higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N6

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This marking guideline consists of 11 pages.

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QUESTION 1

1.1 (a) $L_1 = \frac{Z_o}{\pi (F_2 - F_1)}$

$= \frac{600}{\pi(4\,000 - 1\,000)}$

$= \frac{600}{\pi\ X\ 3\,000}$ ✓

$= \xrightarrow{63{,}65\ mH}$ ✓ (2)

(b) $L_2 = \frac{Zo}{4\pi}(\frac{1}{F1} - \frac{1}{F2})$

$= \frac{600}{4\pi}\ (\frac{1}{1\,000} - \frac{1}{4\,000})$ ✓

$= \xrightarrow{35{,}81\ mH}$ ✓ (2)

(c) $C_1 = \frac{1}{4\pi Zo}(\frac{1}{F1} - \frac{1}{F2})$

$C_1 = \frac{1}{4\pi\ X\ 600}(\frac{1}{1\,000} - \frac{1}{4\,000})$√

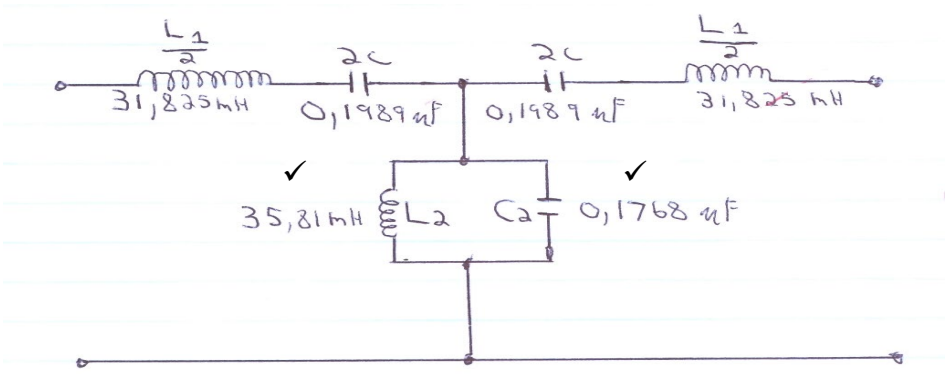
$= \xrightarrow{0{,}09946\ uF}$ √ (2)

(d) $C_2 = \frac{1}{\pi Zo(F_2 - F_1)}$

$= \frac{1}{\pi\ \text{X}\ 600\ \text{X}\ 3\,000}$ √

$= \xrightarrow{0{,}1768\ uF}$ ✓ (2)

(e)



(2)

1.2 1.2.1 Input

1.2.2 Low-pass filter

(2 × 1) (2)

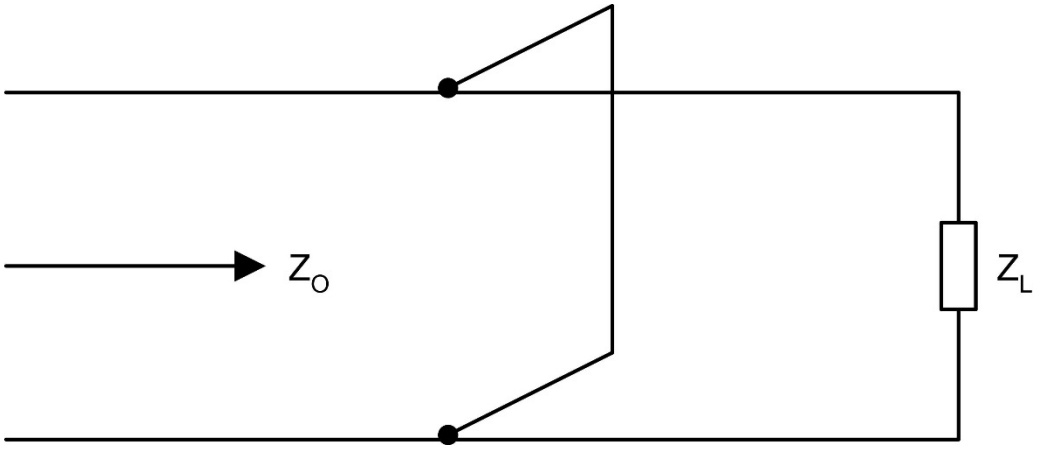
1.3
- Attenuation does not rise sharply at cut-off.
- The characteristic impedance is not constant over the pass band. (2)

