higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T290(E)(M28)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

COMMUNICATION ELECTRONICS N4

(8080224)

28 March 2014 (Y-Paper)
13:00–16:00

Calculators may be used.

This question paper consists of 5 pages, 1 diagram sheet, and 1 formula sheet.

ENGINEERING

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
COMMUNICATION ELECTRONICS N4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write neatly and legibly.

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QUESTION 1

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 An AM signal with 130% modulation is over modulated.

1.2 The output of a bridged T-type attenuator has a constant amplitude and frequency.

1.3 A multi-cavity magnetron is an example of a microwave oscillator in radio communication.

1.4 Bunches are formed when fast moving electrons catch up with the slow moving electrons.

1.5 A band pass filter is used to pass high frequencies.

1.6 Permanent magnets in the travelling wave tube, holds the beam in the centre of the helix.

1.7 A radio antenna is directional.

1.8 Satellite communication is effective because dishes focus signals onto a small pickup unit.

1.9 An FM ratio detector is an example of a microwave amplifier.

1.10 A receiver antenna converts sound waves into electrical currents

(10 x 1) **[10]**

QUESTION 2

2.1 Define the following:

2.1.1 *Kirchhoff's* current law (2)

2.1.2 The superposition theorem. (2)

2.2 Use superposition theorem to determine the current through R_3 as indicated on DIAGRAM SHEET FIGURE 1. (6)

[10]

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QUESTION 3

A coil with a DC resistance of 10 Ω and an inductance of 1.2 H is in parallel with a 420 pF capacitor.

Determine the following:

3.1 The resonance frequency.

3.2 The dynamic impedance.

3.3 The bandwidth.

3.4 The Q-factor of the circuit.

3.5 Prove the answer in QUESTION 3.3 using any alternative method.

(5 x 2) **[10]**

QUESTION 4

4.1 Draw the following attenuators:

4.1.1 L-type attenuator (2)

4.1.2 O-type attenuator (2)

4.2 Draw a circuit diagram of a high pass filter. (3)

4.3 Draw the basic attenuation versus frequency of the filter in QUESTION 4.2. (3)
[10]

QUESTION 5

5.1 Make neat, labelled sketches of the following:

5.1.1 Travelling wave tube (5)

5.1.2 Multi-cavity magnetron (5)
[10]

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QUESTION 6

6.1 Draw a fully labelled block diagram of an AM-transmitter. (5)

6.2 Show, by means of sketches what is meant by the following:

6.2.1 Pulse width modulation (2)

6.2.2 Pulse position modulation (2)

6.2.3 Pulse amplitude modulation (2)

6.3 Make a neat labelled circuit diagram of an AM half-wave detector. (5)

6.4 Define *amplitude modulation.* (2)

6.5 Illustrate by using a basic sketch what is meant by 100% modulation. (2)
[20]

QUESTION 7

7.1 Draw a block diagram of an FM-receiver. (5)

7.2 Briefly explain the function of each stage of the receiver in QUESTION 7.1. (10)
[15]

QUESTION 8

8.1 Define the following:

8.1.1 Skywave (2)

8.1.2 Skip distance (2)

8.1.3 Polarisation (2)

8.2 Define refraction in the ionosphere. (2)

8.3 Determine the length of a standard half-wave dipole antenna used to receive a 90 MHz radio signal. Assume that the velocity of the electromagnetic wave in the antenna is 3×10^8 m/s. (3)

