higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## COMMUNICATION-ELECTRONICS N6

## 14 April 2020

**This marking guideline consists of 11 pages.**

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## QUESTION 1

1.1 **Series L** = $\dfrac{Z_0}{2\pi[f_2 - f_1]}$

= $\dfrac{600}{2\times 3{,}142\left[3{,}2\times 10^3 - 2\times 10^3\right]}$

= **79,567 mH**✓

**Series C** = $\dfrac{f_2 - f_1}{2.\pi.Z_0.f_1.f_2}$

= $\dfrac{3{,}2\times 10^3 - 2\times 10^3}{2\times 3{,}142\times 600\times 2\times 10^3\times 3{,}2\times 10^3}$

= **49,729 nF**✓

**Shunt L** = $\dfrac{Z_0\,[f_2 - f_1]}{4.\pi.f_1.f_2}$

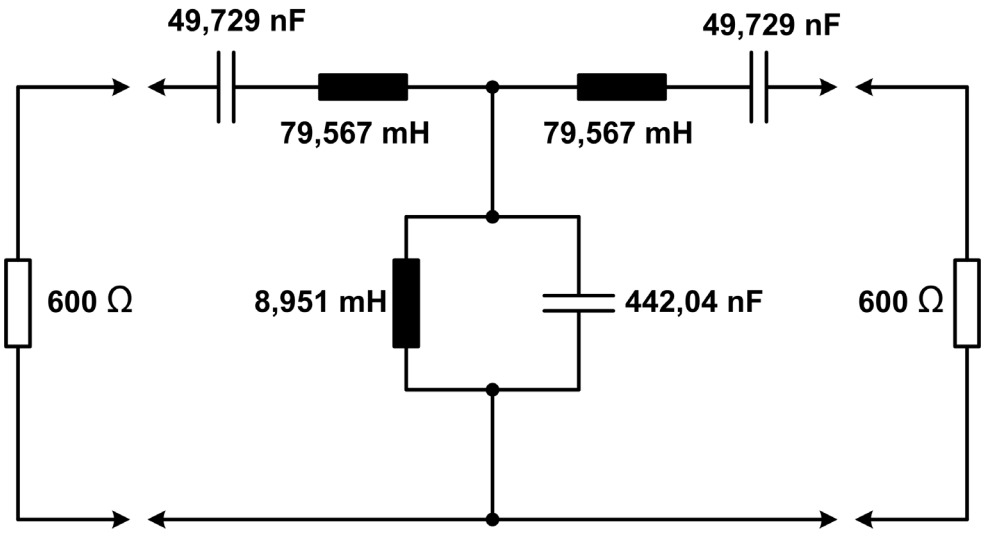
= $\dfrac{600\left[3{,}2\times 10^3 - 2\times 10^3\right]}{4\times 3{,}142\times 2\times 10^3\times 3{,}2\times 10^3}$

= **8,951 mH**✓

**Shunt C** = $\dfrac{1}{\pi.Z_0\,[f_2 - f_1]}$

= $\dfrac{1}{3{,}142\times 600\times\left[3{,}2\times 10^3 - 2\times 10^3\right]}$

= **442,04 nF**✓




✓✓ (6)

1.2 **Series L** = $\frac{Z_o\,(f_2 - f_1)}{2.\pi.f_1.f_2}$

$= \frac{600(10000 - 7500)}{2 \times 3{,}142 \times 10 \times 10^3 \times 7{,}5 \times 10^3}$

