higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N6

19 April 2021

This marking guideline consists of 9 pages.

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QUESTION 1

1.1 $$S^2 = \frac{R_1}{R_2}$$

$$S = \sqrt{\frac{600}{125}} \checkmark$$

$$= 2{,}191 \checkmark$$

$$40 = 20 \log N$$
$$\log N = 2$$
$$N = 100 \checkmark$$

$$R_A = \frac{R(N^2 - 1)}{N^2 - 2NS + 1}$$

$$R_A = \frac{600(10\,000 - 1)}{10\,000 - 2 \times 100 \times 2{,}191 + 1} \checkmark$$

$$= 627{,}5\ \Omega \checkmark$$

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

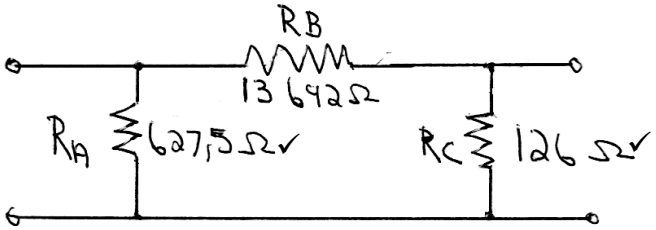
$$= \sqrt{\frac{600 \times 125}{2}\left(\frac{100^2 - 1}{100}\right)} \checkmark$$

$$= 13\,692\ \Omega \checkmark$$

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

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

$$= 126\ \Omega \checkmark$$



(11)

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

1.3 In older design theory, a filter was designed according to the theory and its characteristics were accepted as final. In the modern design approach, the filter is built up or synthesised bit by bit to provide the required characterises as closely as possible. (2)

1.4
- Negative-impedance converter (NIC)
- Gyrator (2)

[17]

QUESTION 2

2.1 A transmission line conveys signals or power from one point to another. (2)

2.2 2.2.1

$$Zo = \sqrt{\frac{L}{C}}$$

$$L = Zo^2C$$

$$= 75^2 \times 64 \times 10^{-12}\checkmark$$

$$= 3{,}6 \times 10^{-7}\checkmark$$

$$= 0{,}36\ \mu\text{H/m}\checkmark$$

$$Zo = \frac{138}{\sqrt{K}} \log \frac{D}{d}$$

$$\log\frac{D}{d} = \frac{Zo}{138/\sqrt{K}}$$

$$= \frac{75}{138/\sqrt{2{,}23}}\checkmark$$

$$= 0{,}81\checkmark$$ (5)

2.2.2 $D = d \times antilog\ 0{,}81$

$$= 0{,}584 \times 6{,}457\checkmark$$

$$= 3{,}77\ \text{mm}\checkmark$$ (2)

2.3 No, an attenuator only consists of resistive components, which are not frequency sensitive. (1 + 2) (3)

2.4

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

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

$$8 \times 103 = \sqrt{300 \cdot R_1} \cdot \left[\frac{10^2-1}{10}\right]$$

$$8 \times 103 = \sqrt{300 \cdot R_1} \times [9{,}9] \checkmark$$

$$\sqrt{300 \cdot R_1} = 808{,}081 \checkmark$$

$$300R1 = 652{,}995 \times 103 \checkmark$$

$$\therefore R1 = 2{,}177\ k\Omega \checkmark$$ (4)

[16]

QUESTION 3

3.1 A vertically polarised antenna has an electric field radiated vertically causing the radiated wave to be vertically polarised. A horizontally polarised antenna has an electric field radiated horizontally causing the radiated wave to be horizontally polarised. (2 × 2) (4)

3.2 3.2.1

$$Es = \sqrt{\frac{(30\ Pt)(Gt)}{di}}$$

$$= \sqrt{\frac{30 \times 10 \times 10^3 \times 316{,}227}{5\,000 \times 10^3}} \checkmark$$

$$= 1{,}948 \times 10^{-3}\ V/m \checkmark$$

$$dB = 10 \log\ Gr$$

$$Gr = \text{antilog}\frac{db}{10}$$

$$\text{antilog} = \frac{25}{10} \checkmark$$

$$Gr = 316{,}227 \checkmark$$ (4)

