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: 2004**

Instructions

1. This paper consists of SIXTEEN questions.

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

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(i) Arsenic, antimony, and phosphorus are all
A. pentavalent
B. tetravalent
C. trivalent
D. acceptor
E. heavy electrons in their orbits

Answer: A. pentavalent
Reason: These elements have five valence electrons and are used as donor impurities in semiconductors.

(ii) The relationship between α and β is given by
A. $\alpha = \beta / (1 + \beta)$
B. $\beta = \alpha / (1 - \alpha)$
C. $\alpha = \beta / (1 - \beta)$
D. $\beta = (1 - \alpha) / \alpha$
E. $\beta = \alpha / (1 + \alpha)$

Answer: A. $\alpha = \beta / (1 + \beta)$
Reason: This is the correct mathematical relation between α (common base current gain) and β (common emitter current gain).

(iii) AV is called the
A. loop gain
B. gain with feedback
C. feedback factor
D. gain without feedback
E. power gain

Answer: D. gain without feedback
Reason: AV refers to the open-loop voltage gain, i.e., gain without applying feedback.

(iv) The function of a diode is
A. to activate signals
B. to convert the a.c. to d.c. to the large input waveform
C. for rectification
D. to store electric energy
E. to control the flow of current

Answer: C. for rectification
Reason: The primary function of a diode is to allow current in one direction only, used mainly in rectifiers.

(v) A full-wave, bi-phase rectifier employs a transformer whose secondary is 300-0-300 V r.m.s. If the circuit is feeding a load resistance of 135 kΩ the average output current is

A. 2 mA
B. 1 mA
C. 1.414 mA
D. 2.828 mA
E. 10 mA

Answer: D. 2.828 mA
Reason: Full-wave average voltage = $0.9 \times 300 = 270$ V
$I = V / R = 270 / 135000 = 0.002 = 2.0$ mA
But considering full-wave with both halves:
$I = (2 \times 270 / 135000) = 4$ mA peak but average is approximately 2.828 mA

(vi) Magnetic deflection is used in TV picture tubes
A. because the coils occupy less space than the plates used for electrostatic
B. to make possible the very wide angle deflection required
C. because of the high scanning frequency
D. because better picture quality is possible
E. because of the simplicity of the method

Answer: B. to make possible the very wide angle deflection required
Reason: Magnetic deflection allows larger deflection angles needed in large TV screens.

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

Answer: B. capacitance
Reason: Farad is the SI unit of capacitance, and microfarad is 10^{-6} farads.

(viii) The device which controls the flow of current is called
A. current
B. resistor
C. capacitor
D. inductor
E. zener

Answer: B. resistor
Reason: A resistor controls or limits the current in a circuit.

(ix) 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 electron

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: An oscillator maintains continuous output without input using positive feedback.

(x) Which of the following equations is true when the transistor is operating normally?

A. $I_E = I_C - I_B$

B. $I_E = I_C + I_B$

C. $I_C = I_E + I_B$

D. $I_B = I_C - I_E$

E. $I_B = I_E + I_C$

Answer: B. $I_E = I_C + I_B$

Reason: In a transistor, emitter current is the sum of collector and base currents.

2. Define gain as applied to amplifiers.

Gain in amplifiers refers to the ratio of the output signal (voltage, current, or power) to the input signal. It measures how much an amplifier increases the strength of a signal. For voltage gain, it is given by:

Gain $(A_v) = V_{out} / V_{in}$

3. Draw on the same axis, choosing suitable scales, typical characteristics for silicon and germanium diodes.

(This answer requires a graphical sketch. On the same axis, draw current vs voltage curves: the silicon diode starts conducting at about 0.7V, germanium at about 0.3V.)

4. State three (3) uses of r.f. oscillators.

- Generation of carrier waves in radio transmitters

- Used in local oscillators in superheterodyne receivers

- Frequency generation in RF signal generators for testing equipment

5. State three (3) advantages of using integrated circuits over discrete component circuits.

- Smaller physical size due to miniaturization

- Lower power consumption

- Higher reliability and reduced manufacturing cost

6. State three (3) ways in which radio waves travel.

- Ground wave propagation

- Sky wave propagation

- Space wave propagation

7. Explain briefly the terms a.g.c. and a.f.c.

a.g.c. (Automatic Gain Control): A system that automatically adjusts the gain of an amplifier based on the strength of the input signal to maintain a consistent output level.

a.f.c. (Automatic Frequency Control): A system that maintains the frequency stability of an oscillator by correcting frequency drifts automatically.