**= 3,183 mH**✓

**Series C** = $\frac{1}{2.\pi.Z_o\,(f_2 - f_1)}$

$= \frac{1}{2 \times 3{,}142 \times 600 \times (10000 - 7500)}$

**= 106,09 nF**✓

**Shunt L** = $\frac{Z_o}{4.\pi.(f_2 - f_1)}$

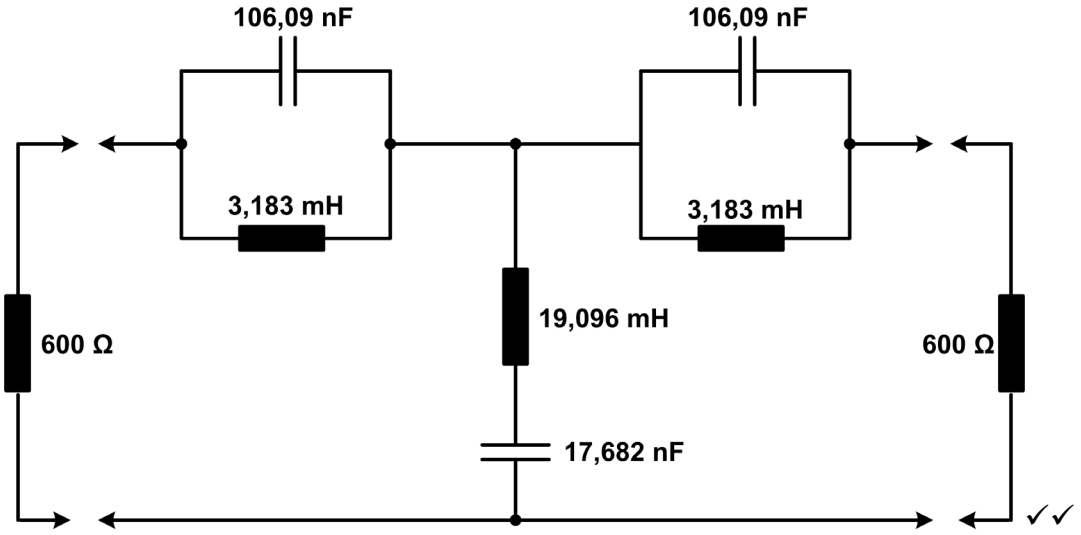
$= \frac{600}{4 \times 3{,}142 \times (10000 - 7500)}$

**= 19,096 mH**✓

**Shunt C** = $\frac{f_2 - f_1}{\pi.Z_o.f_1.f_2}$

$= \frac{10000 - 7500}{3{,}142 \times 600 \times 10000 \times 7500}$

**= 17,682 nF**✓




✓✓ (6)