8.4 Make neat, fully labelled sketches of the following:

8.4.1 The Parabolic Reflector. (2)

8.4.2 The folded dipole antenna. (2)
[15]

TOTAL : 100

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DIAGRAM SHEET

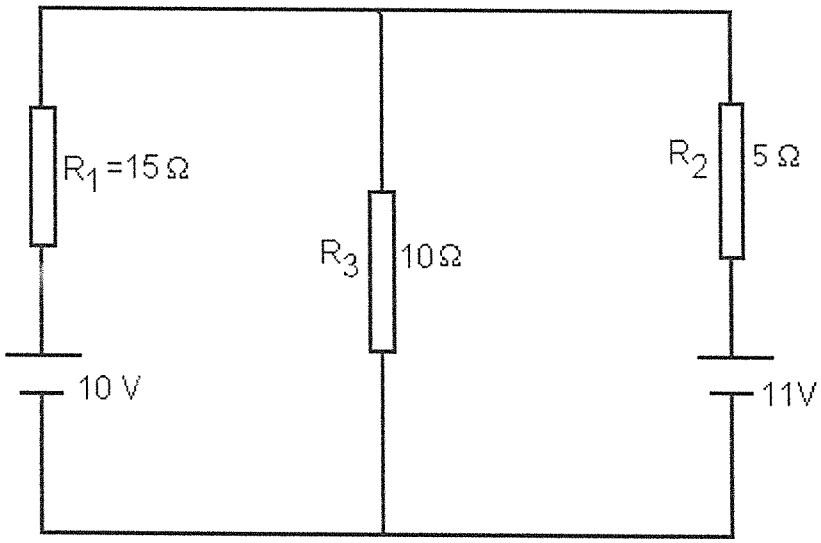

FIGURE 1

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FORMULA SHEET

1. $I = \frac{V}{R}$
2. $X_L = 2\pi fL$
3. $X_C = \frac{1}{2\pi fc}$
4. $Z = \sqrt{R^2 + (X_L - X_C)^2}$
5. $I = \frac{V}{Z}$
6. $V_R = I \,.\, R$

   $V_L = I \,.\, X_L$

   $V_C = I \,.\, X_C$
7. $Cos\phi = \frac{R}{Z}$
8. $I = \sqrt{I_R + I_C^2}$
9. $\theta = Tan^{-1}\frac{I_C}{I_R}$
10. $I = \sqrt{I_R^2 + I_L^2}$
11. $I = \sqrt{I_R^2 + (I_L - L_C)^2}$
12. $\theta = Tan^{-1}\frac{(I_L - I_C)}{I_R}$
13. $f_r = \frac{1}{2\pi\sqrt{LC}}$
14. $C = \frac{1}{4\,.\,\pi^2\,.\,f_r^2\,.\,L}$
15. $L = \frac{1}{4\,.\,\pi^2\,.\,f_r^2\,.\,C}$
16. $Q = \frac{X_L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{f_R}{bandwidth/bandwydte}$
17. $V_c = V \times Q$ *and/en* $V_L = V \times Q$
18. $Z = \frac{L}{CR}$
19. $I_c = I \times Q$
20. $I_L = I \times Q$
21. $f = \frac{v}{\lambda}$
22. $B - W = \frac{R}{2\pi L}$
23. $V_T = \sqrt{V_R{}^2 + (V_C - V_L)^2}$

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REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

COMMUNICATION ELECTRONICS N4

28 MARCH 2014

This marking guideline consists of 9 pages.

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QUESTION 1

1.1 True

1.2 False

1.3 True

1.4 True

1.5 False

1.6 True

1.7 False

1.8 True

1.9 False

1.10 False

(10 x 1) **[10]**

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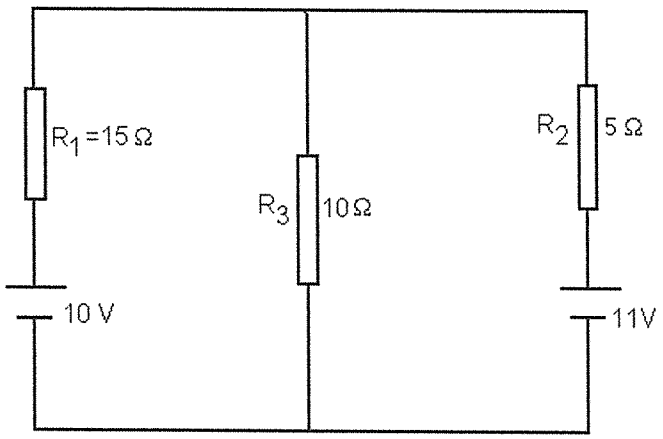
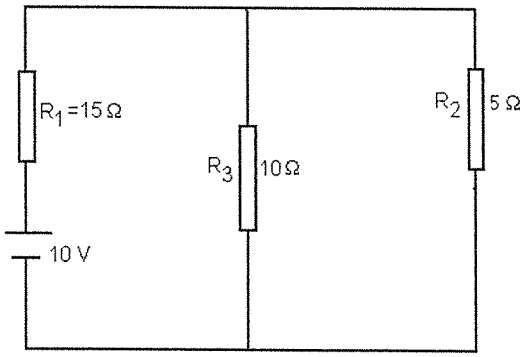
QUESTION 2

