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T380**(E)**(J24)T

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N4

(8080224)

24 July 2018 (X-Paper)
09:00–12:00

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

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 correctly according to the numbering system used in this question paper.
4. Write neatly and legibly.

QUESTION 1: DIRECT CURRENT THEORY (NETWORK THEOREMS)

1.1 Differentiate between the TWO Kirchoff's laws:

1.1.1 Current law

1.1.2 Voltage law

(2 × 3) (6)

1.2 Explain the inter relation between the networks: nortons and thevenin, in terms of impedance. (2)

1.3 Define a *phasor.* (4)

[12]

QUESTION 2: ALTERNATING CURRENT THEORY (VECTORS)

2.1 An AC supply of 50 V is applied across a coil having an inductive reactance of 12 Ω and a resistance of 5 Ω.

Calculate the following:

2.1.1 Total current (5)

2.1.2 Phase angle (6)

2.1.3 Power factor (2)

2.1.4 Draw the phasor diagram (2)

2.2 With the aid of THREE labelled diagrams explain the operation of a pure inductive circuit when an alternating voltage is applied across an inductor. (5)

[20]

QUESTION 3: FREQUENCY RESPONSE (Filters, Attenuators and RC Time Constants)

3.1 Explain in detail the construction of a composite filter. (5)

3.2 Explain the principle of piezoelectric effect on a crystal filter. (5)

3.3 Explain FOUR requirements an attenuator must provide as a resistance network to reduce voltage, current or power in controllable and known amounts that are independent of frequency. (4)

3.4 Differentiate between the TWO RC circuits below in terms of the output voltage and the waveform of the output.

3.4.1 RC integrator circuit

3.4.2 RC differentiator circuit

(2 × 4) (8)
[22]

QUESTION 4: MODULATION

4.1 Define *phase modulation.* (3)

4.2 Explain the process that takes place at the receiving end of the circuit during the transmission of the double side band transmission. (4)

4.3 Explain THREE main reasons for using single-sideband (reduced carrier) working for point-to-point communication. (6)

4.4 Explain the purpose of a carrier wave in telecommunication. (3)
[16]

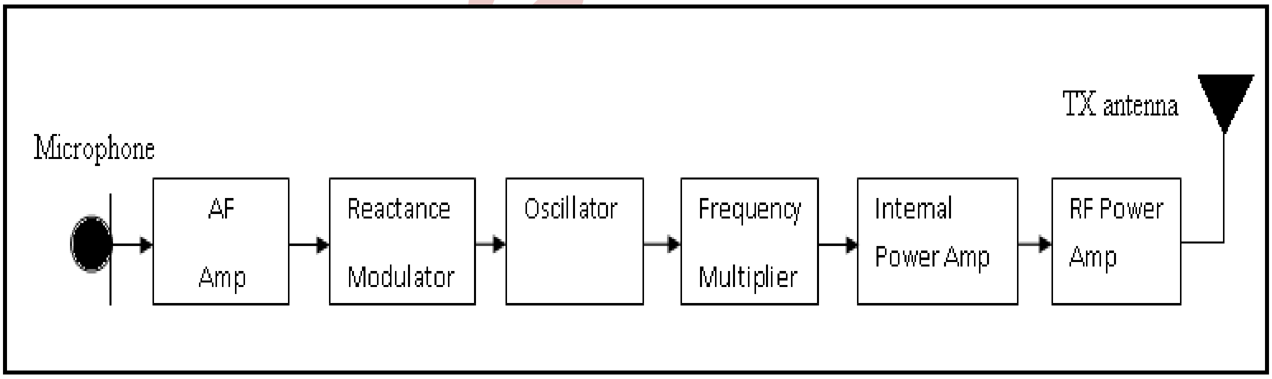
QUESTION 5: DEMODULATION

5.1 Explain the process of demodulation. (3)

5.2 With a neatly labelled circuit diagram, explain the operation of a ratio detector. (7)
[10]

QUESTION 6: COMMUNICATION SYSTEMS

Identify the block diagram below and explain the function of each stage.



[10]

QUESTION 7: RADIO WAVE PROPAGATION

Define the concepts as it relate to antennas:

7.1 Power gain

7.2 Antenna losses

7.3 Beam width

7.4 Radiation resistance

7.5 Polarisation

(5 × 2) **[10]**

TOTAL: 100

COMMUNICATION-ELECTRONICS N4

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, $Q = \frac{X_L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{f_R}{bandwidth}$

17. $V_c = V \times Q \text{ and } V_L = V \times Q$

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

COMMUNICATION-ELECTRONICS N4

24 JULY 2018

This marking guideline consists of 6 pages.

