higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N5

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This marking guideline consists of 9 pages.

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QUESTION 1: AC NETWORKS

1.1 1.1.1

$$C = \frac{1}{(2\pi f)^2 L}$$
$$= \frac{1}{(2\pi \text{ x } 45\text{x}10^6)^2\text{x}100\text{x}10^{-6}} \checkmark$$
$$= 0{,}125 \text{ pF} \checkmark\checkmark \quad (3)$$

1.1.2

$$ZD = \frac{L}{CR}$$
$$= \frac{100\text{x}10^{-6}}{0{,}125\text{x}10^{-12}\text{x}12}$$
$$= 66{,}667 \text{ M}\Omega \checkmark\checkmark \quad (2)$$

1.1.3

$$C = \frac{1}{(2\pi f)^2 L}$$
$$= \frac{1}{(2\pi\text{x } 48\text{x}10^6)^2\text{x}100\text{x}10^{-6}}$$
$$= 0{,}11 \text{ pF} \checkmark\checkmark$$

$$C_T = 0{,}125\text{x}10^{-12} - 0{,}11\text{x}10^{-12}$$
$$= 0{,}015 \text{ pF} \checkmark$$
Thus subtract 0,015 pF ✓ (4)

1.1.4

$$Q_1 = \frac{1}{R}\sqrt{\frac{L}{C}}$$
$$= \frac{1}{12}\sqrt{\frac{100\text{x}10^{-6}}{0{,}125\text{x}10^{-12}}}$$
$$= 2357{,}023 \checkmark\checkmark$$

$$Q_2 = \frac{1}{R}\sqrt{\frac{L}{C}}$$
$$= \frac{1}{12}\sqrt{\frac{100\text{x}10^{-6}}{0{,}11\text{x}10^{-12}}}$$
$$= 2512{,}595 \checkmark\checkmark \quad (4)$$

1.2 $Q = \frac{2\pi(\text{maximum energy stored during one cycle})}{\text{energy dissipated during one cycle}}$ ✓

But max. energy stored by $C = \frac{1}{2}C(\sqrt{2}\,V)^2$ ✓ ….. a capacitor store voltage

$= CV^2$ ….. but $V = I.Xc$

Substituting:

$= C(I.Xc)^2$ ….. ….. but $Xc = \frac{1}{\omega c}$ ✓

$$= C\left(I.\frac{1}{\omega c}\right)^2$$

$$= \frac{I^2}{\omega^2 c}$$ ✓

Energy dissipated per cycle: $t = \frac{1}{f}\text{sec}$

$= \frac{I^2R}{F}$ ✓

Substituting:

$$Q = \frac{2\pi\left(\frac{I^2}{\omega^2 c}\right)}{\frac{I^2R}{F}}$$ ✓

$= \frac{2\pi I^2}{\omega^2 c} \times \frac{F}{I^2R}$ ✓ ….. but $\omega = 2\pi F$

$= \frac{2\pi F}{(2\pi F)^2 c} \times \frac{1}{R}$ ✓

$= \frac{1}{2\pi Fc} \times \frac{1}{R}$ ✓ ….. but $\frac{1}{2\pi Fc} = Xc$

Substituting:

$= Xc \times \frac{1}{R}$

$Q = \frac{Xc}{R}$ ✓

(10)
[23]

QUESTION 2: GENERAL

2.1 Minimum

2.2 (a) Power
(b) Voltage

2.3 Image impedances

2.4 Selectivity

2.5 (a) Telecommunications
(b) Audio signals

2.6 Modulated

2.7 AM

2.8 0,115

(10 × 1) **[10]**

QUESTION 3: FOUR TERMINAL NETWORKS

3.1 Is used for matching purposes only and is designed to give minimum attenuation. (2)

3.2 $\mathrm{Ra} = \mathrm{Ro} = \mathrm{Zo}$

$\mathrm{Rb} = \mathrm{Ro(N\text{-}1)} \ldots\ldots\ldots\ldots\ldots$ but $\mathrm{dB} = 20\log \mathrm{N}$