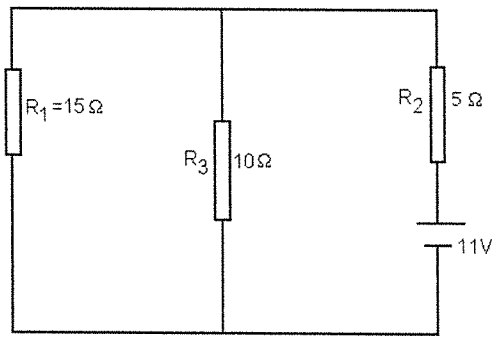
2.1 2.1.1 The algebraic sum of the currents flowing towards a point is equal to the sum of the currents flowing away from that point. (2)

2.1.2 In any network with more than one supply, the current in different circuits may be calculated by considering each supply by itself. (2)

2.2







$R_T = R_1 + \frac{R_2.R_3}{R_2 + R_3}$

$= 15 + \frac{10 \times 5}{10 + 5}$

$= 18.3$ ohm

$I_2 = V_1/R_T \times R_3/(R_2 + R_3)$

$= 10/18.3 \times 5/(5 + 10)$

$= 0,18$ A

$R_T = R_2 + \frac{R_1.R_3}{R_1 + R_3}$

$= 5 + \frac{10 + 15}{10 + 15}$

$= 11$ ohm

$I_4 = V_2/R_T \times R_1/(R_1 + R_3)$

$= 11/11 \times 15/(10 + 15)$

$= 0,6$ A

$I_{R2} = I_2 + I_4$

$= 0,18 + 0,6$

$= 0,78$ A

(6)
[10]

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QUESTION 3

3.1 $F_r = 1/ (2\pi \sqrt{LC})$
$= 1/(2\pi \sqrt{1.2 \times 420 \times 10^{-12}})$
$= 7.1$ kHz (2)

3.2 $Z_D = L/CR$
$= 1.2/(10 \times 420 \times 10^{-12})$
$= 285.7\ k\Omega$ (2)

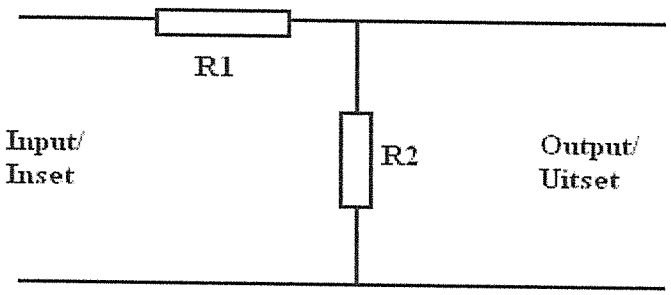
3.3 $B\text{-}W = R/(2\pi L)$
$= 10/(2\pi \times 1.2)$
$= 1.33$ Hz (2)

3.4 $Q\text{-factor} = R^{-1}(\sqrt{L/C})$
$= 10^{-1} (\sqrt{(1.2/ 420 \times 10^{-12})}$
$= 122.5$ (2)

3.5 $B\text{-}W = F_r/Q$
$= 7.1 \times 10^3/122.5$
$= 1.33$ Hz (2)
[10]

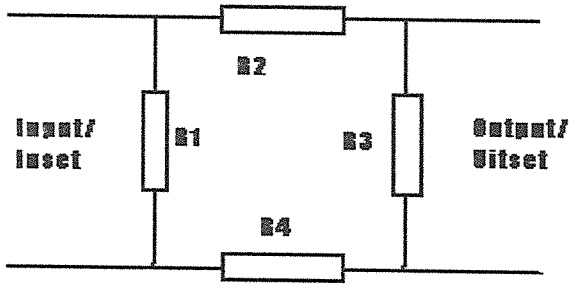
QUESTION 4

4.1 4.1.1 **L-type attenuator**



(2)

