higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N6

3 AUGUST 2018

This marking guideline consists of 11 pages.

Copyright reserved

QUESTION 1: ATTENUATORS AND FILTERS

1.1 $$L = \frac{Z_0}{\pi \times f_c}$$

$$= \frac{600}{3{,}142 \times 7{,}5 \times 10^3}$$

$$= 25{,}461 \text{ mH} \quad (1)$$

$$\text{Series } L = \frac{m \times L}{2}$$

$$m = \frac{2 \times Series}{L}$$

$$= \frac{2 \times 9 \times 10^{-3}}{25{,}461 \times 10^{-3}}$$

$$= 0{,}707 \quad (1)$$

$$m = \sqrt{1 - \frac{f_{c^2}}{f_{\infty^2}}}$$

$$f_\infty = \sqrt{\frac{f_{c^2}}{1 - m^2}}$$

$$= \sqrt{\frac{\left(7.5 \times 10^3\right)}{1 - 0{,}707^2}}^2$$

$$= 10{,}605 \text{ kHz} \quad (2)$$

1.2 $dB = \log N$

$\therefore N = \text{Antilog}\frac{dB}{20}$

$= \text{Antilog}\ \frac{15}{20}$

$= 5{,}623$ (2)

$$Z2 = 2\sqrt{R1, R2}\ \left[\frac{N}{N^2 - 1}\right]$$

$$Z2 = 2\sqrt{R1, 500} \times \left[\frac{5{,}623}{5.623^2 - 1}\right]$$

$$350 = 2\sqrt{R1, 500} \times \left[\frac{5{,}623}{5{,}623^2 - 1}\right]$$

$$350 = 2\sqrt{R1, 500} \times [183{,}649 \text{ x } 10^{-3}]$$

$$2\sqrt{R1, 500} = \frac{350}{183.649 \times 10^{-3}}$$

$$\sqrt{R1, 500} = 952{,}905$$

$$\therefore R1 = 1{,}816\ \text{k}\Omega$$ (4)

1.3 The effect of an insertion loss on a network is realised when the network is inserted between the generator and load, there is a loss of power in the load due to the mismatch between the generator and network, the network and the load and the attenuation through the network.

Hence the insertion loss is the sum of the mismatch losses and attenuation loss. (5)

1.4 Series $L = \dfrac{Z_0(f_2 - f_1)}{2 \times \pi \times f_1 \times f_2}$

$= \dfrac{600(6000 - 3500)}{2 \times 3.142 \times 6000 \times 3500}$

$= 11{,}368$ mH (1)

Series $C = \dfrac{1}{2 \times \pi \times Z_0 \times (f_2 - f_1)}$

$= \dfrac{1}{2 \times 3{,}142 \times 600 \times (6\,000 - 3500)}$

$= 106{,}09$ nF (1)

Shunt $L = \dfrac{Z_0}{4 \times \pi \times (f_1 - f_2)}$

$= \dfrac{600}{4 \times 3{,}142 \times (6\,000 - 3\,500)}$

$= 19{,}096$ mH (1)

Shunt $C = \dfrac{f_2 - f_1}{\pi \times Z_0 \times f_1 \times f_2}$

$= \dfrac{6000 - 3500}{3{,}142 \times 600 \times 6\,000 \times 3\,500}$

$= 63{,}149$ nF (1)

Copyright reserved

1.5 $$L = \frac{Z_0}{4 \times \pi \times f_c}$$

$$= \frac{600}{4 \times 3{,}142 \times 4{,}25 \times 10^3}$$

$$= 11{,}233 \text{ mH}$$ (1)

$$C = \frac{1}{4 \times \pi \times Z_0 \times f_c}$$

$$= 31{,}203 \text{ nF}$$ (1)

$$\text{Series C} = \frac{2 \times C}{m}$$

$$= \frac{2 \times 31{,}203 \times 10^{-9}}{0{,}6}$$

$$= 104{,}01 \text{ nF}$$ (2)