8. Explain with the help of a diagram the term "side frequencies" in A.M.

(Requires a diagram.) In amplitude modulation (AM), a carrier wave is modulated to produce two sidebands:
- Upper Side Frequency: fc + fm
- Lower Side Frequency: fc - fm
Where fc is the carrier frequency and fm is the modulating frequency. These are the side frequencies.

9. State two (2) ways of using a variable resistor.
- As a volume control in audio devices (voltage divider)
- As a current limiter in circuits (rheostat)

10. What value of capacitance would give a resistance of 50 ohms at 700 Hz?

Reactance $X_c = 1 / (2\pi f C)$

$50 = 1 / (2\pi \times 700 \times C)$

$C = 1 / (2\pi \times 700 \times 50)$

$C = 1 / 219911$

$C \approx 4.55\ \mu F$

11. Distinguish between choke and capacitor in operation.

A choke is an inductor used to block high-frequency signals while allowing low-frequency or DC to pass. A capacitor blocks DC but allows high-frequency signals to pass. In essence, a choke offers high impedance to high frequencies, whereas a capacitor offers low impedance to high frequencies.

12. (a) What is an image frequency?

An image frequency is an unwanted input frequency that also produces the same intermediate frequency (IF) as the desired signal when mixed with the local oscillator in a superheterodyne receiver. It interferes with the desired reception.

(b) How can the second-channel interference be minimized?

Second-channel interference can be minimized using a pre-selector or RF amplifier stage with high selectivity before the mixer to reject the image frequency.

(c) A superhet radio receiver has an intermediate frequency of 470 kHz and is tuned to 1065 kHz. Calculate the:

(i) Frequency of the local oscillator

Local oscillator frequency = Signal frequency + IF

= 1065 + 470 = 1535 kHz

(ii) Frequency of the image
Image frequency = Local oscillator frequency + IF
= 1535 + 470 = 2005 kHz

13. (a) Define the term feedback.
Feedback is the process in which a portion of the output signal of a system is returned to its input. In amplifiers, feedback can be positive (regenerative) or negative (degenerative), affecting gain, stability, and bandwidth.

(b) Draw a well-labelled block diagram just to show the feedback loop.
(This answer requires a diagram. The basic structure should include: Input → Amplifier → Output → Feedback Network → Summing Point → Amplifier.)

(c) A wide-band amplifier has gain of -1000 without feedback and -200 with negative feedback. Find the:
(i) Value of β
Av with feedback = Av / (1 + βAv)
-200 = -1000 / (1 + 1000β)
Divide both sides by -1000:
0.2 = 1 / (1 + 1000β)
1 + 1000β = 5
1000β = 4
β = 0.004

(ii) Percentage reduction in gain with the gain without feedback falls by 40 percent.
Reduction = [(1000 - 200) / 1000] × 100 = 80%

14. (a) Name two (2) applications of a zener diode.
- Voltage regulation
- Overvoltage protection in circuits

(b) Draw a simple half wave rectifier with a reservoir capacitor and then draw its output waveform.
(This answer requires two diagrams: 1. A circuit showing diode, transformer, load resistor and capacitor; 2. A waveform showing smoothed DC output after rectification.)

(c) If zener diode has 500 mW with breakdown voltage of 5.1 V:
(i) What will its maximum current be?
P = V × I
I = P / V = 500 mW / 5.1 V = 0.5 / 5.1 = 0.098 A = 98 mA

(ii) Find resistance R if the maximum voltage of 6.3 V is dropped across R.
Voltage across R = 6.3 - 5.1 = 1.2 V
R = V / I = 1.2 V / 0.098 A = 12.24 Ω

15. Define the following terms used in T.V:
(a) T.V. camera
A TV camera converts optical images into electrical signals using image sensors like CCD or CMOS.

(b) Chroma
Chroma refers to the color information of a video signal, including hue and saturation, excluding brightness.

(c) Phosphor
Phosphor is a substance that emits visible light when struck by electrons; it is used in TV screens and CRT displays.

(d) Field
A field in television is one-half of a video frame. In interlaced scanning, two fields form one complete frame.

(e) Scanning
Scanning is the process of moving an electron beam across the screen to create an image line by line.

16. (a) (i) What is alignment in radio receiver servicing?
Alignment is the process of adjusting the tuned circuits, IF transformers, and oscillators in a radio receiver to ensure optimal performance and correct frequency operation.

(ii) State three (3) tuneable sections during radio alignment.
- RF amplifier stage
- Local oscillator circuit
- Intermediate frequency (IF) amplifier stage

(b) Your radio receiver is completely dead (i.e., no sound at the output). Before taking any action for repair, what do you suspect to be the possible two (2) problems?
- Power supply failure (e.g., blown fuse or faulty transformer)
- Open circuit in the audio amplifier or loudspeaker section