4.1.2 **O-type attenuator**



(2)

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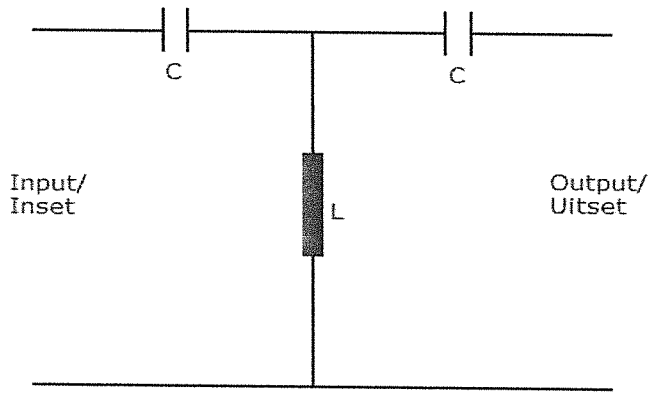
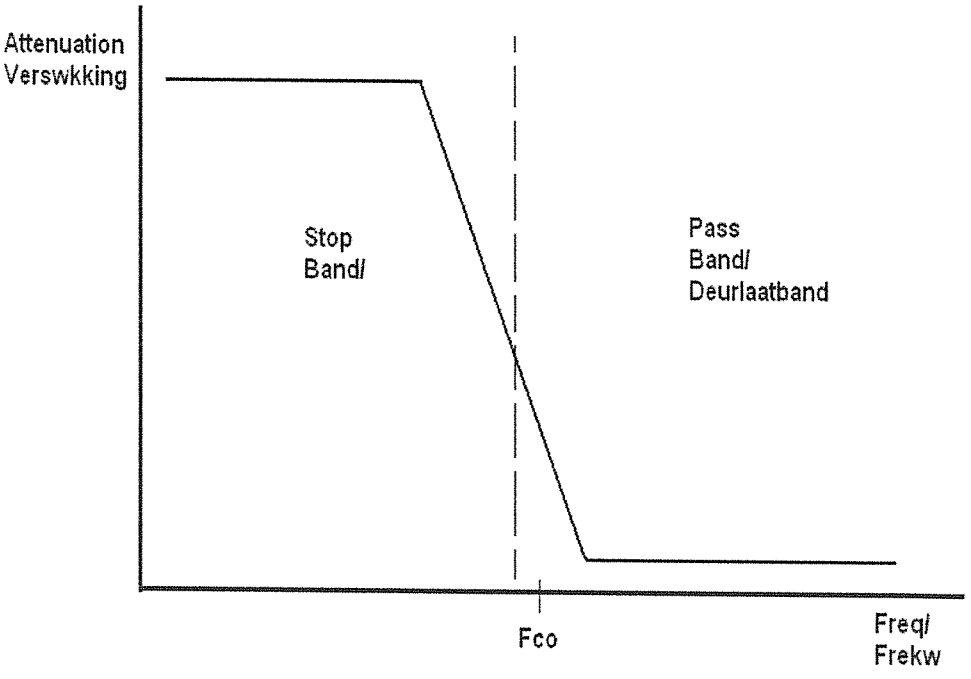
4.2 **High-pass filter.**



(3)

