

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T290(E)(J25)T
AUGUST EXAMINATION

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N4

(8080224)

25 July 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. Write only 'true' or 'false next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 An AM signal with 85% modulation is overmodulated.

1.2 An antenna in any receiver converts audio waves to sound.

1.3 Radio waves travel at a speed of 300×10^6 metres per second.

1.4 A multi-cavity magnetron is an example of a filter in radio communication.

1.5 The impedance of a series circuit at resonance is a minimum.

1.6 A TV antenna is omnidirectional.

1.7 In a klystron amplifier, the function of the magnets is to emit a stream of electrons.

1.8 A microphone converts audio waves into radio frequencies.

1.9 During the day, the F-region in the ionosphere splits up into four layers.

1.10 Ultraviolet radiation from the sun is the primary cause of ionisation.

(10×1) **[10]**

QUESTION 2

2.1 Define the following:

2.1.1 Kirchhoff's current law

2.1.2 Thevenin's theorem

(2×2) (4)

2.2 Use Thevenin's theorem to find the equivalent circuit for the network as shown on the DIAGRAM SHEET (attached). Draw the equivalent circuit. (6)

[10]

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QUESTION 3

A series circuit consists of a resistance of 5 Ω, an inductance of 120 mH and a 320 nF capacitor.

Calculate the following:

3.1 The frequency at resonance

3.2 The bandwidth

3.3 The Q-factor

3.4 Prove the answer in QUESTION 3.3 using any alternative method

3.5 The total current if the supply voltage is 50 mV

(5 × 2) **[10]**

QUESTION 4

4.1 Define a *filter*. (2)

4.2 Draw an H-type attenuator. (2)

4.3 Draw a circuit diagram of a band-pass filter. (3)

4.4 Draw the basic gain versus frequency graph for the filter in QUESTION 4.3. (3)
[10]

QUESTION 5

Make neat, fully labelled sketches of the following:

5.1 Multi-cavity magnetron

5.2 Reflex klystron oscillator

(2 × 5) **[10]**

QUESTION 6

6.1 Draw a block diagram of an AM-transmitter. Briefly explain the function of each stage. (15)

6.2 Draw a circuit diagram of an AM half-wave detector. (5)
[20]

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QUESTION 7

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

7.2 Define the term *frequency modulation.* (2)

7.3 Make a neat, fully labelled circuit diagram of a ratio detector. (5)

7.4 What is the function of the circuit diagram in QUESTION 7.3? (1)

7.5 Define *modulation index.* (2)
[15]

QUESTION 8

8.1 Define the following:

8.1.1 Critical frequency

8.1.2 Silent zone

8.1.3 Beam width

(3 × 2) (6)

8.2 Briefly explain what is meant by sunspots and how they have an influence on radio communication. (3)

8.3 Make neat, fully labelled sketches of the following:

8.3.1 Rhombic antenna

8.3.2 Helix antenna

8.3.3 Standard half-wave antenna

(3 × 2) (6)
[15]