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

$$= \frac{11{,}233 \times 10^{-3}}{0{,}6}$$

$$= 18{,}722 \text{ mH}$$ (1)

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

$$= \frac{4 \times 0.6}{1 - 0{,}6^2} \times 31{,}203 \times 10^{-9}$$

$$= 117{,}011 \text{ nF}$$ (1)

[25]

QUESTION 2: TRANSMISSION LINES

2.1 SWR is the ratio of maximum voltage to minimum voltage along a transmission line. It is also a mismatch between the load and the line. (2)

2.2 2.2.1 $R + j\omega L = 22 + j\,9\,000 \times 35 \times 10^{-3}$

$= 22 + j\,315$

$= 315{,}767 \angle 86°$ (2)

$G + j\omega C = 18 \times 10^{-6} + j\,9\,000 \times 12 \times 10^{-9}$

$= 18 \times 10^{-6} + j108 \times 10^{-6}$

$= 109.49 \times 10^{-6} \angle 80.54^{0}$ (2)

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

$= \sqrt{\left[\left(315.767 \angle 86^{0}\right)\left(109.49 \times 10^{-6} \angle 80.54^{0}\right)\right]}$

$= 185{,}939 \times 10^{-3} \angle 83{,}27^{0}$

$= 21.79 \times 10^{-3} + j184.658 \times 10^{-3}$ (2)

$\lambda = \frac{2\pi}{\beta}$

$= \frac{2 \times 3.142}{184.658 \times 10^{-3}}$

$= 34{,}03$ m (2)

2.2.2 $V = \frac{\omega}{\beta}$

$= \frac{9\,000}{184{,}658 \times 10^{-3}}$

$= 48\,738{,}749$ m/s (2)

2.3 $Z_0 = \sqrt{Z_{O/C} \cdot Z_{S/C}}$

$= \frac{Z_{O^2}}{Z_{/sc}}$

$= \frac{600^2}{900}$

$= 400\ \Omega$ (2)

2.4 $$\rho = \frac{Z_L - Z_O}{Z_L + Z_O}$$

But $Z_L = 300\angle 45^0$

i.e. $Z_L = 212{,}132 + j212{,}132$

$$\therefore \rho = \frac{212{,}132 + j212{,}132 - 400 + j200}{212{,}132 + j212{,}132 + 400 - j200}$$

$$= \frac{-187{,}868 + j412{,}132}{612{,}132 + j12{,}132}$$

$$= \frac{452{,}932\angle 114{,}51°}{612{,}252\angle 1{,}14°}$$

$$= 0{,}74\llcorner 113{,}37°$$ (3)

$\therefore \mathbf{V}_{REFLECTED} = \rho \times \mathbf{V}_{INCIDENT}$

$$= 0{,}74\llcorner 113{,}37 \times 0{,}6\llcorner 30$$

$$= 0{,}444\llcorner 143{,}37 \text{ V}$$

$$= -0{,}356 + J\ 0{,}265 \text{ V}$$ (3)

[20]

QUESTION 3: ANTENNAS

3.1 3.1.1 Beam width is the angular separation of the radiated beam between the half-power points. (1)

3.1.2 Bandwidth is the frequency range over which the radiation is greater than the half-power points. (1)

3.1.3 Aperture is the effective area of an antenna when a signal is received. (2)

3.2

$$\text{Pr} = Pd \times A$$

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

$$= \frac{12 \times 10^{-12}}{0.6 \times 10^{-12}}$$

$$= 20 \text{ m}^2 \quad (2)$$

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

$$= \frac{3 \times 10^{8}}{100 \times 10^{6}}$$

$$= 3 \text{ m} \quad (2)$$

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

$$\therefore \text{G} = \frac{A \times 4 \times \pi}{\lambda^2}$$

$$= \frac{20 \times 4 \times 3{,}142}{3^2}$$

$$= 27{,}929 \quad (3)$$

$$\text{dB} = 10 \log \text{G}$$

$$= 10 \log 27{,}929$$

$$= 14{,}46$$

$$= 14 \text{ dB} \quad (2)$$

3.3

$$\text{Pd} = \frac{30 \times G \times P_t}{120 \times \pi \times d^2}$$

$$= \frac{30 \times 15 \times 30}{120 \times 3{,}142 \times (180 \times 10^3)^2}$$

