higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

COMMUNICATION ELECTRONICS N6

4 December 2023

This marking guideline consists of 11 pages.

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QUESTION 1

1.1 1.1.1 True
1.1.2 False

(2 × 1) (2)

1.2 **Series L** $= \dfrac{Z_o(f_2 - f_1)}{2.\pi.f_1.f_2}$

$= \dfrac{600(7500 - 5000)}{2 \times 3,142 \times 7500 \times 5000}$

$=$ **6,365 mH**✓

Series C $= \dfrac{1}{2.\pi.Z_o.(f_2 - f_1)}$

$= \dfrac{1}{2 \times 3,142 \times 600 \times (7500 - 5000)}$

$=$ **106,09 nF**✓

Shunt L $= \dfrac{Z_o}{4.\pi.(f_2 - f_1)}$

$= \dfrac{600}{4 \times 3,142 \times (7500 - 5000)}$

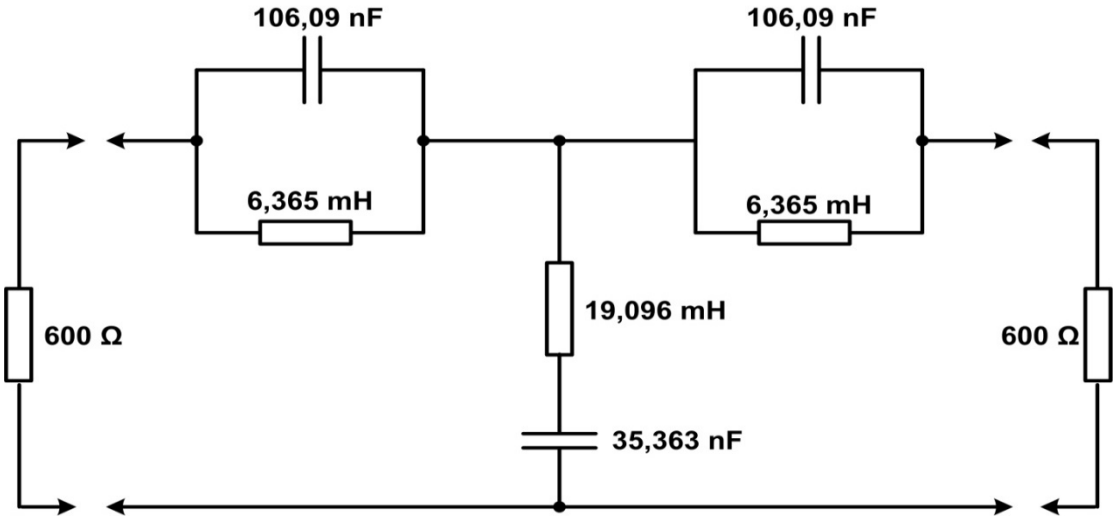
$=$ **19,096 mH**✓

Shunt C $= \dfrac{(f_2 - f_1)}{\pi.Z_o.f_1.f_2}$

$= \dfrac{(7500 - 5000)}{3,142 \times 600 \times 7500 \times 5000}$

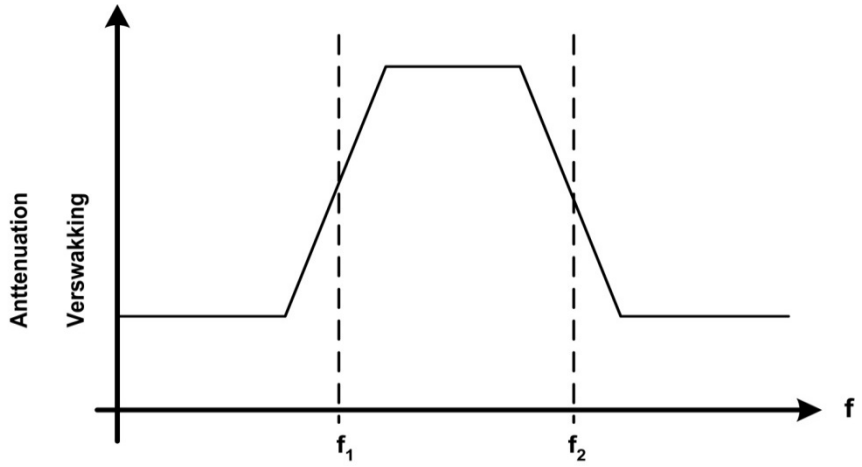
$=$ **35,363 nF**✓

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(SIX marks allocated for the circuit) (10)

