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: 2001**

Instructions

1. This paper consists of SIXTEEN questions.

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

(i) An electric conductor is a material
A. which readily permits the flow of current
B. in which no appreciable current will flow
C. whose property of permitting flow of electrons and holes is very small
D. which allows flow of holes only
E. which does not allow flow of holes

Answer: A. which readily permits the flow of current
Reason: A conductor allows the free movement of electrons, enabling electric current to flow easily.

(ii) A device which allows flow of current in an open circuit without obeying Ohm's law is called
A. capacitor
B. variable resistor
C. variac
D. transistor
E. thyristor

Answer: E. thyristor
Reason: A thyristor is a semiconductor device that can conduct without following Ohm's law once triggered in an open circuit.

(iii) A rectifier is a circuit which converts
A. alternating current to direct current
B. direct current to alternating current
C. apparent power to real power
D. solar power to electric power
E. mechanical energy to electrical energy

Answer: A. alternating current to direct current
Reason: A rectifier is used to convert AC to DC using diodes.

(iv) Micro-farad is a unit of
A. power
B. capacitance
C. voltage
D. charge
E. resistance

Answer: B. capacitance
Reason: Microfarad is a unit of capacitance, equal to 10^{-6} farads.

(v) The function of the zener diode is
A. to set reference voltage

B. to control a.c. power
C. the same as that of a voltmeter
D. the same as that of a p-n junction
E. to measure light intensity

Answer: A. to set reference voltage
Reason: Zener diodes are used in voltage regulation to maintain a fixed reference voltage.

(vi) In rectifier circuits the
A. function of π (Pi) filter is to eliminate the ripple voltage
B. diodes are used to amplify the input signal
C. diodes conduct in both directions
D. π (Pi) filter has three capacitors
E. π (Pi) filter has a capacitor, a resistor and a choke

Answer: A. function of π (Pi) filter is to eliminate the ripple voltage
Reason: The π-filter, using capacitors and an inductor, smoothens the output from a rectifier.

(vii) A transducer is
A. a device that converts variations in a physical quantity into an electrical signal
B. a small d.c. machine
C. an amplifier
D. a radio aid to detection and ranging
E. an aerial

Answer: A. a device that converts variations in a physical quantity into an electrical signal
Reason: Transducers convert forms of energy (e.g., heat, light, pressure) into electrical signals.

(viii) Complementary push-pull amplifier
A. uses four transistors
B. uses one npn transistor and one pnp transistor
C. uses one transformer and one diode
D. has high frequency amplification
E. is used in inverter circuit

Answer: B. uses one npn transistor and one pnp transistor
Reason: Complementary push-pull amplifiers use one npn and one pnp transistor to handle opposite halves of the waveform.

(ix) The bipolar junction transistor
A. has two junctions
B. has both holes and electrons participating in the injection process
C. is made of silicon semiconductor material only

D. is the same as the diode
E. is the same as magnetic amplifier

Answer: B. has both holes and electrons participating in the injection process
Reason: In BJT operation, electrons and holes participate in current conduction.

(x) An oscillator is
A. a tuned amplifier whereby some of the output energy is fed back to the input to sustain the output
B. an intermediate frequency amplifier in a radio receiver
C. a frequency modulator circuit
D. not a circuit in electronics
E. an antenna

Answer: A. a tuned amplifier whereby some of the output energy is fed back to the input to sustain the output
Reason: Oscillators use positive feedback to maintain sustained oscillations without external input.

2. Sketch the output characteristics of a BJT connected in a common emitter and indicate the three important regions.
(The graph plots collector current I_C vs. collector-emitter voltage V_CE for different base currents I_B. The three regions are:)
- Cut-off region: Base current I_B = 0, no collector current flows.
- Active region: Transistor operates normally; I_C depends on I_B.
- Saturation region: V_CE is low; both junctions forward biased.

3. Two capacitors C_1 and C_2 are connected in parallel. Prove that the joint capacitance is the sum of the individual capacitances.
When capacitors are connected in parallel, the total charge is the sum of individual charges:
$Q_{total} = Q_1 + Q_2$
But $Q = C \times V$, and in parallel, voltage V is the same:
$Q_{total} = C_1V + C_2V = (C_1 + C_2)V$
So, $C_{total} = Q_{total} / V = (C_1 + C_2)V / V = C_1 + C_2$
Hence proved: $C_{total} = C_1 + C_2$

4. How must the two p-n junctions of a BJT be biased for proper transistor operation?
For normal transistor operation in the active region:
- The emitter-base junction must be forward biased.
- The collector-base junction must be reverse biased.

5. Write down the equation relating the wavelength and frequency of a radio wave.
$\lambda = c / f$
Where:
λ = wavelength (meters)

c = speed of light (3×10^8 m/s)
f = frequency (Hz)

6. List down three tools used in radio servicing.
- Multimeter (for measuring voltage, current, resistance)
- Signal generator (to inject known signals)
- Oscilloscope (to visualize waveforms and check signal flow)

7. (a) What is modulation as applied in radio transmitter?
Modulation is the process of varying a high-frequency carrier wave in accordance with the information signal (such as voice or data) to be transmitted. It enables the signal to travel long distances and fit within allocated frequency bands.