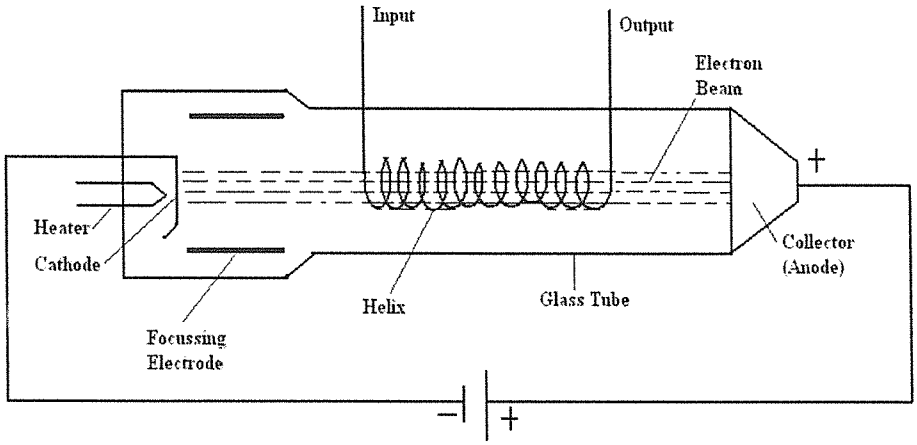
4.3 **Basic graph attenuation v/s frequency for a high-pass filter**



(3)
[10]

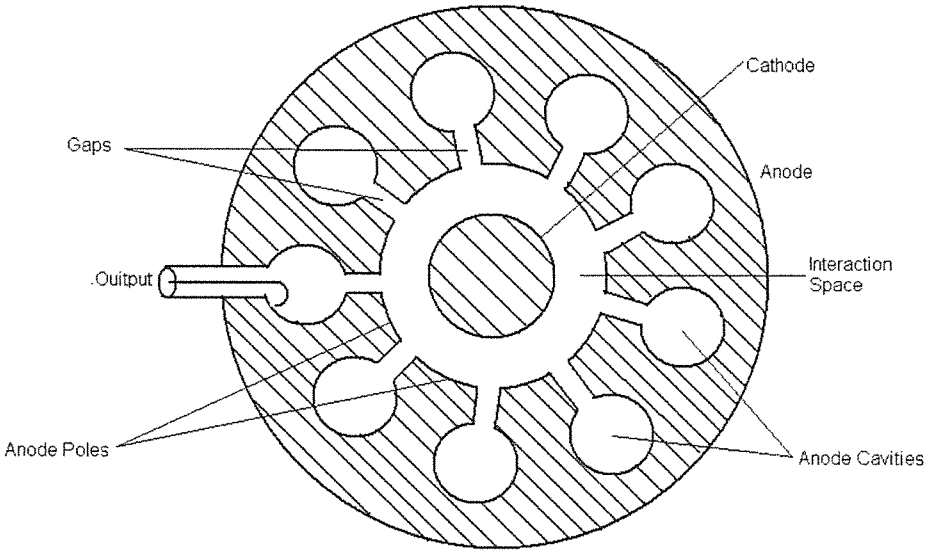
QUESTION 5

5.1 5.1.1 **Travelling-wave tube**



(5)

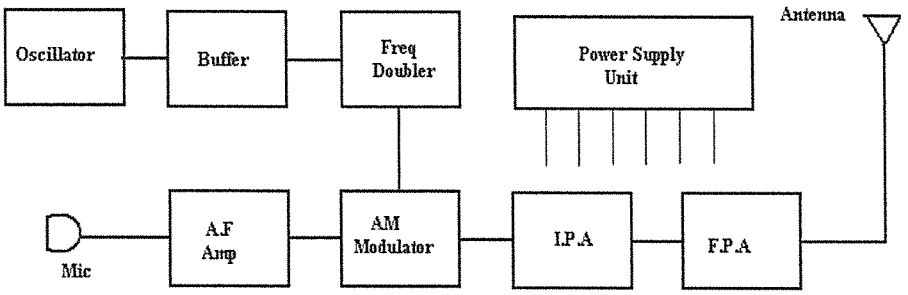
5.1.2 **Multi-cavity magnetron**



(5)
[10]

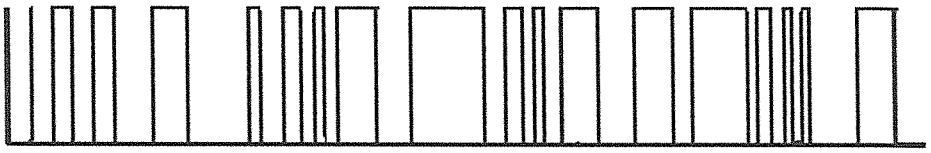
QUESTION 6

6.1 **AM-transmitter**



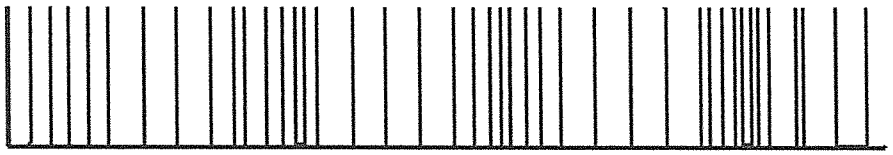
(5)