1.3 $L = \frac{Z_o}{\pi . f_c}$

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

**= 58,757 m**✓

$C = \frac{1}{\pi . Z_o . f_c}$

$= \frac{1}{3,142 \times 600 \times 3,25 \times 10^3}$

**= 163,215 nF**✓

Shunt $C = \frac{m.C}{2}$

$= \frac{0,6 \times 163,215 \times 10^{-9}}{2}$

**= 48,965 nF**✓

Series L = m.L

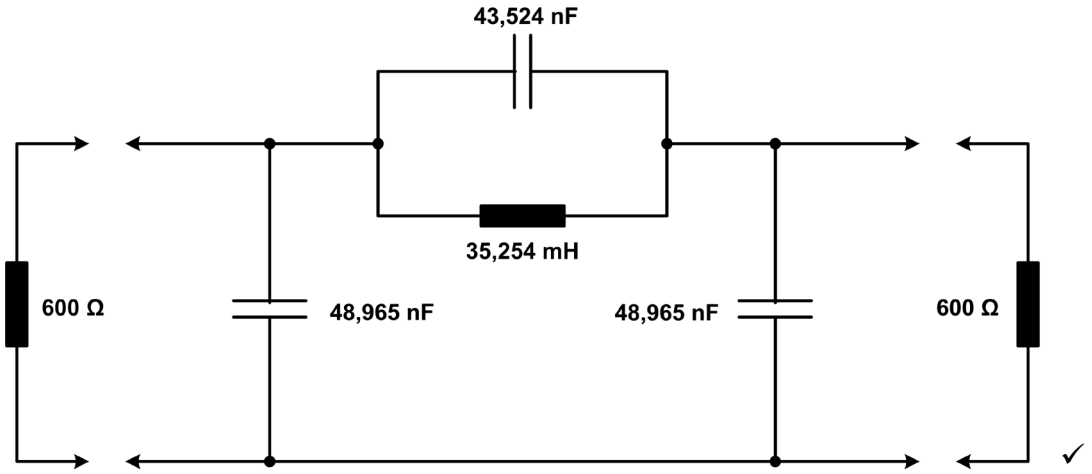
$= 0,6 \times 58,757 \times 10^{-3}$

**= 35,254 mH**✓

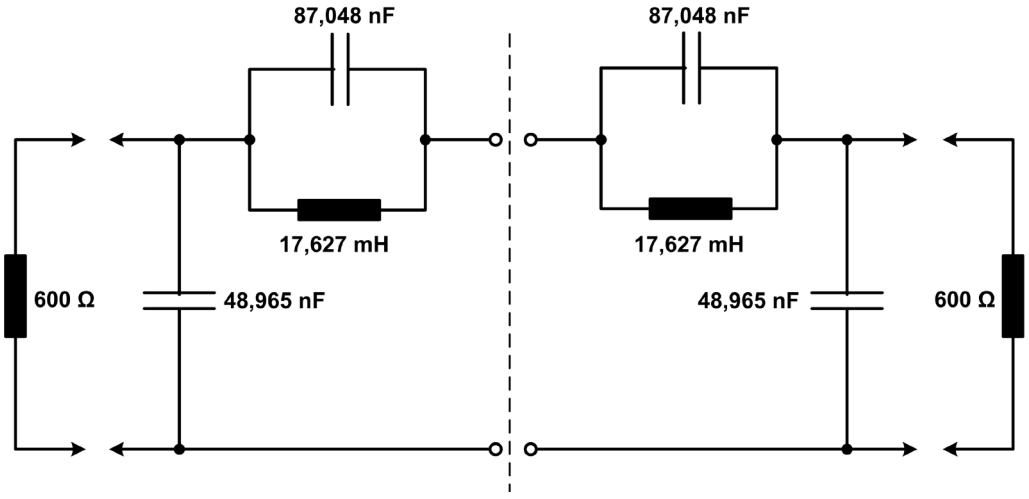
Series $C = \frac{1-m^2}{4m} \cdot C$

$= \frac{1-0,6^2}{4 \times 0,6} \times 163,215 \times 10^{-9}$

**= 43,524 nF**✓




✓

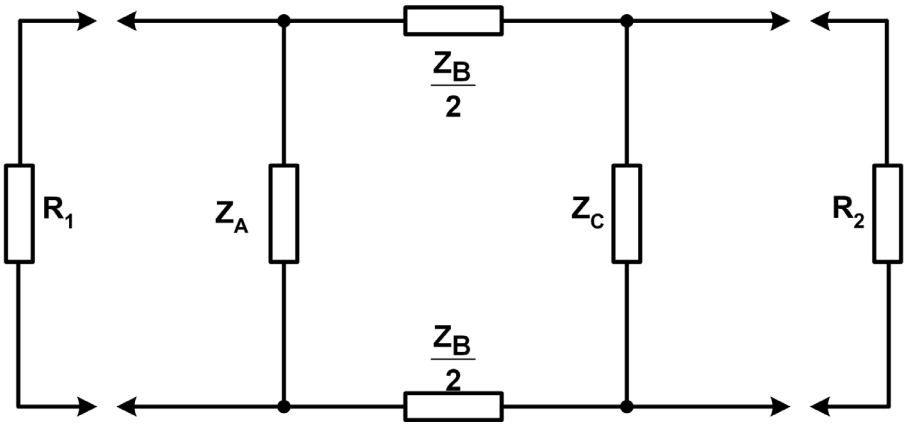



✓ (7)

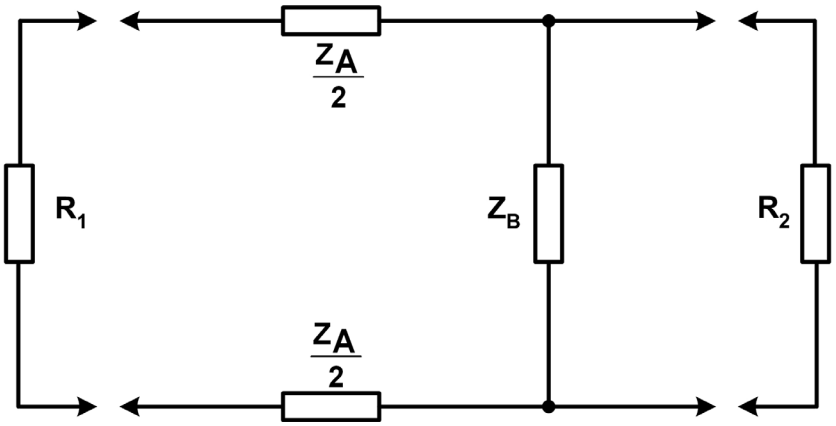
**[19]**

## QUESTION 2

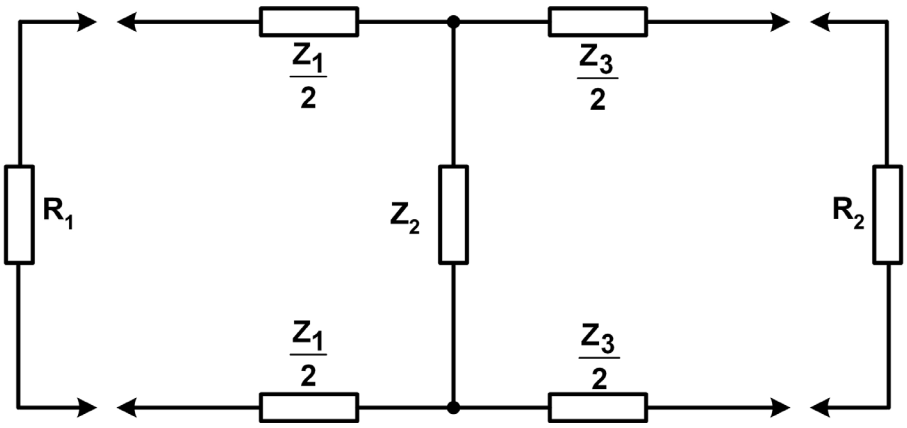
2.1 2.1.1




2.1.2




2.1.3




(3 × 2) (6)