TOTAL : 100

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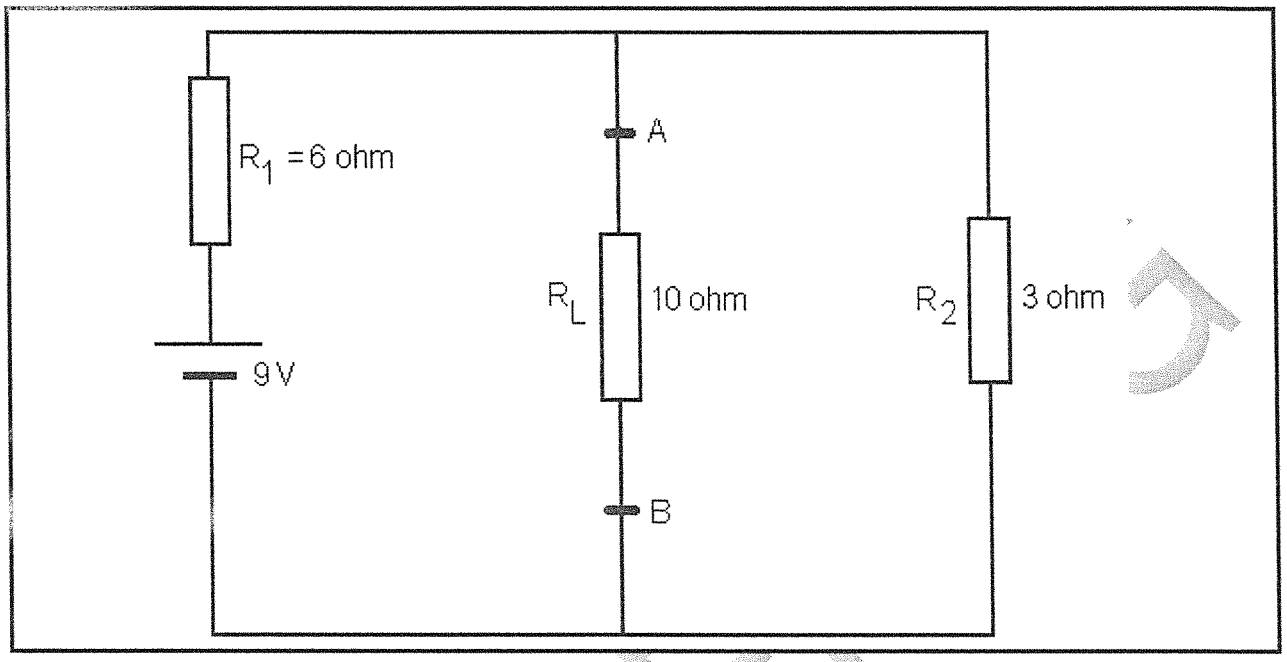
DIAGRAM SHEET



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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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MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

COMMUNICATION-ELECTRONICS N4

25 JULY 2014

This marking guideline consists of 9 pages.

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QUESTION 1

1.1 False
1.2 False
1.3 True
1.4 False
1.5 True
1.6 False
1.7 False
1.8 True
1.9 False
1.10 True

(10 × 1) **[10]**

QUESTION 2

2.1 2.1.1 **Kirchhoff's current law**
In any closed circuit, the algebraic sum of the products of current and resistance of each part of the circuit is equal to the resultant EMF in the circuit.

2.1.2 **Thevenin's theorem**
Any two terminal networks of impedances and generators may be replaced by a single equivalent voltage generator and serie impedance.

(2 × 2) (4)

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2.2

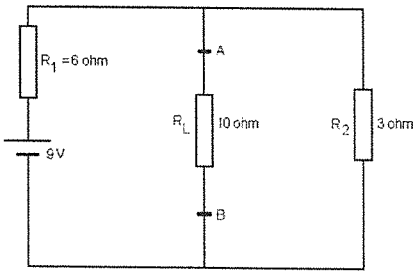
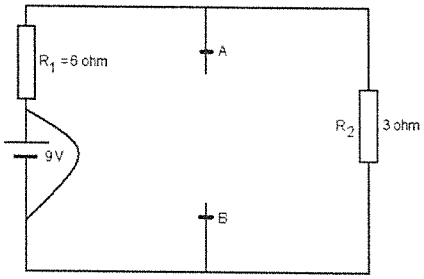


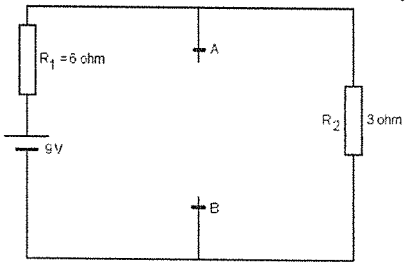
FIGURE 1

Remove load and short-circuit battery



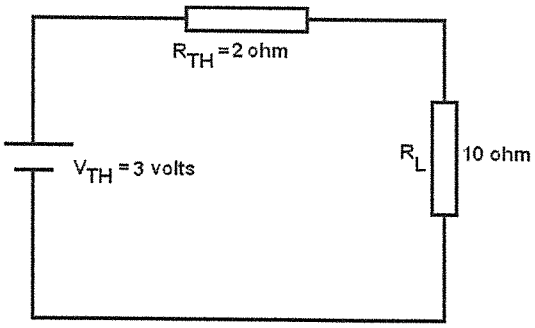
$$R_{AB} = R_{TH} = \frac{R_1 \times R_2}{R_1 + R_2}$$
$$= \frac{6 \times 3}{6 + 3}$$
$$= 2 \text{ ohms}$$