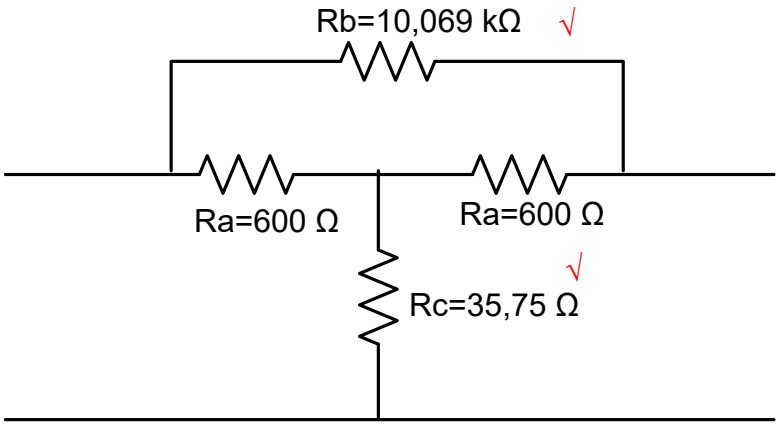
$= 600(17{,}783 - 1)$ $\mathrm{N} = \mathrm{antilog}\frac{25}{20}$

$= 10{,}069\ \mathrm{k\Omega}$ ✓✓ $= 17{,}783$ ✓✓

$$\mathrm{Rc} = \frac{\mathrm{Ro}}{\mathrm{N} - 1}$$

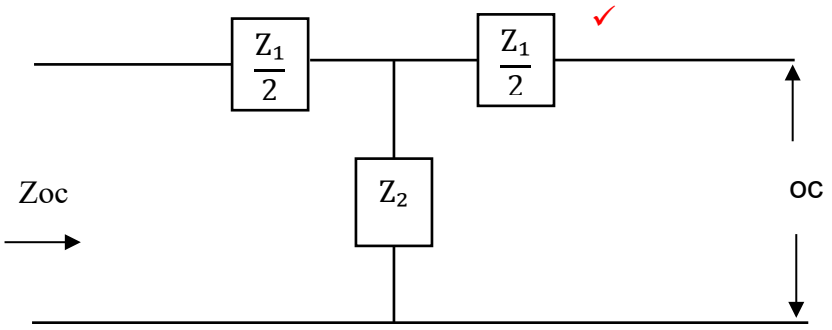
$$= \frac{600}{17{,}783 - 1}$$

$= 35{,}75\ \Omega$ ✓✓



(8)

3.3 Make use of the open circuit impedance:



$Zoc = \frac{Z_1}{2} + Z_2$ ✓ ...and square the formula in both sides ... . eq(1)

$(Zoc)^2 = \left(\frac{Z_1}{2} + Z_2\right)^2$

$= \left(\frac{Z_1}{2} + Z_2\right)\left(\frac{Z_1}{2} + Z_2\right)$

$= \frac{{Z_1}^2}{4} + \frac{Z_1Z_2}{2} + \frac{Z_1Z_2}{2} + {Z_2}^2$

$= \frac{{Z_1}^2}{4} + Z_2Z_2 + {Z_2}^2$ ✓

Make Z2 the subject of the formula:

${Z_2}^2 = Zoc^2 - \left(\frac{{Z_1}^2}{4} + Z_1Z_2\right)$ ✓ but $Zoc^2 = \frac{{Z_1}^2}{4} + Z_1Z_2 = Zoc.Zsc$ ✓

Substitute:

${Z_2}^2 = Zoc^2 - Zoc.Zsc$
$= \sqrt{Zoc^2 - Zoc.Zsc}$ ✓
$Z_2 = \sqrt{Zoc(Zoc - Zsc)}$ ✓

