatly affect overall performance.

(b) Draw a well labelled block diagram of a tuned-radio frequency receiver.

A tuned-radio frequency receiver consists of an antenna, a tuned RF amplifier, a detector stage, an audio frequency amplifier, and a loudspeaker. The antenna receives the signal, the RF amplifier selects and amplifies the desired frequency, the detector extracts the audio signal, and the audio amplifier increases its strength to drive the loudspeaker.

10. Study the circuit shown in the figure below, and then determine the value of current (I_z) when a total current (I) of the circuit is 0.4 mA.

Given

Total current $I = 0.4 \text{ mA}$

Zener voltage = 6 V

Load resistance $R_L = 20 \text{ k}\Omega$

Load current

$$I_L = V \div R_L$$

$$I_L = 6 \div 20000$$

$$I_L = 0.0003 \text{ A}$$

$$I_L = 0.3 \text{ mA}$$

Zener current

$$I_z = I - I_L$$

$$I_z = 0.4 - 0.3$$

$$I_z = 0.1 \text{ mA}$$

Therefore, the zener current is 0.1 mA.

SECTION C (45 Marks)

Answer three (3) questions in this section

11.(a)(i) What will happen if one of the components of the LC tuner circuit of a radio receiver is defective?

If the inductor is defective, the LC circuit will no longer resonate at the desired frequency. This means the receiver will fail to select the required station, leading to weak reception or complete loss of signal because the tuning condition depends directly on the inductance value.

If the capacitor is defective, especially if it is an open or short circuit, the resonant frequency will shift or disappear entirely. As a result, the tuning range of the radio is affected and the receiver will not be able to tune stations correctly.

If either component changes value due to aging or damage, the resonant frequency becomes inaccurate. This causes poor selectivity, overlapping stations, and distorted audio output.

11.(a)(ii) Show how an inductor and a variable capacitor are connected to form a parallel resonance circuit.

In a parallel resonance circuit, the inductor and the variable capacitor are connected across the same two nodes. Both components share the same supply voltage, allowing current to divide between the inductive and capacitive branches.

At resonance, the inductive reactance equals the capacitive reactance, causing circulating currents between L and C while the input current drawn from the source is minimum.

11.(a)(iii) From the circuit drawn in, sketch its response curve.

The response curve of a parallel resonant circuit shows impedance plotted against frequency. At resonance, the impedance reaches a maximum value, forming a sharp peak.

On either side of the resonant frequency, the impedance decreases as the circuit behaves either capacitively at lower frequencies or inductively at higher frequencies.

11.(b) A parallel resonance circuit consists of a 500 pF capacitor and an inductor of 100 mH with resistance of 2 ohms. Determine:

11.(b)(i) The value of frequency at which circuit will resonate.

Given

$$C = 500 \text{ pF} = 500 \times 10^{-12} \text{ F}$$

$$L = 100 \text{ mH} = 0.1 \text{ H}$$

Resonant frequency

$$f = 1 \div (2\pi\sqrt{LC})$$

$$f = 1 \div (2 \times 3.142 \times \sqrt{(0.1 \times 500 \times 10^{-12})})$$

$$f \approx 22500 \text{ Hz}$$

Therefore, the resonant frequency is approximately 22.5 kHz.

11.(b)(ii) The circuit impedance at resonance.

For a parallel resonant circuit, impedance at resonance is given by

$$Z = L \div (C \times r)$$

$$Z = 0.1 \div (500 \times 10^{-12} \times 2)$$

$$Z = 1 \times 10^8 \text{ ohms}$$

Hence, the circuit impedance at resonance is very high.

12.(a) What is the importance of the features used in TV signal transmission and reception?

Blanking is important because it prevents retrace lines from appearing on the TV screen during the return of the scanning beam. This ensures a clean and stable picture display.

TV receiver compatibility ensures that transmitted signals can be correctly received and displayed by different television sets. This allows standardization and widespread usability of broadcast signals.