Replace battery and leave AB open



$R_T = R_1 + R_2 = 6 + 3 = 9$ ohms
$I_T = V/R_T = 9/9 = 1$ A
$V_{AB} = V_{TH} = I_T \times R_2$
$= 1 \times 3$
$= 3$ V

Thevenin's Equivalent Circuit



(6)
[10]

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QUESTION 3

3.1 $F_r = 1/ (2\pi \sqrt{LC})$
$= 1/(2\pi \sqrt{120 \times 10^{-3} \times 320 \times 10^{-9}})$
$= 812.2$ Hz

3.2 B-W $= R/(2\pi L)$
$= 5/(2\pi \times 120 \times 10^{-3})$
$=6.63$ Hz

3.3 Q-factor $= R^{-1}(\sqrt{L/C})$
$= 5^{-1} (\sqrt{120 \times 10^{-3} / 320 \times 10^{-9}})$
$= 122.5$

3.4 Q-factor $= 2\pi f L/R$
$= 2\pi \times 812.2 \times 120 \times 10^{-3}/5$
$= 27.43$

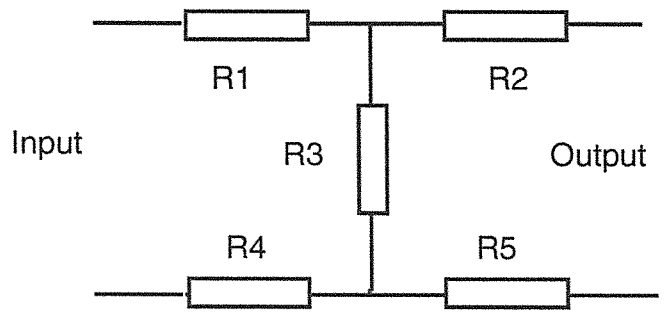
3.5 $I_T = V/Z = 50 \times 10^{-3}/5 = 10$

(5 × 2) **[10]**

QUESTION 4

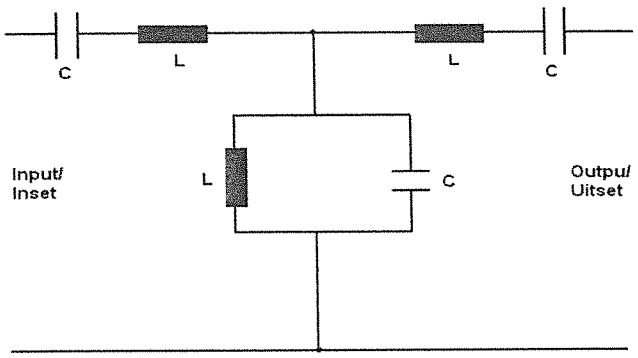
4.1 A **filter** is a network designed to pass a certain band of frequencies while attenuating all others without loss. (2)

4.2 **H-type attenuator**



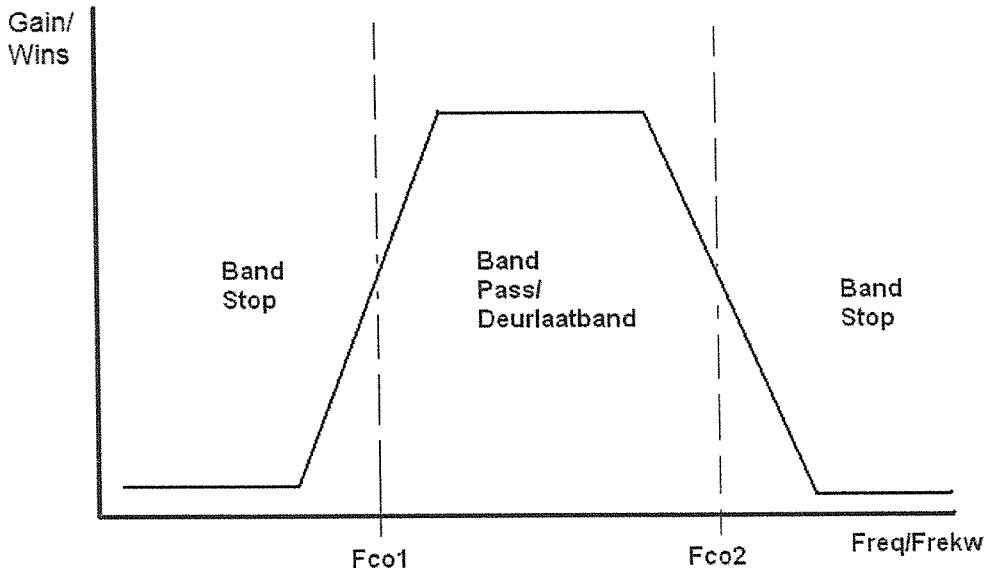
(2)

