higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T320**(E)**(A11)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N6

(8080246)

11 April 2016 (X-Paper)
09:00–12:00

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
COMMUNICATION-ELECTRONICS N6
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.

Tec

QUESTION 1: ATTENUATOR AND FILTERS

1.1 Study FIGURE 1 below and answer the questions.

1.1.1 Identify the filters shown below. (2)

1.1.2 Give the formulae of each component used for calculating their respective values according to the alphabets given.

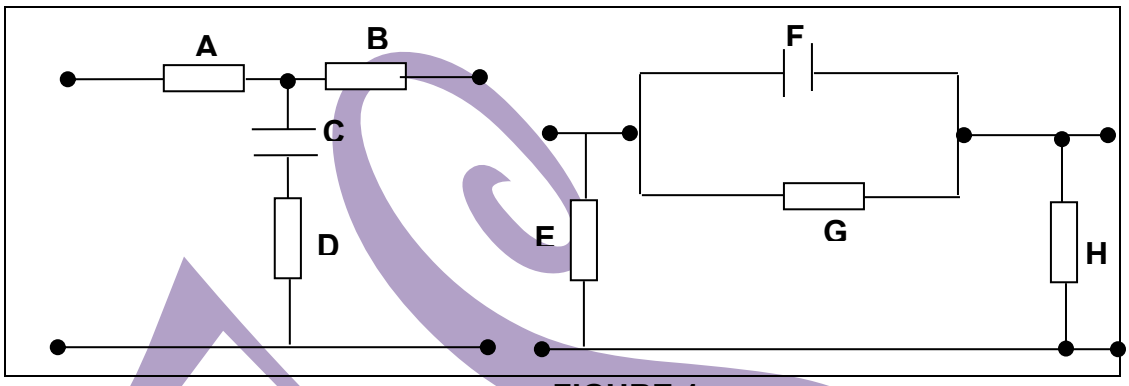


FIGURE 1 (8)

1.2 Design a high-pass m- derived filter with a transmission line of an impedance of 600 ohm, a cut-off frequency of 7 kHz and a frequency of infinite attenuation of 5 kHz. Draw the π–section of the complete filter and insert ALL venues for different components. (15)
[25]

QUESTION 2: TRANSMISSION LINES

2.1 Distinguish with the aid of labelled diagrams between the following TWO types of transmission lines:

2.1.1 The parallel wire (balanced) line

2.1.2 The coaxial (unbalanced) line

(5 x 2) (10)

2.2 Name THREE types of losses occurring in the transmission lines. (2)

2.3 Define the term *stub-line matching.* (2)

2.4 State the THREE most important applications of the Smith-chart. (3)

2.5 A transmission line has an impedance of 250 + *j* 300 ohms and is terminated by a 200 – *j* 150 ohms load.

Determine the incident voltage to the line should 0,9 30° volts be reflected by the load. (8)
[25]

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QUESTION 3: ANTENNAS

3.1 Define the term *capture area.* (3)

3.2 Define the following terms with regard to antennas:

3.2.1 Radiation resistance

3.2.2 Beam width

3.2.3 Polarisation

(3 x 3) (9)

3.3 State FOUR factors which are responsible for power dissipation on energy radiated by the antenna. (4)

3.4 A receiver antenna receives 12 x 10^{-12} watts at a frequency of 100 MHz.

Determine the gain of the antenna in $d\beta$ with a power density of 0,6 x 10^{-12} watts/m^2 at antenna. (7)

[23]

QUESTION 4: NOISE

4.1 Define the term *noise* with regard to electronics. (3)

4.2 Identify and explain the THREE various forms of external noise. (9)

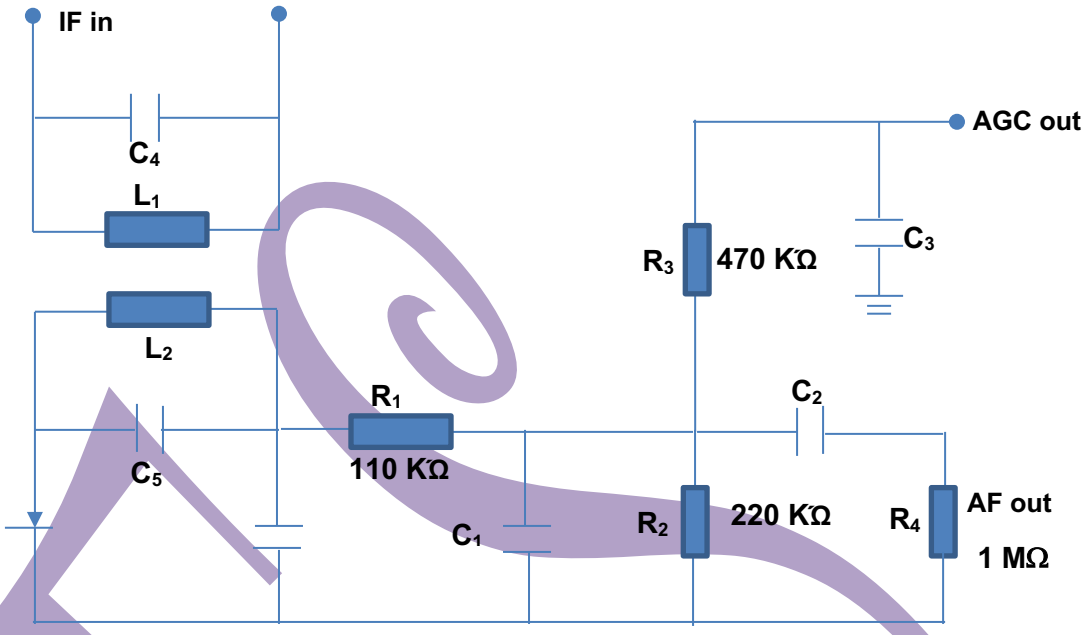
4.3 Calculate the noise voltage at the input of a television radio-frequency amplifier by using a device that has 220 Ω input resistances. The band width of the amplifier is 6 MHz and the temperature is 17 °C. (4)

