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: 2002**

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 flow of current
B. which allows flow of holes only
C. which does not allow flow of holes only
D. in which no appreciable current will flow
E. which allows free flow of neutrons

Answer: A. which readily permits flow of current
Reason: A conductor has free electrons that allow easy flow of electric current.

(ii) Microfarad is the unit of
A. energy
B. power
C. current
D. capacitance
E. inductance

Answer: D. capacitance
Reason: Farad is the SI unit of capacitance; microfarad is 10^{-6} farads.

(iii) The function of a diode is
A. to set reference voltage
B. to control a.c. power
C. the rectification of a.c. to d.c. voltage
D. the same as that of a p-n junction
E. to set the initial current

Answer: C. the rectification of a.c. to d.c. voltage
Reason: A diode allows current to flow in only one direction, converting AC to DC.

(iv) An electronic oscillator
A. needs an external input
B. provides its own input
C. is nothing but an amplifier
D. is just a d.c. converter
E. adjusts the input current

Answer: B. provides its own input
Reason: An oscillator generates a periodic waveform without any external input signal.

(v) A.C.E. amplifier is characterised by
A. low voltage gain
B. moderate power gain

C. signal phase reversal
D. very high output impedance
E. high voltage gain

Answer: E. high voltage gain
Reason: Class A common emitter amplifiers have high voltage gain.

(vi) Feedback in an amplifier always helps to
A. control its output
B. increase its gain
C. decrease its input impedance
D. stabilise its gain
E. sustain the input

Answer: D. stabilise its gain
Reason: Negative feedback stabilises the gain and improves linearity.

(vii) The class – C amplifier is mainly used
A. as an RF amplifier
B. as stereo amplifier
C. in communication sound equipment
D. as distortion generator
E. as audio amplifier

Answer: A. as an RF amplifier
Reason: Class C amplifiers are efficient and suitable for RF applications due to their narrow conduction angle.

(viii) The smallest of the four h-parameters of a transistor is
A. h_{11}
B. h_{21}
C. h_{12}
D. h_{22}
E. v_e

Answer: C. h_{12}
Reason: h_{12} is the reverse voltage gain and is typically very small compared to other h-parameters.

(ix) The current amplification factor alpha dc (αdc) is given by
A. I_E / I_E
B. I_E / I_B
C. I_B / I_E
D. I_B / I_C

E. I_C / I_E

Answer: E. I_C / I_E
Reason: $\alpha = I_C / I_E$ is the common base current gain.

(x) In the case of a junction bipolar transistor, α is
A. positive and >1
B. positive and <1
C. negative and >1
D. negative and <1
E. negative and >1.

Answer: B. positive and <1
Reason: α is always less than 1 and positive because collector current is slightly less than emitter current.

2. Write down the equation relating the wavelength and frequency of a radio wave.
$\lambda = c / f$
Where:
λ = wavelength (in meters)
c = speed of light (3×10^8 m/s)
f = frequency (in Hz)

3. Write down the equations relating three capacitors: C_1, C_2 and C_3 which are connected in:
(a) parallel
$C_{total} = C_1 + C_2 + C_3$

(b) series
$1 / C_{total} = 1 / C_1 + 1 / C_2 + 1 / C_3$

4. Sketch the output characteristics of BJT connected in a common-emitter.
(This requires a diagram. The graph plots collector current (I_C) on the y-axis versus collector-emitter voltage (V_{CE}) on the x-axis for different base currents.)

5. Explain the function of an oscillator.
An oscillator is an electronic circuit that generates a periodic, oscillating signal (such as sine wave or square wave) without requiring an external input signal. It converts DC into an AC signal.

6. Name and explain two main groups of oscillator circuits commonly in application.
- LC Oscillators: Use inductors (L) and capacitors (C) in the tank circuit to determine frequency. Example: Hartley and Colpitts oscillators.
- RC Oscillators: Use resistors (R) and capacitors (C) to produce oscillations at audio or low-frequency ranges. Example: Phase shift and Wien bridge oscillators.