4.3 Band-pass filter



(3)

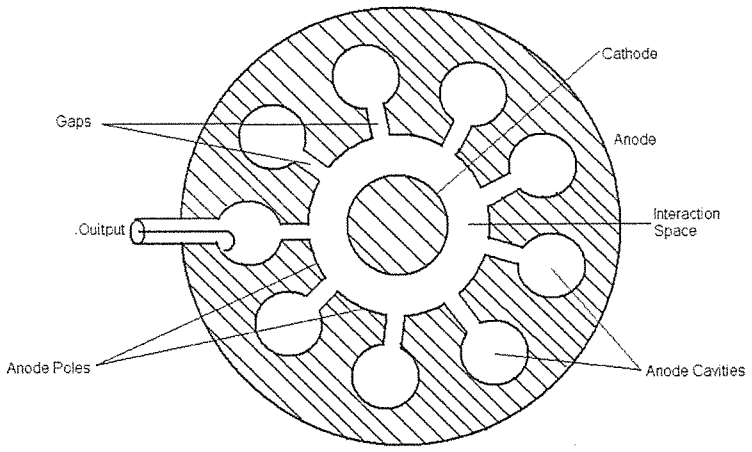
4.4 Gain versus frequency for a band-pass filter



(3)
[10]

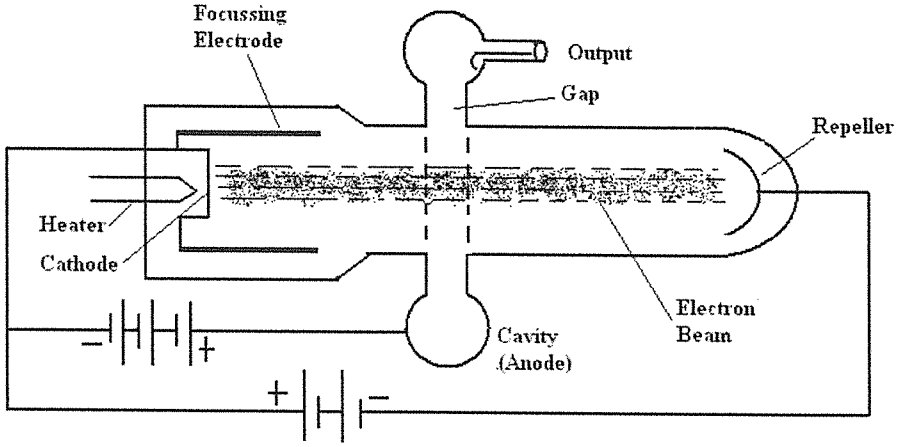
QUESTION 5

5.1 Multicavity magnetron



(5)

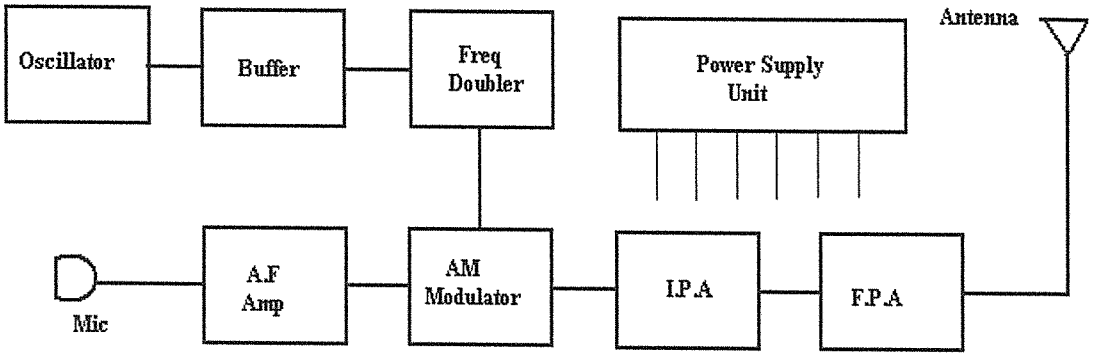
5.2 **Reflex klystron oscillator**



(5)
[10]