Make use of equation 1 and make Z_1 the subject of the formula

$Zoc = \frac{Z_1}{2} + Z_2$
$\frac{Z_1}{2} = Zoc - Z_2$ ✓
$Z_1 = 2(Zoc - Z_2)$ ✓ but $Z_2 = \sqrt{Zoc(Zoc - Zsc)}$ ✓

Substitute:

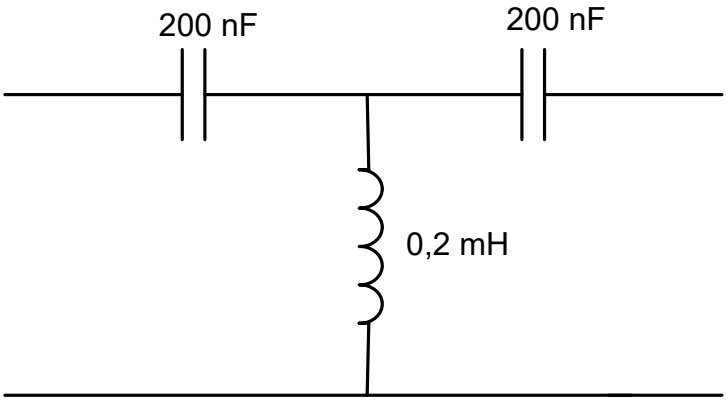
$Z_1 = 2\left[Zoc - \sqrt{Zoc(Zoc - Zsc)}\right]$ ✓

(11)
[21]

QUESTION 4: FILTERS

4.1 Constant K-filter is a simple t-network or π-network and it does not have a sharp cut off frequency. (2)

4.2



$$Z_{OT} = \sqrt{\frac{Z1^2}{4} + Z1Z2} \checkmark \quad \text{but } Z1 = \frac{1}{j\omega C} \checkmark \text{ and } Z2 = j\omega L \checkmark$$

Substitute:

$$= \sqrt{\frac{\left(\frac{1}{j\omega C}\right)^2}{4} + \frac{1}{j\omega C} x \frac{j\omega L}{}} \checkmark$$

$$= \sqrt{-\frac{1}{4\omega^2 C^2} + \frac{L}{C}}$$

$$= \sqrt{\frac{L}{C} - \frac{1}{4\omega^2 C^2}}$$

$$= \sqrt{\frac{L}{C}\left(1 - \frac{1}{4\omega^2 LC}\right)}$$

$$= \sqrt{\frac{L}{C}} x \sqrt{1 - \frac{1}{4\omega^2 LC}} \checkmark$$

Thus if $\frac{1}{\omega^2 LC} < 1$, then Zoт will be real, but if $\frac{1}{\omega^2 LC} > 1$, then Zoт will be imaginary. ✓

$$= \sqrt{\frac{0{,}2x10^{-3}}{100x10^{-9}}} x \sqrt{1 - \left(\frac{1}{4(2\pi x3x10^3)x0{,}2x10^{-3}x100x10^{-9}}\right)} \checkmark$$

$$= \sqrt{2000}\ x\sqrt{1-(35{,}181)} \checkmark$$

$$Zo_T = 44{,}721\ x\ \sqrt{1-(35{,}181)} \checkmark$$

Therefore Zoт is imaginary as $\frac{1}{4\omega^2 LC} > 1$ ✓ (10)

[12]

QUESTION 5: TRANSMITTERS AND RECEIVERS

5.1
- The upper sideband (USB)
- The carrier frequency (FC)
- The lower sideband (LSB) (3)

5.2 5.2.1

$$P_T = P_C\left(1 + \frac{m^2}{2}\right)$$

$$m^2 = 2\left(\frac{P_T}{P_C} - 1\right)$$

$$m^2 = 2\left(\frac{16x10^3}{12x10^3} - 1\right) \checkmark$$

$$= \sqrt{0{,}667}$$

$$= 0{,}816 \checkmark$$ (2)