(b) What is the difference between amplitude modulation and frequency modulation?
- In amplitude modulation (AM), the amplitude of the carrier wave is varied according to the information signal, while frequency remains constant.
- In frequency modulation (FM), the frequency of the carrier wave is varied in proportion to the information signal, while amplitude remains constant.

8. A secondary cell has an emf of 5 V and an internal resistance of 5 ohms. A load R_L is connected across the cell. Find the value of R_L for maximum power transfer.
For maximum power transfer, R_L = r_internal
R_L = 5 Ω

9. In a radio receiver, a diode or transistor is used in the detector circuit. Why?
A diode or transistor is used to demodulate the incoming radio frequency signal, extracting the original audio or baseband signal. It performs rectification, allowing only one part of the signal waveform to pass and thereby retrieving the modulating signal.

10. What is the load of the power amplifier in a radio receiver?
The load of the power amplifier in a radio receiver is typically the loudspeaker. It converts the amplified electrical audio signal into sound waves.

11. Explain in brief the difference between a transformer and a choke.
- A transformer is used to transfer electrical energy between two or more circuits through electromagnetic induction, with voltage and current transformation. It has primary and secondary windings.
- A choke is an inductor used to block or filter AC while allowing DC to pass, especially in power supply circuits. It usually has only one winding and stores energy in its magnetic field to resist changes in current.

12. (a) Explain how the avalanche breakdown occurs in a reverse biased p-n junction.
Avalanche breakdown occurs when a p-n junction diode is heavily reverse biased, and the reverse voltage exceeds a certain critical value. This causes minority carriers in the depletion region to accelerate and

gain sufficient kinetic energy to knock electrons from the valence band of atoms in the semiconductor lattice. These freed electrons further collide with other atoms, creating more charge carriers in a chain reaction. This multiplication process leads to a sudden increase in current, known as avalanche breakdown. It typically happens in lightly doped, thick junctions and is non-destructive if current is limited.

(b) Explain briefly the difference between a p-n junction and a bipolar junction transistor.
A p-n junction is a two-layer semiconductor device formed by joining a p-type and n-type material, used mainly in rectification and switching.
A bipolar junction transistor (BJT) is a three-layer, three-terminal device formed by two p-n junctions. It has three regions: emitter, base, and collector. A BJT can amplify current and act as a switch. Unlike the diode, it controls a large current with a small base current.

13. A transistor has three terminals. It is required to be connected in a circuit which has two input terminals and two output terminals. Explain how to get four terminals from three.
To obtain four terminals from a three-terminal transistor, we use transformer coupling. One side of the transformer provides two input terminals, while the other side provides two output terminals. Another method is to use a combination of common-emitter and additional circuitry to create differential inputs and outputs.

14. A simple transistor amplifier connected in common emitter configuration has a supply +Vcc, collector resistor Rc, base resistor Rb, collector current Ic and collector-emitter voltage Vce.

(a) Is the transistor pnp or npn?
If the supply is +Vcc and the current flows from collector to emitter, it is an npn transistor.

(b) Draw the circuit diagram of the amplifier.
(The diagram should show:)
- Vcc connected to the collector through Rc
- The base connected to Rb from Vcc (through a voltage divider or direct resistor)
- Emitter grounded
- Input signal to base through coupling capacitor
- Output taken across Rc

(c) Calculate the power dissipated in the transistor.
Power dissipated (P) = Vce × Ic
(Use the given or assumed values of Vce and Ic to compute P in watts)

15. (a) Why is interlaced scanning used in a television?
Interlaced scanning is used to reduce flickering and bandwidth requirements. It works by scanning odd and even lines in two separate fields to form a complete frame. This creates a smoother image for the viewer and uses less data than progressive scanning.

(b) Colour television picture tubes always have three electron beams. Give reasons.
Color TV uses three electron beams corresponding to the three primary colors: red, green, and blue. These beams strike phosphor dots on the screen coated in respective colors. The blending of these colors in varying intensities produces a full-color image.

16. (a) Someone brings you a transistor radio receiver to fix. The output is very distorted and the volume is low. The distortion is worse when you increase the volume (turn the sound up). What would you look for first?
First, check the power supply voltage and the output coupling capacitor. Distortion and low volume are often due to poor biasing, defective capacitors, or faulty transistors in the audio amplifier stage.

(b) How would you set the removal of a printed circuit mounted relay from the PCB? This component has five terminals, all soldered through the PCB.
Use a soldering iron and a desoldering pump or braid. Heat each pin while applying the pump to remove solder. Gently pull the relay while heating each pin in sequence until all pins are free. Avoid overheating and damaging the board. Ensure all terminals are desoldered before attempting full removal.