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: 2010**

Instructions

1. This paper consists of SIXTEEN questions.

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

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

(i) In the n-p-n transistor under forward biased condition p – layer is extremely thin because
A the material used for p-type semiconductor is very costly.
B the p-type semiconductor requires more energy to disturb the electrons in the valence band.
C 90% electrons can be collected at the collector.
D 90% electrons can be controlled at the emitter.
E movement of electrons towards the junction is seized.

Answer: C 90% electrons can be collected at the collector
Reason: The thin base ensures most injected electrons from the emitter reach the collector.

(ii) Which of the following displays has minimum power consumption?
A Light emitting diode (LED)
B Liquid crystal display (LCD)
C Nixie tube
D Fluorescent lamps
E Gas filled tubes

Answer: B Liquid crystal display (LCD)
Reason: LCDs use less power as they manipulate light with minimal current compared to other displays.

(iii) If one wishes to amplify the potential difference between two points in a circuit when neither of these points is grounded, which of the following amplifier will be used?
A RC coupled amplifier
B Transformer coupled amplifier
C Differential amplifier
D Audio power amplifier
E Direct-coupled amplifier

Answer: C Differential amplifier
Reason: Differential amplifiers amplify the voltage difference between two ungrounded points.

(iv) Which of the following statement is true?
A L-type filter with series C and shunt L is low pass filter
B π-type filter with series C and shunt L is low pass filter
C T-type filter with series C and shunt L is low pass filter
D L-type filter with series C and shunt L is C-low pass filter
E K-type filter with series C and shunt L is low pass filter

Answer: E K-type filter with series C and shunt L is low pass filter
Reason: A K-type low pass filter uses this structure to allow low frequencies while attenuating high ones.

(v) Which of the following diodes has almost zero minority carrier storage time?
A Rectifier
B Schottky
C PIN
D Zener
E Tunnel

Answer: B Schottky
Reason: Schottky diodes are majority carrier devices, so they have negligible charge storage time and switch very fast.

(vi) Which wave predominates at large distance above the earth?
A Ground wave
B Sky wave
C Space wave
D Both sky wave and ground wave
E Ground wave or space wave

Answer: B Sky wave
Reason: Sky waves are reflected by the ionosphere and travel long distances beyond the line of sight.

(vii) Which of the following oscillator is expected to give highest Q-factor?
A Crystal controlled oscillator
B Tuned oscillator
C Wein bridge oscillator
D Colpitts oscillator
E Hartley oscillator

Answer: A Crystal controlled oscillator
Reason: Crystal oscillators have very high Q due to low energy loss, resulting in stable, sharp frequency.

(viii) What is the name of the transformer's coil into which voltage is induced?
A Step down transformer
B Primary winding
C Secondary winding
D Induction coil
E Turn’s ratio coil

Answer: C Secondary winding
Reason: Voltage is induced into the secondary coil via electromagnetic induction from the primary.

(ix) A silicon controlled rectifier (SCR) is a

A unijunction device
B device with three junctions
C a device with four junctions
D a combination of diac and triac
E PNPN device

Answer: E PNPN device
Reason: An SCR is a four-layer (PNPN) device used for controlled rectification.

(x) Which of the following is not a correct relationship between α and β?
A $\beta = \alpha / (1 - \alpha)$
B $\alpha = \beta / (1 + \beta)$
C $\alpha = 1 - \beta$
D $1 + \beta = 1 / (1 - \alpha)$
E $1 + \beta = 1 / (1 - \alpha)$

Answer: C $\alpha = 1 - \beta$
Reason: This is incorrect. The correct relation is $\alpha = \beta / (1 + \beta)$. Hence, option C is not a valid expression.

2. Two capacitors C_1 and C_2 are connected in parallel across two points of p.d V volts. Calculate the:
(a) Equivalent capacitance, C of the circuit.
$C = C_1 + C_2$

(b) Energy E stored in the equivalent capacitance, C.
$E = \frac{1}{2} C V^2$

3. (a) What is the difference between BJT and JFET?