$$= 1{,}105 \times 10^{-9}\ \text{W/m}^2 \quad (2)$$

$$\gamma = \frac{C}{f}$$

$$= \frac{3 \times 10^8}{90 \times 10^6}$$

$$= 3{,}333\ \text{m} \quad (1)$$

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

$$= \frac{12 \times 3{,}333^2}{4 \times 3{,}142}$$

$$= 10{,}607\ \text{m}^2 \quad (2)$$

$$\text{Pr} = \text{Pd} \times \text{A}$$

$$= 1{,}105 \times 10^{-9} \times 10{,}607$$

$$= 11{,}721 \times 10^{-9}\text{W} \quad (2)$$

[20]

QUESTION 4: NOISE

4.1 4.1.1
- Lightning
- Static electricity (Any ONE) (1)

4.1.2
- Ignition systems
- Electric motors
- Fluorescent lights (Any ONE) (1)

4.1.3 The random noise generated in a resistance or resistive component of any impedance. (2)

4.1.4 The noise that is radiated by stars and is distributed fairly uniformly over the entire sky. (2)

4.2 4.2.1

$$F = 1 + \frac{R_{eq}}{R_a}$$

$$= 1 + \frac{75}{180}$$

$$= 1{,}417$$

(2)

$$\therefore dB = 10 \log F$$

$$= 10 \log 1{,}417$$

$$= 1{,}514 \text{ dB}$$

(2)

4.2.2

$$T_{eq} = To\ (F - 1)$$

$$To = \frac{T_{eq}}{F-1}$$

$$= \frac{100}{1.417 - 1}$$

$$= 240 \text{ K}$$

(2)

$$T = 273 - To$$

$$= 273 - 240$$

$$= 33\ ^0C$$

(2)

4.3 The Shannon-Hartley theorem specifies that the maximum signalling speed or channel capacity may not be exceeded for a given bandwidth and noise level without the error rate. (2)

4.4 $dB = 10 \log S/N$

$$\therefore S/N = \text{antilog } \frac{dB}{10}$$

$$= \text{antilog } \frac{20}{10}$$

$$= \text{antilog } 2$$

$$= 100 \quad (3)$$

$$C = \Delta f \times \log 2 (1 + S/N)$$

$$= 15 \times 10^3 \times \log 2 (1 + 100)$$

$$= 15 \times 10^3 \times \frac{\log 101}{\log 2}$$

$$= 99\,873 \text{ bits/sec} \quad (2)$$

4.5 $$E_n = \sqrt{4 \times K \times T \times \Delta \times f \times R}$$

$$\therefore T = \frac{E_n^{\,2}}{4 \times K \times \Delta f \times R}$$

$$= \frac{\left[\left(26.112 \times 10^{-6}\right)\right]^2}{4 \times 1.38 \times 10^{-23} \times 9 \times 10^3 \times 4.5 \times 10^6}$$

$$= 305 \text{ Kelvin} \quad (3)$$

$$\therefore {}^0C = 305 - 273$$

$$= 32\ {}^0C \quad (1)$$

[25]

Copyright reserved

QUESTION 5: MODULATION AND DEMODULATION

5.1
- Single-sideband transmission is used in multichannel telephony for economy of power and bandwidth. There is a saving in carrier power because one sideband power is used and adjacent channels can be used for other messages leading to economy of bandwidth.
- In case of point-to-point transmission the total transmitted power can be concentrated in one sideband only to give the signal-to-noise required at the receiver.

5.2 In independent sideband transmission the signal may be transmitted with or without a pilot carrier and the process consists of producing two separate single-sideband signals. One message is superimposed on one of the sidebands and another message on the other sideband. The two messages are then mixed with or without a carrier in a hybrid circuit.

(2 × 5) **[10]**

TOTAL: 100

Copyright reserved