QUESTION 6

6.1 **AM-transmitter**



THE FUNCTION OF EACH STAGE

Oscillator
Supplies RF signal (carrier) of constant amplitude and frequency

Buffer
Amplifies a small amount only
Stabilizes the oscillator output

Frequency doubler
Doubles frequency (tuned to 2nd harmonic)

Microphone
Sound waves are converted to electrical currents

Speech amplifier
Amplifies the signal from the microphone

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Modulator
Input: audio signal + carrier
Output: modulated carrier wave

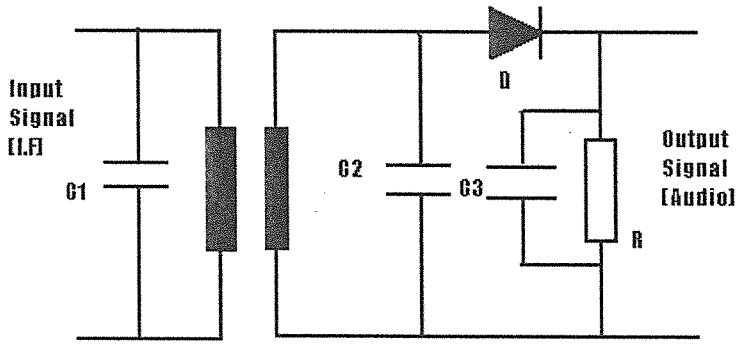
IPA
Amplify the AM signal

PA (final)
The modulated carrier is amplified to have sufficient energy to drive antenna circuits

Antenna
Convert electric currents into electromagnetic waves which are radiated into free space.

Power supply unit
Supplies regulated DC voltage to all stages (15)

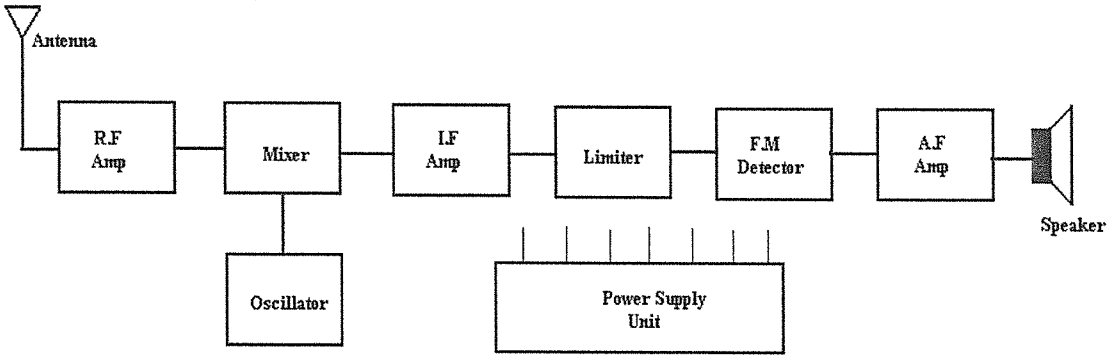
6.2 **AM half-wave detector**



(5)
[20]

QUESTION 7

7.1 **FM superheterodyne receiver**



(5)