[14]

QUESTION 2

2.1
- The size of the conductors
- The spacing of the conductors
- The dielectric constant of the insulator (3)

2.2 Make use of a stub constructed as shown below:



The stub is a short piece of wire that is short-circuited across the transmission line. (4)

2.3 $$N = \frac{I_{(in)}}{I(out/uit)}$$

$$= \frac{3}{1}$$

$$= 3$$

$$Z_1 = R_G\left[\frac{N^2+1}{N^2-1}\right] - 2\sqrt{R_G.R_L}\left[\frac{N}{N^2-1}\right]$$

$$= 560\left[\frac{3^2+1}{3^2-1}\right] - 2\sqrt{560\times 480}\left[\frac{3}{3^2-1}\right]$$

$$= 311{,}156\ \Omega$$

$$Z_2 = 2\sqrt{R_G.R_L}\left[\frac{N}{N-1}\right]$$

$$= 2\sqrt{560\times 480}\left[\frac{3}{3^2-1}\right]$$

$$= 388{,}844\ \Omega$$

$$Z_3 = R_L\left[\frac{N^2+1}{N^2-1}\right] - 2\sqrt{R_G.R_L}\left[\frac{N}{N^2-1}\right]$$

$$= 480\left[\frac{3^2+1}{3^2-1}\right] - 2\sqrt{560\times 480}\left[\frac{3}{3^2-1}\right]$$

$$= 211{,}156\ \Omega$$ (6)

2.4 No, an attenuator only consists of resistive components, which are not frequency-sensitive. (3)
[16]

QUESTION 3

3.1 3.1.1

$$Z_O = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

$$= \sqrt{\frac{30 + j2 \times 3,142 \times 1,7 \times 10^{3} \times 0,5 \times 10^{-3}}{1,9 \times 10^{-6} + j2 \times 3,142 \times 1,7 \times 10^{3} \times 0,045 \times 10^{-9}}}$$

$$= \sqrt{\frac{30 + j5,341}{1,9 \times 10^{-6} + j480,726 \times 10^{-9}}}$$

$$= \sqrt{\frac{30,471 \angle 10,1^{0}}{1,96 \times 10^{-6} \angle 14,2^{0}}}$$

$$= 3,943 \times 10^{3} \angle -2,1^{0}$$

$$= \mathbf{3,94 \times 10^{3} - j\ 144,486\ \Omega} \quad (4)$$

3.1.2

$$\gamma = \sqrt{(R + j\omega L)(G + j\omega C)}$$

$$= \sqrt{\left(30,471 \angle 10,1^{0}\right)\left(1,96 \times 10^{-6} \angle 14,2^{0}\right)}$$

$$= 7,728 \times 10^{-3} \angle 12,2^{0}$$

$$= \mathbf{7,553 \times 10^{-3} + j\ 1,633 \times 10^{-3}}$$

$$\gamma = \alpha + j\beta$$

$$\therefore \beta = \mathbf{1,633 \times 10^{-3}\ rad/km} \quad (3)$$

3.1.3 $\therefore \alpha = \mathbf{7,553 \times 10^{-3}\ nepers/km}$ (2)