3.2.2 $$P'd = \frac{Es^2}{120\pi}$$

$$= \frac{(1{,}948 \times 10^{-3})^2}{120\pi} \checkmark$$

$$= 1{,}0066 \times 10^{-3}\ \text{W/m}^2 \checkmark \quad (2)$$

3.2.3 $$\text{Pr} = \frac{10Pt \times Gt}{\pi d^2}$$

$$= \frac{10 \times 10 \times 10^3 \times 316{,}227}{4\pi \times (5\,000 \times 10^3)^2} \checkmark$$

$$= 1{,}00658 \times 10^{-3}\ \text{W/m}^2 \checkmark \quad (2)$$

3.2.4 $$Er = \sqrt{\frac{30Pr}{d}}$$

$$= \sqrt{\frac{30 \times 1{,}00658 \times 10^{-7}}{5\,000 \times 10^3}} \checkmark$$

$$= 3{,}475 \times 10^{-10}\ \text{V/m} \checkmark \quad (2)$$

3.2.5 $$Pd = \frac{Es^2}{120\pi}$$

$$= \frac{(3{,}475 \times 10^{-10})^2}{120\pi} \checkmark$$

$$= 3{,}204 \times 10^{-22}\ \text{W/m}^2 \checkmark \quad (2)$$

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3.2.6 $Si = d \times A$

$= Gr \times \frac{\gamma^2}{4\pi}$

$= 316{,}227 \times \frac{0{,}62^2}{4\pi}$

$= 9{,}059\ \text{m}^2$✓

$\gamma = \frac{3 \times 10^8}{F}$

$= \frac{3 \times 10^8}{500 \times 10^3}$

$= 0{,}6\ \text{m}$✓

$\therefore Si = Pd \times A$✓

$= 3{,}204 \times 10^{-22} \times 9{,}059$✓

$= 2{,}9026 \times 10^{-21}\ \text{W}$✓ (5)

[21]

QUESTION 4

4.1 Thermal agitation noise is generated in a receiver by the rapid and random motion of the molecules, atoms and electrons that increase with temperature according to simplified atomic theory in all types of materials used to construct such resistors. (5)

4.2 $F = 1 + \frac{Req}{Ra}$

$= 1 + \frac{30}{50}$✓

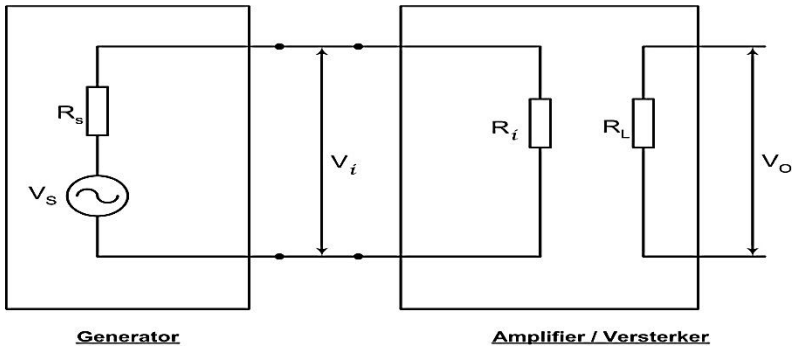
$= 1{,}6$✓

$10 \log 1{,}6 = 10 \times 0{,}204 = 2{,}04\ \text{dB}$✓

$Teq = To(F - 1) = 290(1{,}6\ - 1)$✓

$= 290 \times 0{,}6$✓
$= 174\ \text{K}$✓ (6)

4.3



(4)

4.4

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

$$\therefore R'_{eq} = R_a\,(F - 1)$$

$$= 50(41 - 1)$$
$$= 2\ k\Omega\checkmark\checkmark$$

$$R'_{eq} = R_{eq} - R_t$$

$$\therefore R_t = R_{eq} - R'_{eq}$$
$$= 9 \times 10^3 - 2 \times 10^3$$
$$= 7\ k\Omega\checkmark\checkmark$$