[16]

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QUESTION 5: MODULATION AND DEMODULATION

5.1 Refer to the practical diode detector circuit below to calculate the maximum index which may be applied to it without causing negative peaks.



(7)

5.2 Distinguish between the following terms:

5.2.1 Modulation

5.2.2 Demodulation

(2 x 2) (4)

[11]

TOTAL: 100

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COMMUNICATION-ELECTRONICS N6

FORMULA SHEET

1. Filters

Low-pass/Laedeurlaat

$$f_c = \frac{1}{\pi \sqrt{L \,.\, C}} \qquad Z_o = \sqrt{\frac{L}{C}}$$

High-pass/Hoëdeurlaat

$$f_c = \frac{1}{4 \,.\, \pi \sqrt{L \,.\, C}} \qquad Z_o = \sqrt{\frac{L}{C}}$$

Low-pass m-derived sections (also for half-sections)
Laedeurlaat-m-afgeleide seksies (ook vir halfseksies)

T-section
T-seksie

Series/Serie $L = \frac{m \,.\, L}{2}$

Shunt/Sjunt $C = m \,.\, C$

Shunt/Sjunt $L = \frac{1 - m^2}{4 \,.\, m} \,.\, L$

π-section
π-seksie

Shunt/Sjunt $C = \frac{m \,.\, C}{2}$

Series/Serie $L = m \,.\, L$

Series/Serie $C = \frac{1 - m^2}{4 \,.\, m} \,.\, C$

$$m = \sqrt{1 - \frac{f_c^2}{f_\infty^2}} \qquad L = \frac{Z_o}{\pi \,.\, f_c} \qquad C = \frac{1}{\pi \,.\, Z_o \,.\, f_c}$$

High-pass m-derived sections (also for half-sections)
Hoëdeurlaat-m-afgeleide seksies (ook vir halfseksies)

T-section
T-seksie

Series/Serie $C = \frac{2 \,.\, C}{m}$

Shunt/Sjunt $C = \frac{4 \,.\, m}{1 - m^2} \,.\, C$

π-section
π-seksie

Series/Serie $C = \frac{C}{m}$

Series/Serie $L = \frac{4 \,.\, m}{1 - m^2} \,.\, L$

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Shunt/Sjunt $L = \frac{L}{m}$

Shunt/Sjunt $L = \frac{2 \cdot L}{m}$

$m = \sqrt{1 - \frac{f_\infty^2}{f_c^2}}$ $L = \frac{Z_o}{4 \cdot \pi \cdot f_c}$ $C = \frac{1}{4 \cdot \pi \cdot Z_o \cdot f_c}$

Band-pass sections
Banddeurlaatseksies

Series/Serie $L = \frac{Z_o}{2 \cdot \pi \, [f_2 - f_1]}$

Series/Serie $C = \frac{f_2 - f_1}{2 \cdot \pi \cdot Z_o \cdot f_1 \cdot f_2}$

Shunt/Sjunt $L = \frac{Z_o \, [f_2 - f_1]}{4 \cdot \pi \cdot f_1 \cdot f_2}$

Shunt/Sjunt $C = \frac{1}{\pi \cdot Z_o \, [f_2 - f_1]}$

Band-stop sections
Bandsperseksies

Series/Serie $L = \frac{Z_o \, [f_2 - f_1]}{2 \cdot \pi \cdot f_1 \cdot f_2}$

Series/Serie $C = \frac{1}{2 \cdot \pi \cdot Z_o \, [f_2 - f_1]}$

Shunt/Sjunt $L = \frac{Z_o}{4 \cdot \pi \cdot [f_2 - f_1]}$

Shunt/Sjunt $C = \frac{f_2 - f_1}{\pi \cdot Z_o \cdot f_1 \cdot f_2}$

2. *Attenuators*
Verswakkers

Symmetrical
Simmetries

Bridged T-type
Gebrugde T-tipe

$Z_B = Z_o \, [N - 1]$

$Z_c = \frac{Z_o}{N - 1}$

$Z_A = Z_o$

where/waar $dB = 20 \log N$

Asymmetrical
Asimmetries

L-type
L-tipe

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$$Z_A = \sqrt{R_1\,(R_1 - R_2)}$$