3.2 3.2.1 To tune out reactive components

3.2.2 To measure power along a transmission line

3.2.3 To match an unbalanced device to a balanced device

3.2.4 To determine the position and size of the first voltage maximum from the load

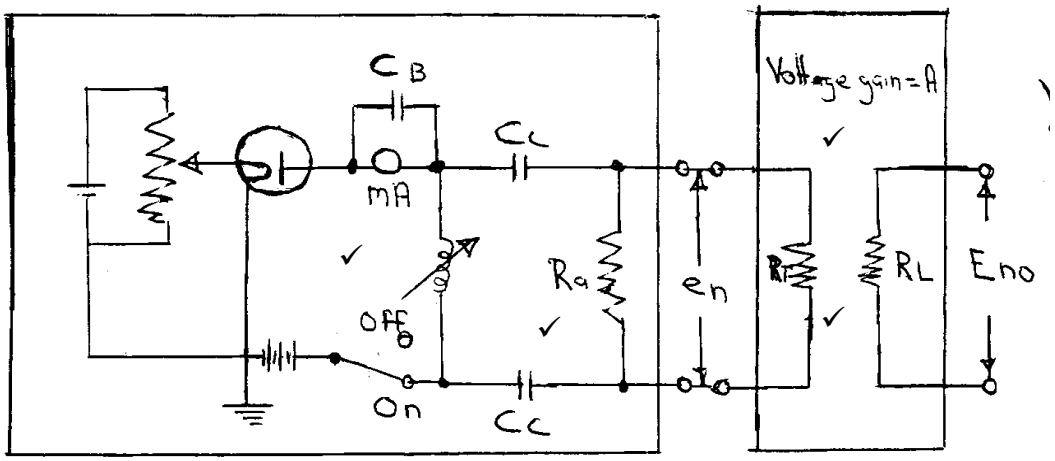
(4 × 1) (4)

3.3
- Normalise the impedance.
- $Z_O = \frac{R}{Z_o} \pm j\frac{X}{Z_o}$
- Plot R on the centre line and X on the circle.
- Follow the two lines until they intersect each other and plot this point.
- Draw the circle with a radius equal to the centre of the chart and the point plotted in the step above.
- Read off the SWR at the bottom of the circle where it intersects the centre line. (6)

[19]

QUESTION 4

4.1 **DIODE NOISE GENERATOR** **RECEIVER UNDER TEST**



NOISE FIGURE MEASUREMENT (5)

4.2 4.2.1 $\mathbf{E_n} = \sqrt{4.K.T.\Delta F.(R_1 + R_2)}$

$= \sqrt{4 \times 1{,}38 \times 10^{-23} \times (273 + 25) \times 20 \times 10^3 \times (7{,}2 \times 10^3 + 5 \times 10^3)}$

$= 2{,}003\ \mu V$

4.2.2 $$R'_{eq} = \left[R_{eq} - R_t\right] + \frac{R_{out/uit}}{A^2}$$

$$= \left[7,2\times10^3 - 5\times10^3\right] + \frac{18\times10^3}{20^2}$$

$$= 2,245\ k\Omega$$

$$\therefore F = 1 + \frac{R'_{eq}}{R_a}$$

$$= 1 + \frac{2245}{300}$$

$$= 8,483$$

(2 × 3) (6)

4.3 4.3.1 $$R_{eq} = R_A + \frac{R_B}{A_1^2} + \frac{R_C}{A_1^2.A_2^2} + \frac{R_D}{A_1^2.A_2^2.A_3^2}$$

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

$$= 300 + 1\,750$$

$$= 2,05\ k\Omega$$

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

$$= \frac{30\times10^3\times150\times10^3}{30\times10^3 + 150\times10^3} + 35\times10^3$$

$$= 60\ k\Omega$$

$$= \frac{R_{2(out/uit)}.R_{3(in)}}{R_{2(out/uit)} + R_{3(in)}} + R_{3(eq)}$$

$$= \frac{6\times10^6\times1,5\times10^6}{6\times10^6 + 1,5\times10^6} + 3\times10^6$$

$$= 4,2\ M\Omega$$

$$R_D = R_{3(out)}$$

$$= 600\ M\Omega$$

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$$\therefore R_{eq} = 2{,}05\times10^{3} + \frac{60\times10^{3}}{9} + \frac{4{,}2\times10^{6}}{9\times36} + \frac{600\times10^{6}}{9\times36\times81}$$

