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 7 pages.

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QUESTION 1: ATTENUATORS AND FILTERS

1.1 An attenuator is the resistance network that is used to reduce voltage, current or power in controllable and known amounts that are independent of frequency. (2)

1.2
- L-type
- T-type
- π-type
- Ladder-type
- Bridged-type (5)

1.3 $S^2 = \frac{R_1}{R_2}$

$= \frac{600}{125}$

$= 2{,}191$

$40 = 20 \log N$✓

$\log N = 2$✓

$= 200$✓

$R_A = \frac{R(N^2-1)}{N^2-2NS+1}$✓

$= \frac{600(10\,000-1)}{10\,000-2\times100\times2{,}191+1}$✓

$= 627{,}5\ \Omega$✓

$R_B = \sqrt{\frac{R_1 \times R_2}{2}\left(\frac{N^2-1}{N}\right)}$

$= \sqrt{\frac{600\times125}{2}\left(\frac{100^2-1}{100}\right)}$✓

$= 13\,692\ \Omega$✓

$R_C = \frac{R_2(N^2-1)}{N^2-\frac{2N}{S}+1}$

$= \frac{125(100^2-1)}{100^2-\frac{2\times100}{2{,}191}+1}$✓

$= 126\ \Omega$✓ (10)

1.4
- The attenuation does not rise rapidly at the cut-off frequency.
- The characteristic impedance is not constant over the pass band. (2)

1.5
- Low-pass
- High-pass
- Band- pass
- Band-stop (4)

1.6 $L_1 = \frac{Z_0}{\pi(f_2 - f_1)}$ ✓

$= \frac{600}{3{,}142(4000-1000)}$ ✓

= 63,65 mH✓

$L_2 = \frac{Z_0}{4\pi}\left(\frac{1}{f_1} - \frac{1}{f_2}\right)$ ✓

$= \frac{600}{4 \times 3{,}142}\left(\frac{1}{1\,000} - \frac{1}{4\,000}\right)$ ✓

= 35,81 mH✓

$C_1 = \frac{1}{4\pi \times Z_O}\left(\frac{1}{f_1} - \frac{1}{f_2}\right)$ ✓

$= \frac{1}{4 \times 3{,}142 \times 600}\left(\frac{1}{1000} - \frac{1}{400}\right)$ ✓

= 0,09946 Mf✓

$C_2 = \frac{1}{\pi \times Z_0(f_2 - f_1)}$ ✓

$= \frac{1}{3{,}142 \times 600 \times 3000}$ ✓

= 0,1768 μF ✓ (12)
[35]

QUESTION 2: TRANSMISSION LINES

2.1 A transmission line is defined as a means of conveying a signal or power from one point to another. (2)

2.2
- The size of the conductor
- The spacing of the conductor
- The dielectric constant of the inulator (3)

2.3 2.3.1 $R + j\omega L = 78 + j\ 10\ 000 \times 1{,}75 \times 10^{-3}$
$= 78 + j\ 17{,}5$
$= 79{,}94 \angle 12^{o}\ 39' \checkmark$

$G + j\omega C = 62 \times 10^{-6} + j\ 10\ 000 \times 0{,}0945 \times 10^{-6}$
$= 62 \times 10^{-6} + j\ 945$
$= 945 \times 10^{-6} \angle 86^{0}15' \checkmark$

$$Z_O = \frac{R + j\omega L}{G + j\omega C}$$
$$= \frac{78 + j10\ 000 \times 1{,}75 \times 10^{-3}}{62 \times 10^{-6} + j10\ 000 \times 0{,}0945 \times 10^{-6}}$$
$$= \frac{79{,}94}{947 \times 10^{-6}} \angle -36^{0}48'$$
i.e. $Z_O = 290 \angle -36^{0}48' \checkmark$ (3)

2.3.2 $\gamma = (R + j\omega L)(G + j\omega C)$

$= (79{,}94 \angle 12^{o}\ 39')(945 \times 10^{-6} \angle 86^{0}15')$
$= 79{,}94 \times 10^{-6} \times 947 \angle 49^{0}27')$
i.e. $\gamma = 0{,}275 \angle 49^{0}27')$

thus $\gamma = 0{,}179 + j\ 0{,}209$

α (In nepers) $= 0{,}179$ nepers per km✓

α (In decibels) = 1,56 dB per km✓ (2)