6.2 6.2.1 **Pulse width modulation**



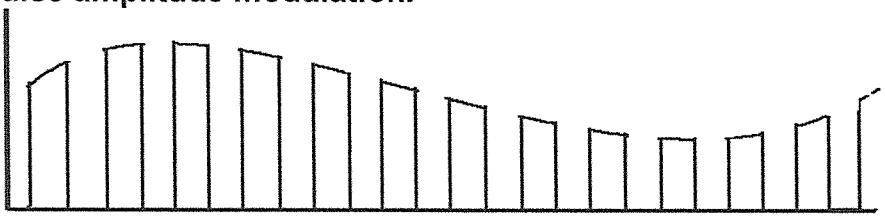
(2)

6.2.2 **Pulse position modulation.**



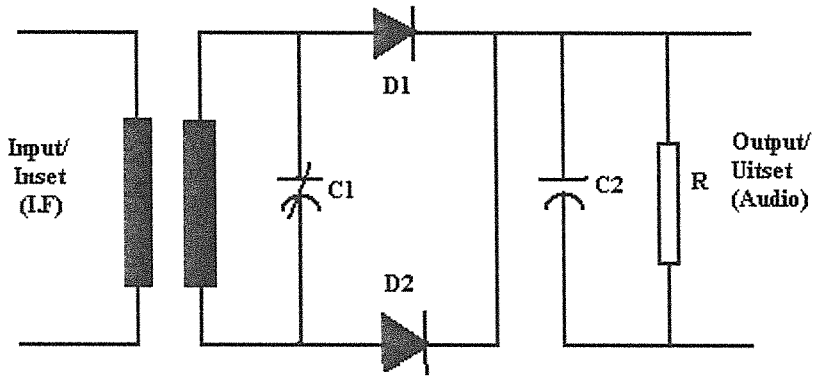
(2)

6.2.3 **Pulse amplitude modulation.**



(2)

6.3 **AM Full-wave detector**

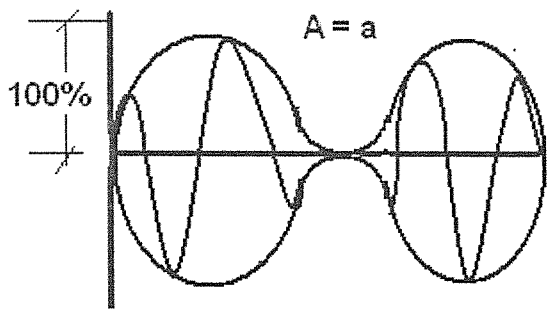


(5)

6.4 **Amplitude modulation**

A process whereby the amplitude of the carrier wave is made to vary in accordance with the instantaneous value of the modulating signal. (2)

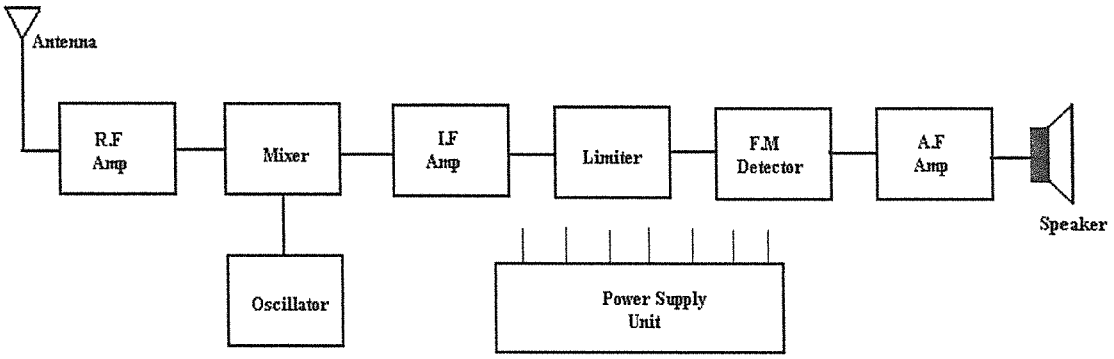
6.5



(2)
[20]

QUESTION 7

7.1 **FM-receiver**



(5)

7.2 **FUNCTION OF EACH STAGE**

Antenna
Converts electromagnetic waves into minute electrical currents.