1.3



(2)

1.4 $L = \frac{Z_o}{4.\pi.f_c}$

$= \frac{600}{4 \times 3,142 \times 3,75 \times 10^3}$

$=$ **12,731 mH**

$C = \frac{1}{4.\pi.Z_o.f_c}$

$= \frac{1}{4 \times 3,142 \times 600 \times 3,75 \times 10^3}$

$=$ **35,363 nF**

Series C = $\frac{2.C}{m}$

= $\frac{2 \times 35,363 \times 10^{-9}}{0,6}$

= **117,877 nF**

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

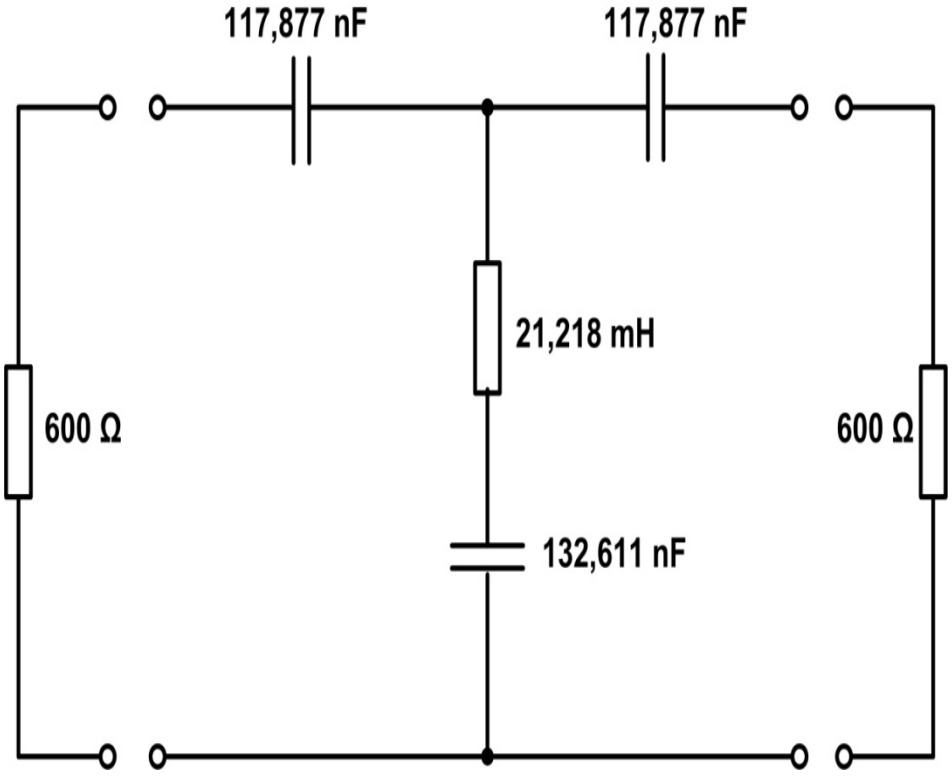
= $\frac{12,731 \times 10^{-3}}{0,6}$

= **21,218 mH**

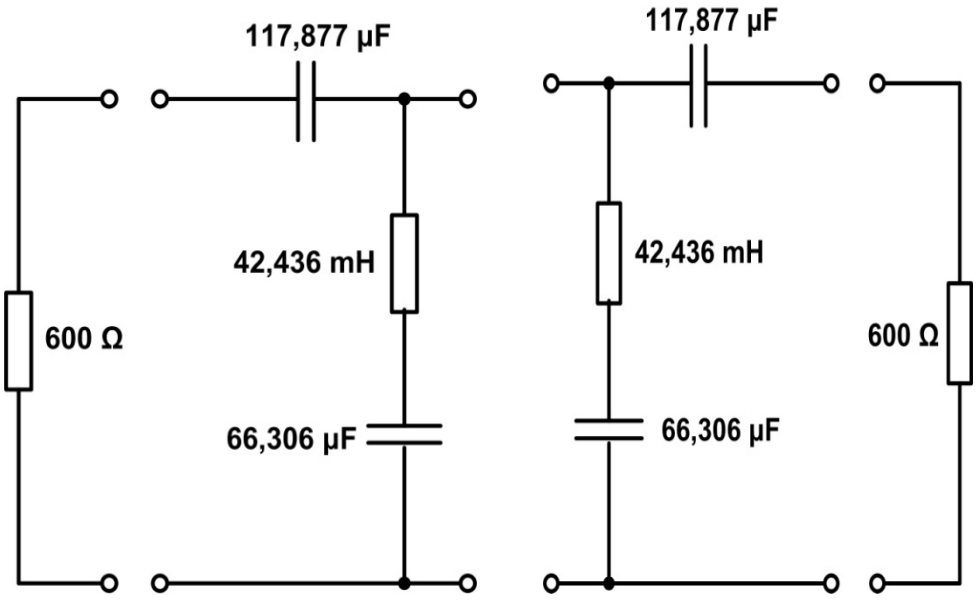
Shunt C = $\frac{4.m}{1-m^2} \times C$

= $\frac{4 \times 0,6}{1-0,6^2} \times 35,363 \times 10^{-9}$

= **132,611 nF**



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(6)
[20]

QUESTION 2

2.1

Insertion loss:

$$= 20 \log \frac{I_1}{I_2} \checkmark$$

Without the network:

$$I_1 = \frac{V}{R_1 + R_2}$$

$$= \frac{V}{480 + 320} \checkmark$$

$$= \frac{V}{800} \checkmark$$

With the network: $I_S = \dfrac{V}{R_1 + Z_1 + \left[\dfrac{Z_2(Z_3 + R_2)}{Z_2 + Z_3 + R_2}\right]}$

$= \dfrac{V}{480 + 280 + \left[\dfrac{350(220 + 320)}{350 + 220 + 320}\right]}$ ✓

$= \dfrac{V}{972{,}36}$ ✓

$\therefore I_2 = \dfrac{Z_2}{Z_2 + Z_3 + R_2} \cdot I_S$

$= \dfrac{350}{350 + 220 + 320} \times \dfrac{V}{972{,}36}$ ✓

$= \dfrac{350V}{865400}$ ✓

$\therefore$ Insertion loss:

$= 20 \log \dfrac{I_1}{I_2}$

$= 20 \log \times \dfrac{\dfrac{V}{800}}{\dfrac{350V}{865400}}$ ✓

$= 20 \log \times \dfrac{865400V}{280000V}$

$=$ **9,801 dB**✓✓ (10)

2.2

N_A for 5 dB:

$dB = 20 \log N_A$

$\therefore N_A = anti\text{-}log \dfrac{dB}{20}$

$= anti\text{-}log \dfrac{5}{20}$

$=$ ***1,778***

N_B for 10 dB:

$dB = 20 \log N_B$

$\therefore N_B = anti\text{-}log \dfrac{dB}{20}$

$= anti\text{-}log \dfrac{10}{20}$

$=$ **3,162**

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$$\mathbf{Z_B} = Z_o(N_A - 1)$$

$$= 600(1{,}778 - 1)$$

$$= \mathbf{466{,}8\ \Omega}\checkmark$$

$$\mathbf{Z_C} = \frac{Z_0}{N_A - 1}$$

$$= \frac{600}{1{,}778 - 1}$$

$$= \mathbf{771{,}208\ \Omega}\checkmark$$

$$\mathbf{Z_B} = Z_o(N_B - 1)$$

$$= 600(3{,}162 - 1)$$

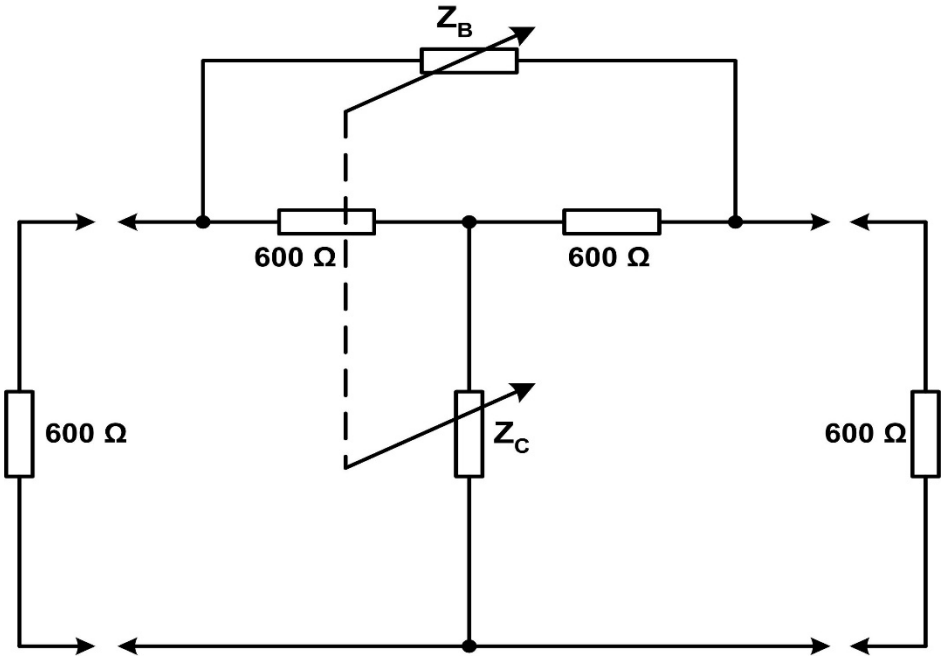
$$= \mathbf{1{,}297\ k\Omega}\checkmark$$

$$\mathbf{Z_C} = \frac{Z_0}{N_B - 1}$$

$$= \frac{600}{3{,}162 - 1}$$

$$= \mathbf{277{,}521\ \Omega}\checkmark$$

$\therefore Z_B$ should be variable between 466,8 Ω to 1,297 kΩ✓
$\therefore Z_C$ should be variable between 277,521 Ω to 771,208 Ω✓



(FOUR marks for the circuit) (10)
[20]

QUESTION 3

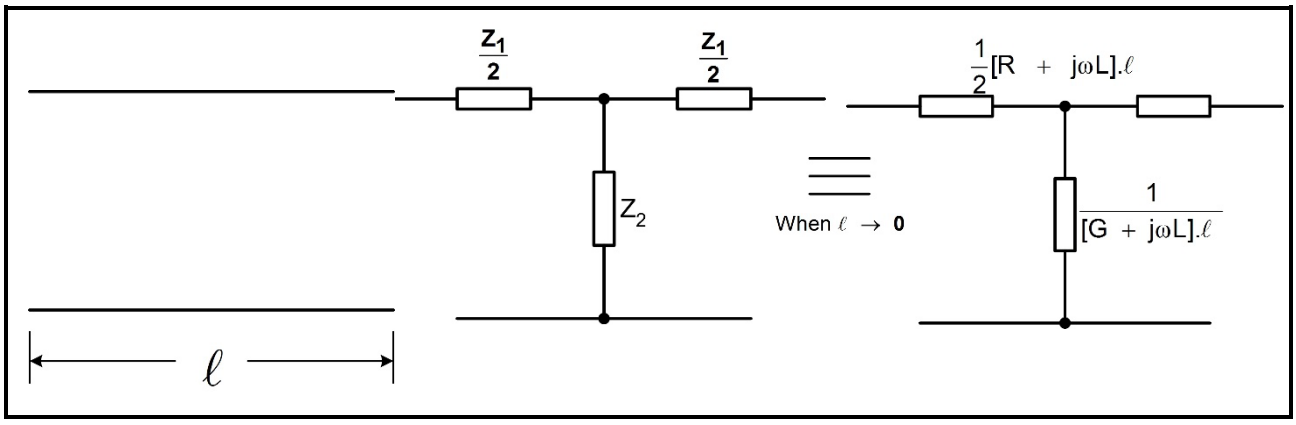
3.1 The point source radiator on an isotropic antenna is a theoretical antenna that radiates equal amounts of energy in all directions✓ which is used as a basis for comparison between antennas.✓ (2)