5.2.2

$$m_T = \sqrt{m_1{}^2 + m_2{}^2}$$

$$= \sqrt{0{,}816^2 + 0{,}2^2}$$

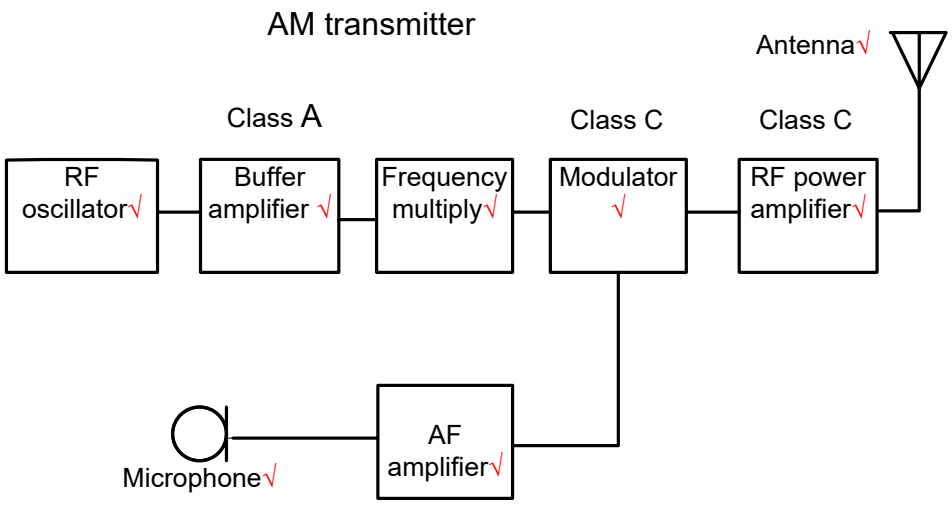
$$= 0{,}841 \checkmark$$

$$P_T = P_C\left(1 + \frac{m^2}{2}\right)$$

$$= 12x10^3\left(1 + \frac{0{,}841^2}{2}\right) \checkmark$$

$$= 16{,}244\ kW \checkmark$$ (3)

5.3



- RF oscillator generates a constant amplitude RF which will be modulated and transmitted.✓
- Buffer amplifier isolates the oscillator from load variations in other parts of the transmitter and provides stability to the oscillator.✓
- Frequency multiplier multiply the oscillator's output frequency to the required carrier frequency for transmission✓
- Modulator superimposes the audio signal onto the radio frequency carrier wave✓
- RF power amplifier amplifiers the RF modulated carrier wave to drive the antenna at the rated output power.✓
- Microphone converts mechanical sound waves to electrical currents for amplification by the audio amplifier.✓
- AF amplifier amplifiers the AF signals from the microphone to the required value for superimposing the RF by the modulator.✓
- Antenna converts the electrical current RF signals into electro-magnetic energy which is radiated into space.✓ (16 × 1) (16)

[24]

QUESTION 6: ANTENNAS

6.1
- Wider bandwidth
- Higher input impedance
- Less noise in the received signals
- Has a balanced line feed (Any 2 x 1) (2)

6.2 It is a unidirectional antenna used in commercial point-to-point HF communication. (2)

6.3 Directive gain is the ratio of power density radiated in a particular direction compared to the power density that would be radiated by the isotropic antenna. (2)

[6]

QUESTION 7: BODE PLOTS

7.1 Bode diagrams are an approximation of the frequency and phase response of an RC circuit. (2)

OR

Bode diagrams are graphs of the frequency response of a system. They are usually a combination of a Bode magnitude plot, expressing the magnitude of the frequency response and a Bode phase plot, expressing the phase shift

7.2 Phase lead and lag network controllers are used to improve the accuracy of bandwidths and provide amplifier stability. (2)
[4]

TOTAL: 100

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