2.2 **$N_A$ for 3 dB:**

$dB = 20 \log N_A$

$\therefore N_A = anti\text{-}log \frac{dB}{20}$

$= anti\text{-}log \frac{3}{20}$

$= \mathbf{1,413}$✓

$\mathbf{Z_B} = Z_o(N_A - 1)$

$= 600(1,413 - 1)$

$= \mathbf{247,8\ \Omega}$✓

$\mathbf{Z_C} = \frac{Z_0}{N_A - 1}$

$= \frac{600}{1,413 - 1}$

$= \mathbf{1,453\ k\Omega}$✓

**$N_B$ for 5 dB:**

$dB = 20 \log N_B$

$\therefore N_B = anti\text{-}log \frac{dB}{20}$

$= anti\text{-}log \frac{5}{20}$

$= \mathbf{1,778}$✓

$\mathbf{Z_B} = Z_o(N_B - 1)$

$= 600(1,778 - 1)$

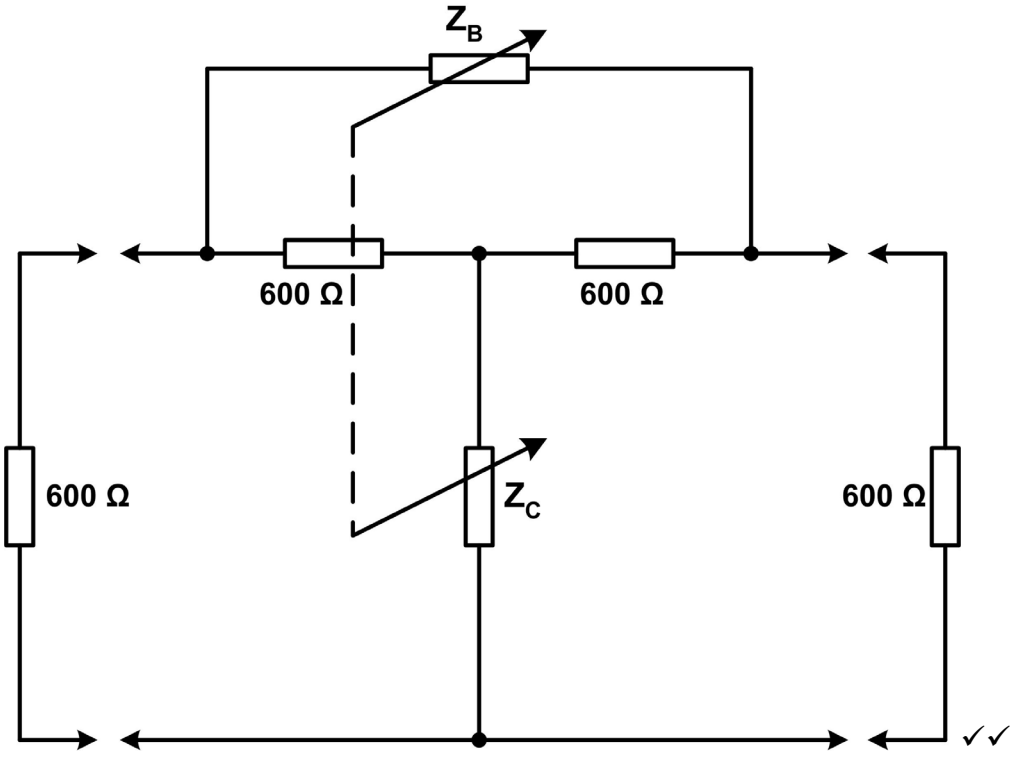
$= \mathbf{466,8\ \Omega}$✓

$\mathbf{Z_C} = \frac{Z_0}{N_B - 1}$

$= \frac{600}{1,778 - 1}$

$= \mathbf{771,208\ \Omega}$✓

$\therefore Z_B$ should be variable between 247,8 Ω to 466,8 Ω.
$\therefore Z_C$ should be variable between 771,208 Ω to 1,453 kΩ.