BJT (Bipolar Junction Transistor) is a current-controlled device, while JFET (Junction Field Effect Transistor) is a voltage-controlled device. BJT uses both electrons and holes for conduction, while JFET uses only one type of carrier (majority).

(b) What happens if you interchange the polarities of electrolytic capacitor in a rectifier circuit?

The capacitor may get damaged or explode because electrolytic capacitors are polarized and must be connected correctly. Reverse polarity causes leakage or breakdown.

4. (a) What do you understand by the terms ‘frequency’ and ‘amplitude’ as applied in a sine wave?

Frequency is the number of complete wave cycles per second, measured in Hertz (Hz).
Amplitude is the maximum value or strength of the wave from its equilibrium position.

(b) Calculate the frequency of an electromagnetic wave when traveling in free space if it has a wavelength of

(i) 3 cm

$f = c / \lambda = 3\times10^{8} / 0.03 = 1\times10^{10}$ Hz

(ii) 1000 cm

$f = 3\times10^{8} / 10 = 3\times10^{7}$ Hz

(iii) 200 m

$f = 3\times10^{8} / 200 = 1.5\times10^{6}$ Hz

5. Find the current in the circuit shown in Figure 1. Assume an ideal diode.

From −6 V to +4 V, diode drops 0.7 V.
Voltage across resistor = −6 + 0.7 + 4 = −1.3 V
Current, I = V / R = −1.3 / 200 = −0.0065 A = −6.5 mA
Negative sign shows current flows in opposite direction to assumed.

6. (a) What is the 'resonant frequency' of a tuned circuit of an oscillator?

The resonant frequency is the frequency at which the inductive and capacitive reactances are equal in magnitude and cancel each other, allowing maximum energy transfer.

(b) If a tuned circuit has L = 58.6 μH and C = 300 pF, calculate the frequency of oscillation.

$f = 1 / (2\pi\sqrt{(LC)})$
$= 1 / (2\pi\sqrt{(58.6\times10^{-6} \times 300\times10^{-12})})$
$= 1 / (6.2832 \times \sqrt{1.758\times10^{-8}})$
$= 1 / (6.2832 \times 1.326\times10^{-4})$
$= 1 / 8.33\times10^{-4}$
$= 1.2\times10^{3}$ kHz = 1.2 MHz

7. Mention three (3) advantages of using an integrated circuit (ICs)?

Small size and low weight
Lower cost due to mass production
High reliability due to fewer soldered connections

8. For a R-L-C series circuit in which R = 10 Ω, L = 100 μH and C = 100 pF, calculate the:
(a) Resonant frequency (f)
$f = 1 / (2\pi\sqrt{(LC)})$
$= 1 / (6.2832 \times \sqrt{(100\times10^{-6} \times 100\times10^{-12})})$
$= 1 / (6.2832 \times \sqrt{1\times10^{-14}})$

$= 1 / (6.2832 \times 10^{-7})$
$= 1.59$ MHz

(b) Impedance (Z) of the circuit at resonance
$Z = R = 10\ \Omega$ (at resonance, $X_L = X_C$)

(c) Q – factor of the circuit
$Q = (1/R) \times \sqrt{(L/C)}$
$= (1/10) \times \sqrt{(100\times10^{-6} / 100\times10^{-12})}$
$= 0.1 \times \sqrt{1\times10^{6}} = 0.1 \times 1000 = 100$

9. (a) If the amplitude of the radio frequency is 10 mV and that of the carrier wave is 20 mV, determine the modulation depth.
$m = A_m / A_c = 10 / 20 = 0.5 = 50\%$

(b) Mention two (2) types of modulation.
Amplitude modulation
Frequency modulation

10. (a) In the atomic structure of a semiconductor, which energy band do free electrons exist?

Conduction band

(b) How are holes created in an intrinsic semiconductor?

When electrons are thermally excited from the valence band to the conduction band, they leave behind holes.

(c) Why is current more easily established in a semiconductor than in an insulator?