7. What is the application of a feedback in an amplifier?
Feedback is used to control gain, improve stability, reduce distortion, increase bandwidth, and improve input and output impedance of amplifiers.

8. State the advantages of negative feedback.
- Stabilizes gain
- Reduces distortion
- Increases bandwidth
- Improves linearity
- Controls input and output impedances

9. Name applications of direct-coupled amplifier.
- Used in low-frequency amplifications
- Biomedical instruments like ECG
- Operational amplifier circuits
- Analog signal processing

10. State the characteristics of a C.C. amplifier.
- High input impedance
- Low output impedance
- Voltage gain approximately equal to 1
- Acts as a buffer
- Provides impedance matching

11. A secondary cell has an emf of 12 V and an internal resistance of 5 Ω. A load R_L is connected across the cell. Find the value of R_L for maximum transfer.
For maximum power transfer, $R_L = r_{internal}$
$R_L = 5\ \Omega$

12. In a negative feedback amplifier, $A = 100$, $\beta = 0.04$ and $V_i = 50$ mV. Calculate the:
(a) gain with feedback
$A_f = A / (1 + A\beta) = 100 / (1 + 100 \times 0.04) = 100 / (1 + 4) = 100 / 5 = 20$

(b) output voltage
$V_o = A_f \times V_i = 20 \times 50\ mV = 1000\ mV = 1\ V$

(c) feedback factor
Given: $\beta = 0.04$

(d) feedback voltage
$V_f = \beta \times V_o = 0.04 \times 1\ V = 0.04\ V$

13. Calculate the input and output resistances, overall current, voltage and power gains for a CE connected transistor having the following h-parameters:
$r_i = 30\ \Omega$, $r_o = 400\ \Omega$, $r_e = 0.75\ M\Omega$, $\alpha = 0.95$, $R\_L = 10\ k\Omega$ and $R\_s = 400\ \Omega$
(This question requires a longer calculation involving hybrid model equations, which should be done step-by-step based on transistor analysis formulas.)

14. A tuned-collector oscillator has a fixed inductance of 100 µH and has to be tunable over the frequency band of 500 kHz to 1500 kHz. Find the range of variable capacitor to be used.
Use $f = 1 / (2\pi\sqrt{(LC)}) \rightarrow C = 1 / (4\pi^2 f^2 L)$

At f = 500 kHz:
$C\_max = 1 / (4\pi^2 \times (5\times10^5)^2 \times 100\times10^{-6})$
$C\_max \approx 202.6$ pF

At f = 1500 kHz:
$C\_min = 1 / (4\pi^2 \times (1.5\times10^6)^2 \times 100\times10^{-6})$
$C\_min \approx 22.5$ pF

So, the variable capacitor should range from about 22.5 pF to 202.6 pF.

15. A single-phase half wave rectifier supplies power to a 1000 Ω load. The sinusoidal a.c. supply has an rms value of 200 V. The step-down transformer has a turn ratio $N_1/N_2 = 10$. Neglecting forward resistance of the diode, calculate the d.c. voltage across the load.
V_rms_secondary = 200 / 10 = 20 V
$V\_peak = \sqrt{2} \times 20 = 28.28$ V
V_dc for half wave = V_peak / π = 28.28 / 3.14 = 9.01 V

16. (a) Name two applications of zener diode.
- Voltage regulation
- Overvoltage protection

(b) A 24 V, 600 mW zener diode is to be used for providing a 24 V stabilised supply to a variable load. If input voltage is 32 V, calculate:
(i) Series resistance R required
P = 600 mW → I = P / V = 600 mW / 24 V = 0.025 A
Total current = 0.025 A
R = (32 - 24) / 0.025 = 8 / 0.025 = 320 Ω

(ii) Diode current when load resistance is 1200 Ω
Load current = V / R = 24 / 1200 = 0.02 A
Total current = 0.025 A
Diode current = Total - Load = 0.025 - 0.02 = 0.005 A = 5 mA