QUESTION 1

1.1 1.1.1 Current law states that in a parallel circuit, the algebraic sum of the current meeting at a junction of a circuit is equal to the algebraic sum of the current, flowing away from the same junction of a circuit, i.e. the algebraic sum of the current is zero.

1.1.2 Voltage law states that in a series circuit, the algebraic sum of all voltage drops measured across each resistor is equal to the algebraic sum of all supply voltages. i.e. the algebraic sum of all the voltages in a circuit (voltage drops and supply voltages) in a closed loop is zero.

(2 × 3) (6)

1.2 The equivalent impedance at the terminal AB of both circuits are identical (2)

1.3 A phasor is defined as any physical quantity that possesses both magnitude and direction. It is represented by means of a straight line. (4)

[12]

QUESTION 2

2.1 2.1.1

$$Z = \sqrt{R^2 + XL^2}$$

$$Z = \sqrt{5^2 + 12^2}$$

$$= 13\ \Omega$$

$$IT = \frac{V}{Z}$$

$$= \frac{50}{13}$$

$$= 3,85\ A$$

(5)

2.1.2 $VR = I \times R$

$= 3,85 \times 5$

$= 19,25$ V

$VL = I \times X_L$

$= 3,85 \times 12$

$= \mathbf{46,2\ V}$

$IZ = \sqrt{I \times R^2 + I \times XL^2}$

i.e $VZ = \sqrt{VR^2 \times VL^2}$

$= \sqrt{19,25^2 + 46.2^2}$

Hence **IZ = 50 V**

$COS\vartheta = \frac{IR}{IZ}$ or $COS\vartheta = \frac{R}{Z}$

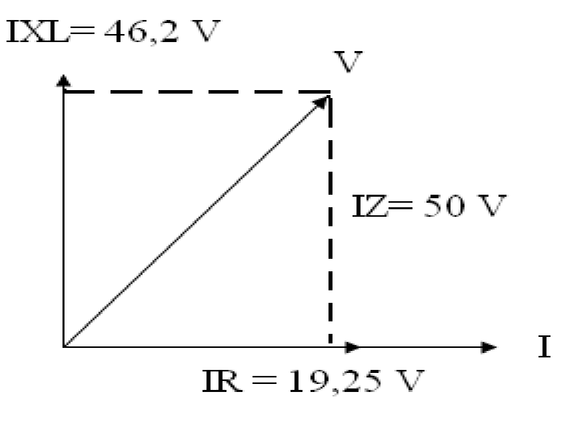
$= \frac{19,25}{50}$ or $\frac{5}{13}$

$\vartheta = COS^{-1}\frac{19,25}{50}$ or $\vartheta = COS^{-1}\frac{5}{13}$

$= 67,38^0$ or $= 67,38^0$ ° (6)

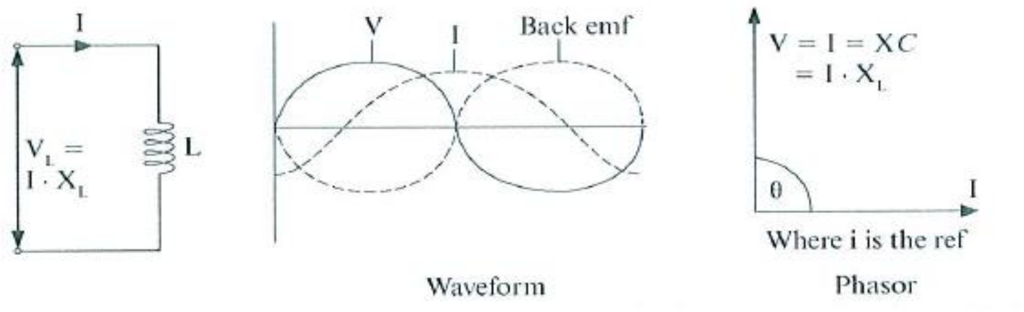
2.1.3 pf = $\cos\theta$
= 0, 385 log (2)

2.1.4



(2)

2.2



(5)
[20]

QUESTION 3

3.1 A composite filter is a combination of the prototype and derived sections connected in tandem and designed to give the required input impedance and sharpness of cut-off frequency. The derived section is designed to give the required sharpness of cut-off frequency. The prototype section compensates for the falling off of attenuation of the derived section beyond the frequency of infinite attenuation. (5)

3.2 Piezoelectric effect is a process whereby the crystal is placed under mechanical strain, such as compression, expansion, bending and/or twisting; the mechanical energy expended is converted to minute electrical energy. (5)

3.3 It must

- provide the correct input impedance
- provide the correct output impedance
- provide the correct attenuation
- be independent of frequency (4)

3.4 3.4.1 In RC integrator circuit, the output voltage is taken from across the capacitor and the wave of the output form is dependent upon the time constant and the frequency and the shape of the input waveform. The RC product is many times greater than the duration and the interval of the pulses to be integrated is usually sufficient to provide good integration.