Negative vision modulation improves noise immunity because noise tends to increase signal amplitude. Since brighter parts correspond to lower signal levels, noise has less visible effect on the picture.

Aspect ratio is important because it defines the proportional relationship between picture width and height. Correct aspect ratio ensures that images appear natural and undistorted on the screen.

12.(b) A TV receiver is tuned to a channel where the vision carrier frequency is 799.25 MHz and IF is 39.5 MHz.

12.(b)(i) The frequency of the local oscillator.

Local oscillator frequency

$$= \text{Vision carrier} + \text{IF}$$

$$= 799.25 + 39.5$$

$$= 838.75 \text{ MHz}$$

12.(b)(ii) The frequency of the sound carrier when it is placed 6 MHz above the picture carrier.

$$\begin{aligned} &\text{Sound carrier frequency} \\ &= 799.25 + 6 \\ &= 805.25 \text{ MHz} \end{aligned}$$

12.(b)(iii) The intermediate frequency of the sound carrier.

$$\begin{aligned} &\text{Sound IF} \\ &= \text{Local oscillator} - \text{Sound carrier} \\ &= 838.75 - 805.25 \\ &= 33.5 \text{ MHz} \end{aligned}$$

13.(a) Three elements of a Yagi-Uda antenna operate at 150 MHz. Calculate:

$$\begin{aligned} &\text{Wavelength} \\ &\lambda = c \div f \\ &\lambda = 3 \times 10^8 \div 150 \times 10^6 \\ &\lambda = 2 \text{ m} \end{aligned}$$

13.(a)(i) Length of driven element.

$$\begin{aligned} &\text{Driven element length} = \lambda \div 2 \\ &= 2 \div 2 \\ &= 1 \text{ m} \end{aligned}$$

13.(a)(ii) Length of director element.

$$\begin{aligned} &\text{Director length is about 5 percent shorter than driven element.} \\ &= 0.95 \times 1 \\ &= 0.95 \text{ m} \end{aligned}$$

13.(a)(iii) Length of reflector element.

$$\begin{aligned} &\text{Reflector length is about 5 percent longer than driven element.} \\ &= 1.05 \times 1 \\ &= 1.05 \text{ m} \end{aligned}$$

13.(b) Draw a three elements Yagi antenna with given specifications.

The reflector of length 7 cm is placed at the rear on a support bar. The driven element of length 3 cm is mounted at the center and connected to the feeder line.

The director of length 5 cm is positioned in front of the driven element to direct radiation forward.

14.(a) Show how two NPN transistors are connected in a Darlington pair.

In a Darlington pair, the emitter of the first NPN transistor is connected to the base of the second transistor. The collectors of both transistors are connected together to the supply voltage.

The input current flows into the base of the first transistor, while the output is taken from the emitter of the second transistor. Collector current flows from the supply through both collectors to the load, while emitter current flows through the second transistor to ground.

14.(b) The amplifier produces a peak-to-peak output of 8 V with average dc power of 1.6 W.

14.(b)(i) Calculate the r.m.s signal voltage.

Peak voltage

$$V_p = 8 \div 2 = 4 \text{ V}$$

RMS voltage

$$V_{rms} = V_p \div \sqrt{2}$$

$$V_{rms} = 4 \div 1.414$$

$$V_{rms} \approx 2.83 \text{ V}$$

14.(b)(ii) Find the amplifier output power.

Given load resistance $R_L = 80$ ohms

Output power

$$P = V_{rms}^2 \div R_L$$

$$P = 2.83^2 \div 80$$

$$P \approx 0.1 \text{ W}$$

14.(b)(iii) Determine the circuit efficiency.

Efficiency

$$= \text{Output power} \div \text{DC input power}$$

$$= 0.1 \div 1.6$$

= 0.0625

Therefore, the circuit efficiency is 6.25 percent.