3.2 3.2.1 The vertically polarised antenna is described as an antenna which has an electric field radiated vertically✓ causing the radiated wave to be vertically polarised.✓

3.2.2 The horizontally polarised antenna is described as an antenna which has an electric field radiated horizontally✓ causing the radiated wave to be horizontally polarised.✓

(2 × 2) (4)

3.3



$$Z_0 = \sqrt{\frac{Z_1^2}{2} + Z_1 Z_2}\ \checkmark$$

But $$\frac{Z_1}{2} = \frac{1}{2}[R + j\omega L]\ .\ l$$

$$Z_2 = \frac{1}{[G + j\omega C].l}\ \checkmark$$

$$\therefore\ Z_0 = \sqrt{\frac{(R + j\omega L)^2\ l^2}{2} + \frac{(R + j\omega L)\ l}{(G + j\omega C)\ l}}\ \checkmark$$

Let $l = 0$

$$\therefore\ Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}\ \checkmark\checkmark$$

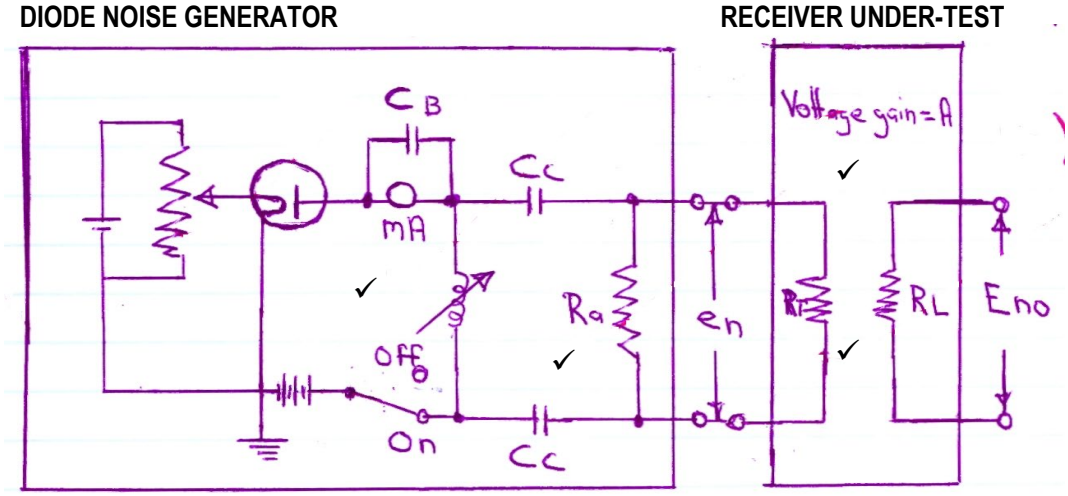
(9)
[15]

QUESTION 4: NOISE

4.1 Thermal agitation noise is generated in a receiver✓ by the rapid and random motion of the molecules,✓ atoms and electrons, which increase with temperature according to simplified atomic theory,✓ in all types of materials used to construct such resistors.✓ (4)