RF Amplifier
Amplify signal to which it is tuned

Mixer
Input: RF + Oscillator frequency (carrier)
Output: IF, 3 other frequencies + noise

Oscillator
Generates signal of constant amplitude and frequency (carrier)

IF Amplifier
Amplifies intermediate frequency (RF + Carrier)

Limiter
Prevent amplitude variations

FM Detector
Changes frequency variations to voltage variations

AF Amplifier
Amplify the audio output from detector to drive the loudspeaker

Loudspeaker
Converts audio signal to sound

Power Supply Unit
Supply regulated DC voltage to all stages

(10)
[15]

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QUESTION 8

8.1 8.1.1 **Sky-wave**
It is radiated at an angle above the horizontal and its behaviour is entirely dependant upon the ionosphere. It is radiated skyward and then refracted back to earth. (2)

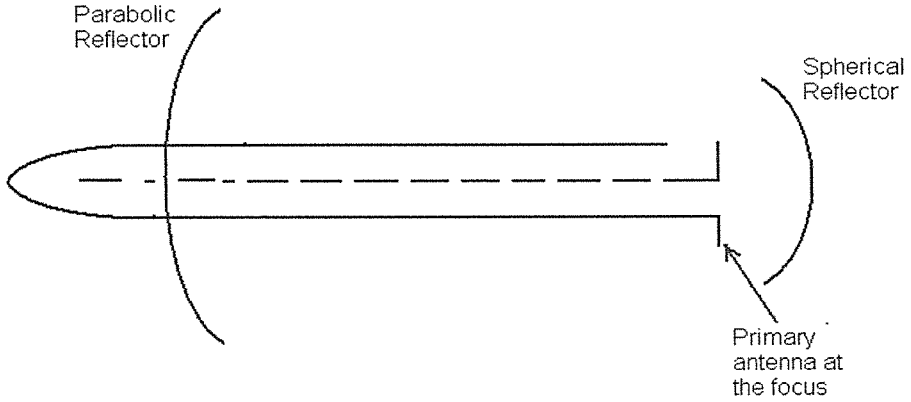
8.1.2 **Skip Distance**
Distance fro, the transmitter to the point where the sky-wave is first heard. It depends on the critical angle and the ionosphere layer heights (2)

8.1.3 **Polarization**
It refers to the direction space of the electric field which is radiated from the antenna and is parallel to the antenna itself (2)

8.2 **Refraction in the ionosphere**
It is the bending of a path of a wave due to change in velocity when it passes from one medium to another. (2)

8.3 $\lambda = v/f$
$= 3 \times 10^8/90 \times 10^6$
$= 3.33$ m/s
length of half-wave dipole antenna = 3.33/2 = 1.67 m (3)

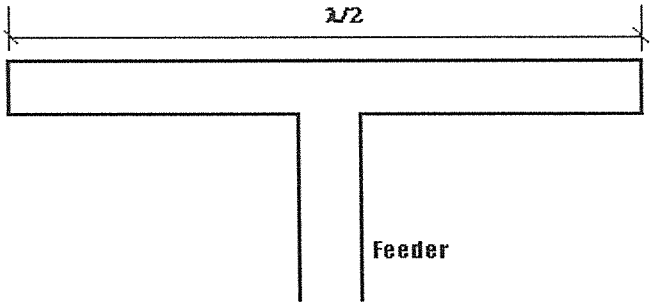
8.4 8.4.1 **Parabolic Reflector**



(2)

Folded dipole antenna

8.4.2



(2)
[15]

TOTAL : 100

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