In semiconductors, the energy gap is small, allowing electrons to move with small energy, while insulators have large energy gaps.

11. Determine the peak value of the output voltage for the circuit shown in Figure 2.

Input peak = 250 V
Transformer ratio = 2:1 → secondary peak = 250 / 2 = 125 V
Ideal diode → V_{peak_output} = 125 V (assuming full-wave, no drops)
Answer: 125 V

12. (a) Define the following terminologies:
(i) Electron gun
A device in CRT that emits and focuses a beam of electrons toward the screen.

(ii) Phosphor
A substance that emits visible light when struck by electrons; used to coat CRT screens.

(iii) Interlacing
A technique in TV where the image is scanned in two fields, each with alternate lines, to reduce flickering.

(iv) Chrominance
The component of a video signal that carries color information (hue and saturation).

(v) Raster
The pattern of horizontal scanning lines on a CRT screen.

(b) (i) Mention two (2) types of deflection system applied in the cathode ray tube (CRT).

Electrostatic deflection
Electromagnetic deflection

(ii) List down three (3) primary colours as applied in the colour television.

Red
Green
Blue

(iii) Explain the term 'amplifier gain' as applied in the electronic circuit.

Amplifier gain is the ratio of output signal to input signal in an amplifier, either in terms of voltage, current, or power.

13. (a) Explain the following terms as applied in electronics:
(i) Transducer
A device that converts one form of energy into another (e.g., microphone converts sound to electrical signal).

(ii) Rectification
The process of converting alternating current (AC) into direct current (DC).

(iii) Conductivity of the material
A measure of how well a material allows the flow of electric current.

(iv) Selectivity of a resonant circuit
The ability of a circuit to respond to a specific frequency while rejecting others.

(b) Figure 3 is a block diagram of the super heterodyne AM radio receiver. Study it carefully and then indicate the names of the numbered blocks.

1 – Mixer
2 – Local Oscillator
3 – IF Amplifier
4 – Detector
5 – Audio Amplifier
6 – Speaker

14. An amplifier circuit consists of an NPN transistor, power supply +Vcc, biasing resistor R_1 and R_2 (potential divider method), collector resistor Rc, emitter resistor Re and capacitor C_1.

(a) Draw the circuit diagram of the amplifier.

[Standard NPN amplifier diagram using voltage divider biasing, Rc on collector, Re on emitter, and C_1 as coupling capacitor.]

(b) Write the equation of the load line.

$V_{CE} = V_{CC} - I_C(R_C + R_E)$

15. (a) Explain the meaning of the following terms in connection with amplifiers:
(i) Saturation point
The point where the transistor conducts maximum current and V_{CE} is minimum.

(ii) Cut-off point
The point where the base-emitter junction is not forward biased and the transistor is OFF ($I_C \approx 0$).

(b) Study Figure 4 carefully then calculate the following values at cut-off point:

(i) Collector-emitter voltage, V_{CE}
At cut-off, $I_C = 0$, so no voltage drop across Rc
$V_{CE} = V_{CC} = 6$ V

(ii) Collector current, I_C
At cut-off, $I_C = 0$ A

16. (a) Explain the term *television*.

Television is a telecommunication system that transmits moving images and sound over a distance through radio waves or cables to display on a screen, allowing viewers to see and hear broadcasts of events, shows, or information in real time.

(b) Give the speed of television waves in free space.

The speed of television waves in free space is 3.0×10^8 meters per second.

(c) A wavelength of television antenna must be equal to half the wavelength of the signal received. Calculate the length of antenna when the television receiver is tuned to a television station transmitting at 300 MHz.

Given:
Frequency $f = 300$ MHz $= 300 \times 10^6$ Hz
Speed of wave $c = 3.0 \times 10^8$ m/s
Wavelength $\lambda = c / f = 3.0 \times 10^8 / 300 \times 10^6 = 1$ meter
Length of antenna $= \lambda / 2 = 1 / 2 = 0.5$ meters

Answer: 0.5 meters