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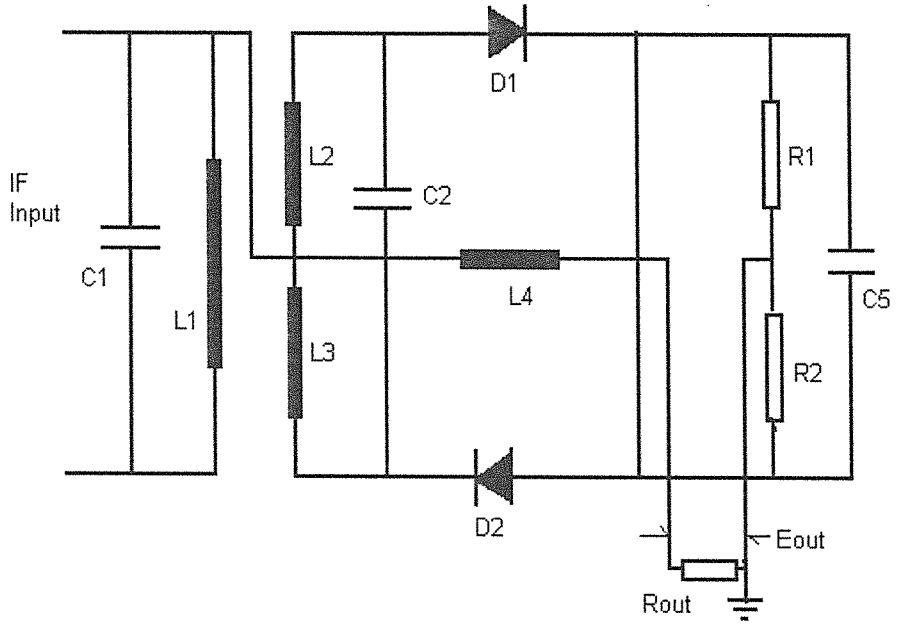
7.2 **Frequency modulation**
A process whereby the frequency of the carrier wave is made to vary in accordance with the instantaneous value of the modulating signal. (2)

7.3 **Ratio detector**



(5)

7.4 Converts frequency variations to voltage variations.
Converts FM signal to an audio signal. (1)

7.5 Modulation index - The degree of modulation in an FM system (2)
[15]

QUESTION 8

8.1 8.1.1 **Critical frequency**
The maximum frequency at which a radio wave directed vertically upwards is refracted by a layer of the ionosphere and above which it penetrates the layer

8.1.2 **Silent zone**
The silent region extending from the limit of the useful ground wave to the distant point where the signal is first heard.

8.1.3 **Beam width**
The angular separation between the two points on the major lobe of radiation at which the power received at a distant point is one half of that received at the axis of the lobe at the same distance.
(3 × 2) (6)

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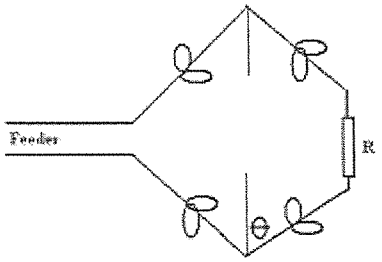
8.2 ***Sunspots and their influence on radio communication***

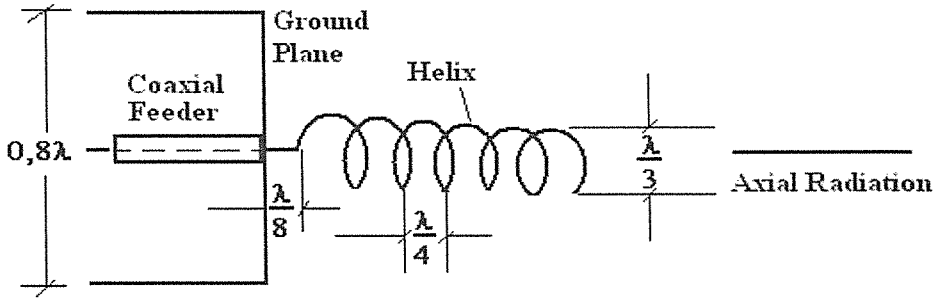
- ✓ *Temperature of the sun varies causing variation in ultraviolet radiation.*
- ✓ *Ultraviolet radiation from the sun is the main cause of ionisation.*
- ✓ *Variation in ionisation of ionosphere layers has an effect on radio communication.* (3)

8.3 8.3.1 **Rhombic antenna**



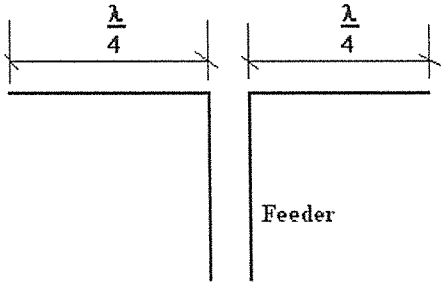
(2)

8.3.2 **Helix antenna**



(2)

8.3.3 **Standard half-wave dipole antenna**



(2)
[15]

TOTAL : 100

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