3.4.2 In a RC-differentiator circuit, the output voltage is taken from across the resistor and the wave of the output form is dependent upon the time constant and the frequency and the shape of the input waveform. The RC product should be much smaller than the duration of the interval of the pulses to be differentiated is usually sufficient to provide good differentiation.

(2 × 4) (8)
[22]

QUESTION 4

4.1 Phase modulation is a process whereby the phase of the carrier wave is made to vary in accordance with the instantaneous value of the modulating signal. (3)

4.2 During transmission of the double side band, at the receiving end of the circuit the receiver accepts both side bands and the carrier wave and uses the carrier wave to demodulate the side bands to reproduce the original modulating frequencies (4)

4.3
- Only a restricted number of receivers are involved and so more expensive and sophisticated single side band equipment may be used
- It is economical because there is a considerable saving of power.
- There is a saving in bandwidth because only one sideband is transmitted.

(3 × 2) (6)

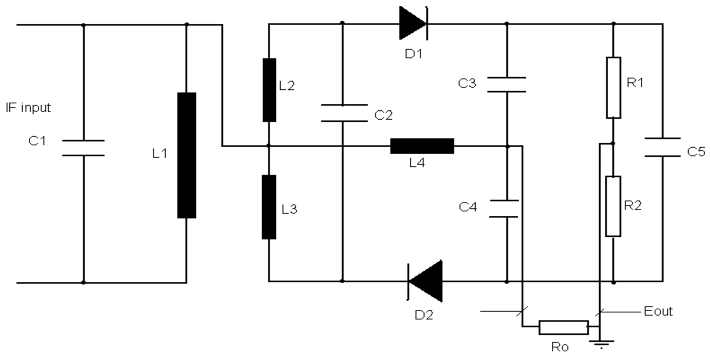
4.4 Carrier waves are used in telecommunication to convey either video or audio signals (3)

[16]

QUESTION 5

5.1 Demodulation is a process of extracting or recovering the information from a modulated signal. (3)

5.2



During the positive half cycles of the input signal, current flows from L_2 through L_4, R_3, R_1, D_1 and back to L_2. During the negative half cycles of the input signal, current flows from L_3 through D_2, R_2 R_3, L_4, and back to L_3. The audio output voltage is developed across R_3,C_5 filters off any voltage variations present on the FM signal. No limiter required due to the action of C_5. (7)

[10]

QUESTION 6

6.1 FM Transmitter (2)

6.2
- Microphone: It converts mechanical sound waves to electrical currents for amplification by the audio amplifier.
- Audio Frequency Amplifier: It amplifies the signal from the microphone to the required value for superimposing the radio frequency by the modulator
- Reactance modulator: It converts the audio frequency into a reactive component which is directly proportional to the amplitude and frequency of the intelligence.
- RF Oscillator: It generates the RF which has constant amplitude that is to be modulated and transmitted.
- Frequency Multiplier: It multiplies the oscillator's output frequency to the required carrier frequency for transmission
- Intermediate Power Amplifier: It isolates the oscillator from load variations in other parts of the transmitter and provides stability to the oscillator.
- RF Power Amplifier: It sufficiently amplifies the RF modulated carrier wave to a value enough to drive the antenna circuits.
- Antenna: It converts electrical energy into electromagnetic energy which is radiated into free space. (8)

[10]

QUESTION 7

7.1 It is the ratio of power fed to an antenna compared to the field strength power radiated from the antenna.

7.2 It is the ratio of the actual radiation resistance to the total resistant that dissipated power.

7.3 It is the regular separation between the two half power points on the radiation patterns and applier to the narrow beat

7.4 The ratio of power radiated by the antenna to the square of the current at the feed point

7.5 Is the direction in space of the electric vector of the electromagnetic wave radiated from an antenna and is parallel to the antenna

(5 × 2) **[10]**

TOTAL: 100

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