4.2 The equivalent noise resistance of an amplifier or receiver is the sum of the input terminating resistance✓ and the equivalent noise resistance of the first stage,✓ together with the noise resistance of the previous stages refer to the input.✓ (3)

4.3



(5)

4.4 4.4.1

$$R_{EQ} = R_A + \frac{R_B}{A_1^{\,2}} + \frac{R_C}{A_1^{\,2} \times A_2^{\,2}}$$

$$R_A = R_{1(IN)} + R_{1(eq)}$$

$$= 6.,\times 10^3 + 9 \times 10^3$$

$$= 15{,}8 \text{ k}\Omega ✓✓$$

Since R_C = R_2 (output)

$$= 20 \text{ M}\Omega ✓$$

$$\therefore \quad R_B = \frac{R_{1(OUT)} \times R_{2(IN)}}{R_{1(OUT)} + R_{2(IN)}} + R_{2(eq)}$$

$$= \frac{\left(15 \times 10^3\right) \times \left(18 \times 10^3\right)}{\left(15 \times 10^3\right) + \left(18 \times 10^3\right)} + 12 \times 10^3 ✓$$

$$= 20{,}182 \text{ k}\Omega ✓✓$$

$$\therefore\ R_{EQ} = R_A + \frac{R_B}{A_1^{\,2}} + \frac{R_C}{A_1^{\,2} \times A_2^{\,2}}$$

$$= 15{,}8 \times 10^3 + \frac{20{,}82 \times 10^3}{12^2} + \frac{20 \times 10^6}{12^2} + \frac{20 \times 10^6}{12 \times 20^2}$$

= 16,.287 kΩ✓✓

$$E_n = \sqrt{4.K.T.\Delta f.R}$$

$$= \sqrt{\left(4 \times 1{,}38 \times 10^{\ -23}\right) \times 297 \times 7{,}5 \times 10^6 \times 16{,}287 \times 10^3}$$

= 44,751 µV✓✓ (10)

4.4.2 $E_n = \sqrt{4.K.T.\Delta f.}\,(R_{1+}\,R_2\ )$

$= \sqrt{(4\ \text{x}1{,}38\ \text{x}\ 10^{-23})\ \text{x}\ 298\ \text{x}\ (4{,}2\ \text{x}\ 10^3 +\ 5{,}6\ \text{x}\ 10^3)\ \text{x}\ 750\ \text{x}\ 10^3)}$✓

= **<u>11 µV</u>**✓✓ (3)

[25]

QUESTION 5

5.1
5.1.1 Better
5.1.2 Wide
5.1.3 Transistor
5.1.4 Valve
5.1.5 Poor
5.1.6 Better

(6 × 1) (6)

5.2 An AM linear modulator is used for large power transmitters requiring good linearity✓ to ensure that anode modulation is employed.✓ The modulator comprises a class B audio amplifier which drives a class C radio frequency amplifier.✓ The class C amplifier is biased well beyond the cut-off frequency and the anode current flows in pulses for a part of the audio cycle allowing the output to be rich in harmonics with a fairly undistorted AM signal.✓ (4)

5.3 5.3.1 It is the ratio of power density radiated in a specific direction to the power density by an isotropic antenna.✓✓

5.3.2 It is a device that will convert an electro-magnetic quantity into a corresponding electrical current.✓✓

5.3.3 It is a device that will convert an electrical current into a corresponding electro-magnetic quantity.✓✓

(3 × 2) (6)

5.4 $\lambda = \frac{C}{f}$

$= \frac{3 \times 10^8}{120 \times 10^6}$

$=$ **2,5 m**✓

$A = \frac{G.\lambda^2}{4.\pi}$

$= \frac{12 \times 2,5^2}{4 \times 3,142}$

$=$ **5,968 m²**✓

$Pr =$ Pd. A

$\therefore Pd = \frac{Pr}{A}$

$= \frac{5 \times 10^{-13}}{5,968}$ ✓

$=$ **83,78 × 10^{-15} W/m²**✓ (4)

[20]

TOTAL: 100

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