2.3.3 (Phase constant) $\beta = 0{,}209$ radians per km
$= 11^{o}\ 58'$ per km✓ (1)

2.3.4 (Wavelength) $\lambda = \frac{2\pi}{\beta}$
$$= \frac{2 \times 3{,}142}{0{,}209}$$
= 30 km✓ (1)

2.3.5 (Velocity) $v = \frac{\omega}{\beta}$

$= \frac{10\,000}{0{,}209}$

= 47 840 km per second✓ (1)

2.3.6 (Time taken) $t = \frac{displacement}{velocity}$

$= \frac{100}{47840}$

= 0,00209 seconds✓

= 2,09 milliseconds✓ (2)

[15]

QUESTION 3: ANTENNAS

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

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

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

(3 × 2) (6)

3.2 3.2.1 Polarisation refers to the direction in space of the electric vector of the electromagnetic wave radiated from an antenna and is parallel to the antenna itself.

3.2.2 Capture area refers to the effective receiving area of the parabolic reflector and may be calculated from the power received and its comparison with the power density of the signal being received.

3.2.3 Effective electrical length refers to the fact that antennas behave as though electrically they are taller than their physical height reason being the effect of top loading and their finite thickness instead of being infinitely thin.

(3 × 3) (9)

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3.3 $$Pt = \frac{(4 \times 3,142)^3 \times r^4 \times \Pr}{Gt \times Gr \times Q \times \lambda^3}$$

Path loss = 2 × distance × attenuation
= 2 × 120 × 0,008
= 1,92 dB✓

Hence Pt must be increased by 1,92 dB or multiplied by 1,556.

And r = 120 000 m

Also Gt = GR = 34 dB

D = 10 log N✓

N = Antilog $\frac{34}{10}$

$\therefore Q = 10\ m^2$✓

Pt = $\frac{(4 \times \pi)^3 \times r^4 \times \Pr}{Gt \times Gr \times Q \times \lambda^3}$ × Path loss✓

$= \frac{(4 \times 3,142)^3 \times (120 \times 10^3)^4 \times 10^{-13,5}}{(2512)^2 \times 10 \times (0,23)^2} \times 1,556$

= 6 kW✓ (5)
[20]

QUESTION 4: NOISE

4.1 Pulse-duration modulation gives better signal-to-noise performance because it uses a larger bandwidth to achieve better signal-to-noise ratio as noise affects mainly the trailing edge which carries the modulation. (4)

4.2 $$E_n = \sqrt{4 \times K \times T \times \Delta \times f \times R_1 + R_2}$$

$$= \sqrt{4(1,38 \times 10^{-23})(290 \times 6 \times 10^6)(300 + 200)}$$

$$= \sqrt{4(1,38 \times 10^{-23})(290 \times 6 \times 10^6)(500)}$$

= 6,9 µV (3)

4.3 4.3.1

$$F = 1 + \frac{R^{/}eg}{Ra}$$

$$= 1 + \frac{R_{eq} - R_t}{R_a} \checkmark$$

$$= 1 + \frac{2\,000 - 1000}{200} \checkmark$$

$$= 1 + \frac{1\,000}{200} \checkmark$$

$$= 6 \checkmark$$

$$\therefore 6 \text{ in decibels} = 10 \log_{10} 6$$

= 7,78 dB✓ (5)

4.3.2

$$F = 1 + \frac{Teg}{T_O}$$

$$6 = 1 + \frac{Teg}{298K}$$

T_{eq} = 5 × 298✓

= 1 490✓

= 1 217 °C✓ (3)

[15]

QUESTION 5: MODULATION AND DEMODULATION

5.1 A frequency-modulation system gives a considerable improvement in the signal-to-noise ratio obtained compared to that obtained by an amplitude-modulation system. (3)

5.2 Most radio-communication systems use angle modulation because of its immunity to amplitude varying noise. (3)

5.3
- Pulse-amplitude modulation (PAM)
- Pulse-duration modulation (PDM)
- Pulse-position modulation (PPM)
- Pulse-code modulation (PCM) (4)

5.4 Multiplexing is defined as the sending of a number of separate signals together, over the same cable, simultaneously without interference. (2)

5.5
- VHF broadcasting
- Satellite communication
- FM radar (3)

[15]

TOTAL: 100

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