$$Z_B = \sqrt{\frac{(R_1 \,.\, R_2^2)}{R_1 - R_2}}$$

T-Type
T-Tipe

$$Z_1 = R_1\left[\frac{N^2+1}{N^2-1}\right] - 2\sqrt{R_1 \,.\, R_2}\left[\frac{N}{N^2-1}\right]$$

$$Z_2 = 2\sqrt{R_1 \,.\, R_2}\left[\frac{N}{N^2-1}\right]$$

$$Z_3 = R_2\left[\frac{N^2+1}{N^2-\ 1}\right] - 2\sqrt{R_1 \,.\, R_2}\left[\frac{N}{N^2-1}\right]$$

where/waar $dB = 20 \log N$

π-type
π-tipe

$$Z_A = R_1\left[\frac{N^2-1}{N^2 - 2\,.\,N\,.\,S + 1}\right]$$

$$Z_B = \frac{\sqrt{R_1 \,.\, R_2}}{2}\left[\frac{N^2-1}{N}\right]$$

$$Z_c = R_2\left[\frac{N^2-1}{N^2 - 2\,.\,N/S + 1}\right]$$

where/waar $dB = 20 \log N$ *and/en* $S = \sqrt{\frac{R_1}{R_2}}$

Insertion loss/Tussenskakelverlies $= 20 \log \frac{I_1}{I_2}$

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3. Transmission lines
Transmissielyne

$$Z_o = \sqrt{Z_{o/c} \cdot Z_{s/c}} \qquad Z_o = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

$$\gamma = \sqrt{[R + j\omega L][G + j\omega C]} \qquad \gamma = \alpha + j\beta$$

$$\lambda = \frac{2 \cdot \pi}{\beta} \qquad V = \frac{\omega}{\beta} \qquad t = \frac{d}{v}$$

$$L.G = C.R$$

$$VSWR = \frac{Z_R}{Z_o} \text{ or/of } \frac{Z_o}{Z_R}$$

$$\text{Also/ook } VSWR = \frac{1 + \rho}{1 - \rho}$$

$$\rho = \frac{Z_R - Z_o}{Z_R + Z_o}$$

$$\rho = \frac{V_{(reflected\ /\ weerkaatste)}}{V_{(incident\ /\ insident)}}$$

Normalised impedance/Genormaliseerde impedansie

$$Z_o^{'} = \frac{R}{Z_o} \pm j\,\frac{X}{Z_o}$$

4. Noise/Geruis

$$E_n = \sqrt{4KT\Delta fR} \qquad E_n = \sqrt{4KT\Delta f\,[R_1 + R_2]}$$

$$R_{eq} = R_A + \frac{R_B}{A_1^2} + \frac{R_c}{A_1^2 \cdot A_2^2}$$

$$\text{where/ waar } R_A = R_{1in} + R_{1eq}$$

$$R_B = \frac{R_{1(out\ /\ uit)} \cdot R_{2(in)}}{R_{1(out\ /\ uit)} + R_{2(in)}} + R_{2(eq)}$$

$$R_c = R_{2out\ /\ uit}$$

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$$F = 1 + \frac{R'_{eq}}{R_a} \qquad R'_{eq} = R_{eq} - R_t$$

$$F = \frac{S/N_{(in)}}{S/N_{(out/uit)}} \qquad F = 1 + \frac{T_{eq}}{T_o}$$

$$C = \Delta f \log_2 [1 + S/N]$$

where/waar $dB = 10 \log S/N$

5. *Modulation*
Modulasie

$$m = \frac{V_m}{V_c} \qquad \eta = \frac{P_{dc}}{P_c} \times 100\%$$

$$P_{dc} = I_{mean} \times V_{dc} \qquad P_{\text{mod}} = \frac{P_{SB}}{\eta}$$

$$P_{SB} = \frac{m^2 . P_c}{2}$$

$$P_T = P_c + P_{SB}$$

6. *Antennae/Antennas*

$$P_r = P_d \times A \qquad A = \frac{\lambda^2}{4 . \pi} \qquad \lambda = \frac{c}{f}$$

$$P_r = P_d \times A . G_r \qquad \textit{where/waar} \qquad dB = 10 \log G$$

$$P_d = \frac{E^2}{120 . \pi} \qquad P_d = \frac{P_t . G_t}{4 . \pi . d^2}$$

$$P_d = \frac{30 . G . P_t}{120 . \pi . d^2} \qquad P_t = \frac{[4 . \pi]^3 . d^4 . P_r}{G_t . G_r . Q . \lambda^2}$$

$$P_r = \frac{10 . P_t . G_t}{4 . \pi . d^2} \qquad E_r = \frac{\sqrt{30 . P_r}}{d}$$

$$E_S = \frac{\sqrt{30 . P_t . G_t}}{d} \qquad A = \frac{G . \lambda^2}{4 . \pi}$$

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