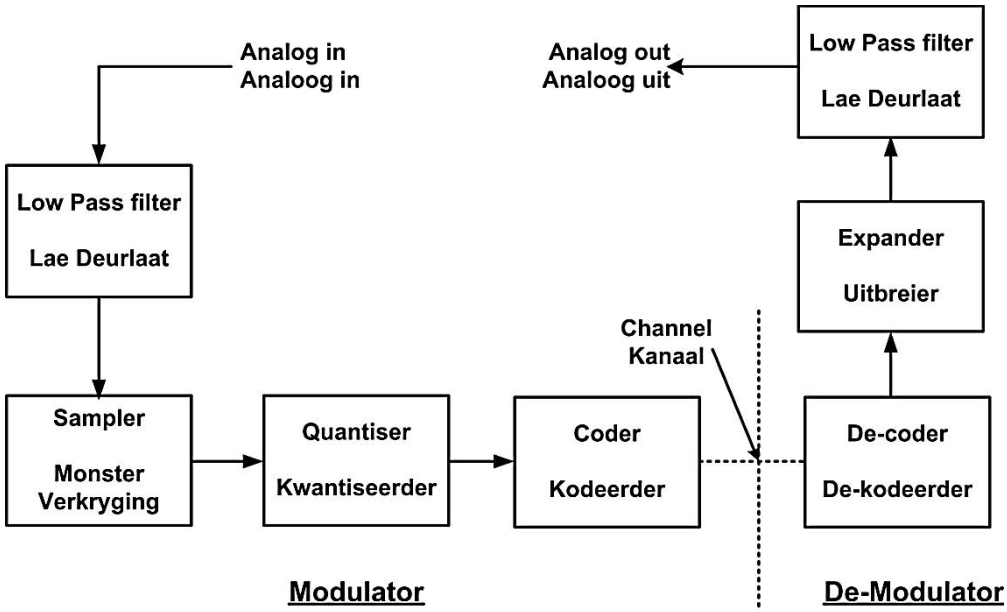
(4)
[19]

QUESTION 5

5.1 5.1.1 In pulse amplitude modulation (PAM), the amplitude of a train of digital pulses is varied in proportion to the amplitude of the modulating signal. (1)

5.1.2 In pulse position modulation (PPM), the amplitude and width of the pulses are kept constant, while the position of each pulse, in relation to the position of a recurrent reference pulse, is varied by each instantaneous sampled value of the modulating wave. (2)

5.2



(10)
[13]

QUESTION 6

6.1 $$E_S = \frac{\sqrt{30.P_t.G}}{d}$$

$$= \frac{\sqrt{30 \times 60 \times 10^3 \times 15}}{150 \times 10^3} \checkmark$$

$$= 34{,}641 \times 10^{-3} \text{ V/m}^2 \checkmark\checkmark$$ (3)

6.2 $$P_d' = \frac{E_s^2}{120.\pi}$$

$$= \frac{\left(34{,}641 \times 10^{-3}\right)^2}{120 \times 3{,}142} \checkmark$$

$$= 3{,}183 \times 10^{-6} \text{ W/m}^2 \checkmark$$ (2)

6.3 $$P_{reflected} = \frac{10.P_t.G}{4\pi d^2}$$

$$= \frac{10 \times 60 \times 10^3 \times 15}{4 \times 3,142 \times \left(150 \times 10^3\right)^2} \checkmark$$

$$= 31,827 \times 10^{-6} \text{ W} \checkmark \quad (2)$$

6.4 $$E_r = \sqrt{\frac{30.P_{reflected}}{d}}$$

$$= \sqrt{\frac{30 \times 31,827 \times 10^{-6}}{150 \times 10^3}} \checkmark$$

$$= 79,783 \times 10^{-6} \text{ volt/m}^2 \checkmark \quad (2)$$

6.5 $$P_d = \frac{E_r^2}{120.\pi}$$

$$= \frac{\left(79,783 \times 10^{-6}\right)^2}{120 \times 3,142} \checkmark$$

$$= 16,882 \times 10^{-12} \text{ W/m}^2 \checkmark \quad (2)$$

6.6 $$\lambda = \frac{C}{f}$$

$$= \frac{3 \times 10^8}{950 \times 10^6}$$

$$= 0,316 \text{ m} \checkmark$$

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

$$= \frac{0,316 \times 15}{4 \times 3,142}$$

$$= 0,377 \text{ m}^2 \checkmark$$

$$P_r = Pd \times A$$

$$= 16,882 \times 10^{-12} \times 0,377$$

$$= 6,365 \times 10^{-12} \text{ W} \checkmark \quad (3)$$

[14]

TOTAL: 100

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