$$= 2{,}05 \times 10^{3} + 6{,}667 \times 10^{3} + 12{,}963 \times 10^{3} + 22{,}862 \times 10^{3}$$

$$= 44{,}542\ k\Omega \quad (8)$$

4.3.2 $$E_n = \sqrt{4.K.T.\Delta f.R_{eq}}$$

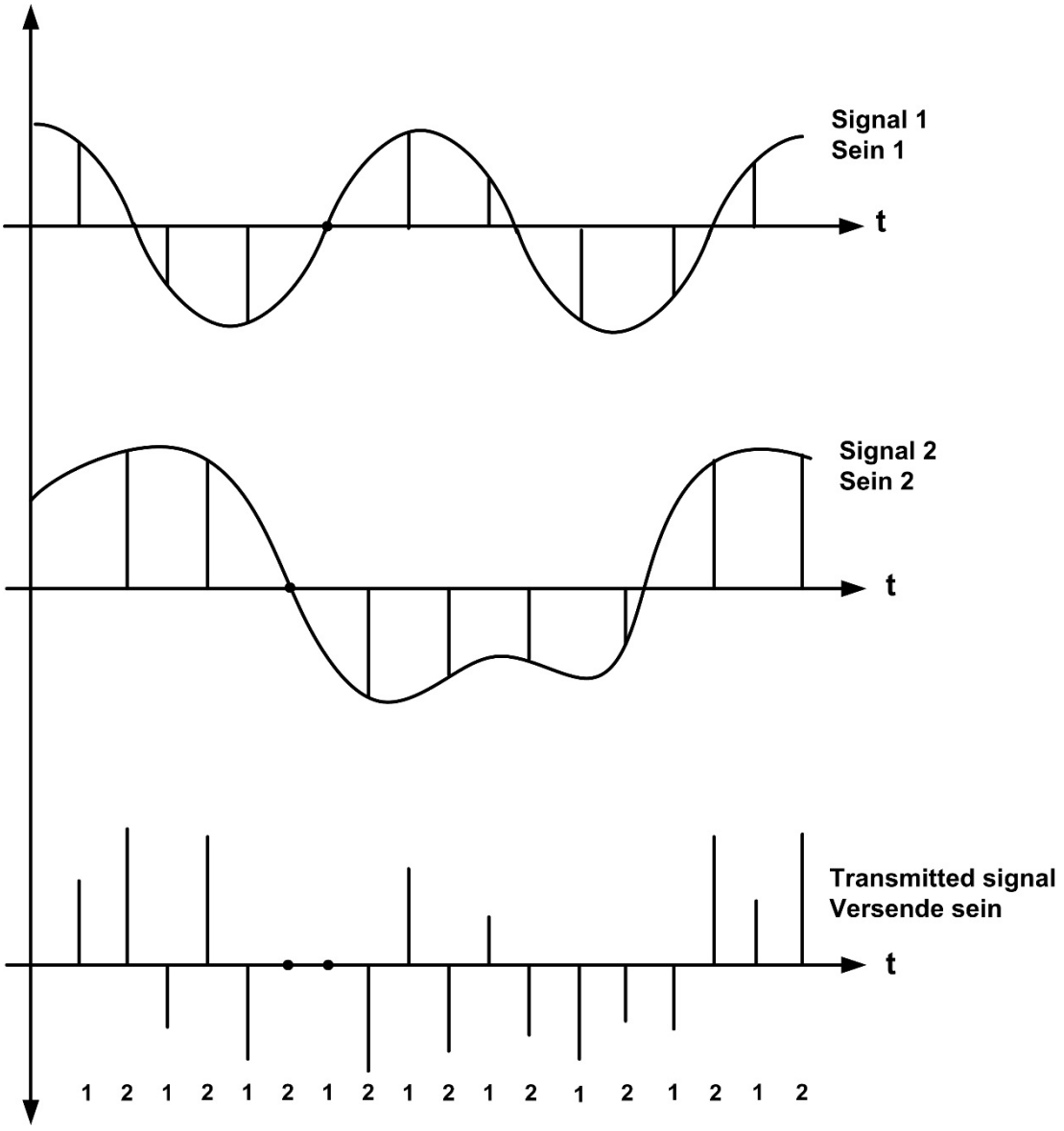
$$= \sqrt{4\times1{,}38\times10^{-23}\times(273+25)\times9\times10^{3}\times44{,}542\times10^{3}}$$

$$= 2{,}568\ \mu V \quad (2)$$

[21]

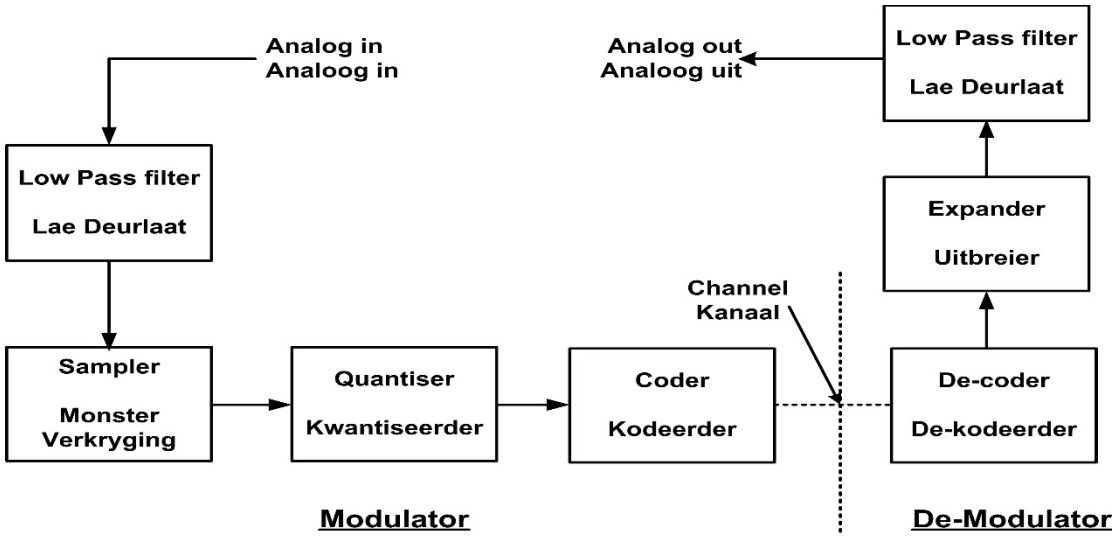
QUESTION 5

5.1 Sampling is a process whereby parts of a signal are taken at a tempo of t = ½ f seconds and only the sample is transmitted.



(6)

5.2



(10)
[16]

QUESTION 6

6.1 Path loss = $2 \times 100 \times 0,002$

= 0,4 dB

Path loss = antilog $\frac{dB}{10}$

= antilog $\frac{0,4}{10}$

= 1,096

$\lambda = \frac{c}{f}$

$= \frac{3 \times 10^8}{3 \times 10^9}$

= 0,1 m

$P_t = \frac{[4\pi]^3 \ . d^4 \ . P_r}{G_t \ . G_A \ . Q \ . \lambda^2} \times 1,096$

$= \frac{[4 \times 3,142]^3 \times \left[100 \times 10^3\right]^4 \times \left[1,8 \times 10^{-18}\right]}{20 \times 20 \times 9 \times 0,1^2} \times 1,096$

= 10,879 kW (10)

6.2 6.2.1 It is the ratio of power density radiated in a specific direction to the power density radiated by an isotropic antenna.

6.2.2 It is the ratio of power fed to an antenna to the power radiated by the antenna.

(2 × 2) (4)
[14]

TOTAL: 100

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