✓✓ (8)
**[14]**

## QUESTION 3

3.1 3.1.1

$$\textbf{SWR} = \frac{Z_L}{Z_o}$$

$$= \frac{750}{600}$$

$$= \textbf{1,25}\checkmark$$ (1)

3.1.2

$$\rho = \frac{Z_L - Z_o}{Z_L + Z_o}$$

$$= \frac{300 + j450 - 600 - j0}{300 + j450 + 600 + j0}$$

$$= \frac{-300 + j450}{900 + j450}$$

$$= \frac{540,833\angle 123,7^0}{1006,231\angle 26,6^0}$$

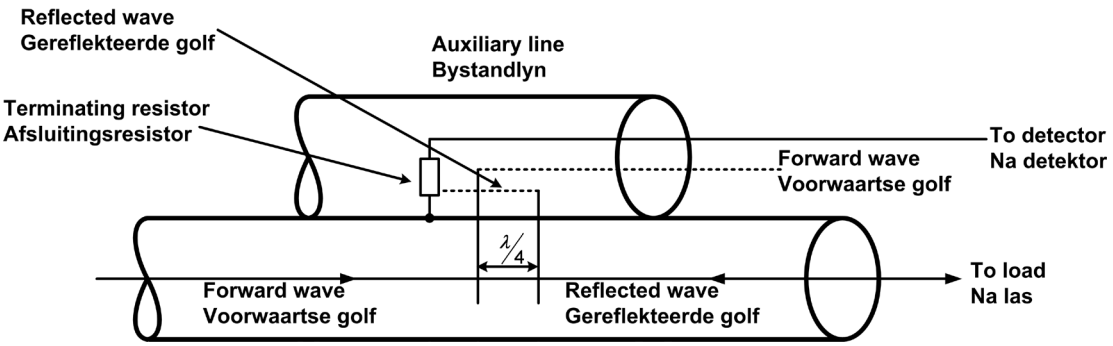
$$= \textbf{0,537}\angle 97,1^0\ \checkmark\checkmark$$

$$\therefore \textbf{SWR} = \frac{1+\rho}{1-\rho}$$

$$= \frac{1+0,537}{1-0,537}$$

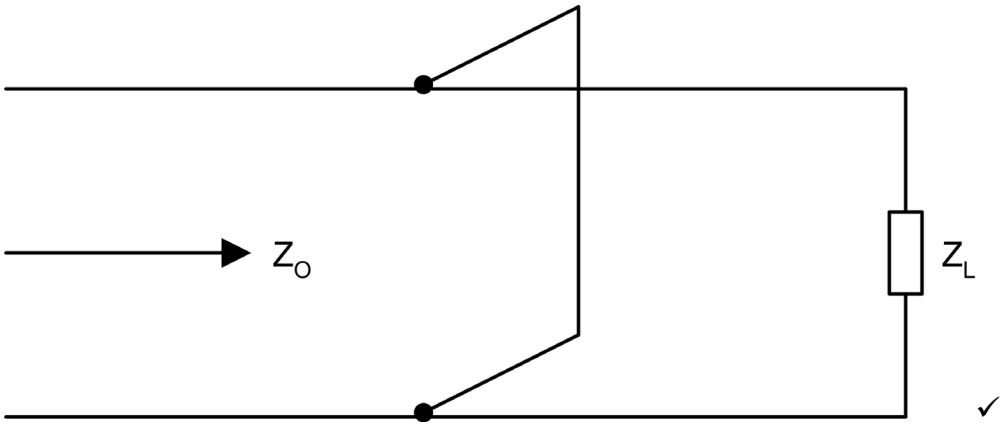
$$= \textbf{3,32}\checkmark\checkmark$$ (4)

3.2




(8)

3.3




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

**[17]**

**QUESTION 4**

4.1 4.1.1

$$R_{eq} = R_A + \frac{R_B}{A_1^2} + \frac{R_c}{A_1^2 \cdot A_2^2}$$

$R_A = R_{1(IN)} + R_{1(eq)}R_C$ $= R_{2(OUT)}$

$= 9 \times 10^3 + 12 \times 10^3$ **$= 30\ M\Omega$✓**

**$= 21\ k\Omega$✓**

$$R_B = \frac{R_{1(OUT)} \cdot R_{2(IN)}}{R_{1(OUT)} + R_{2(IN)}} + R_{2(eq)}$$

$$= \frac{18\times10^3 \times 20\times10^3}{\left(18\times10^3\right) + \left(20\times10^3\right)} + 15\times10^3$$

**$= 24{,}474\ k\Omega$✓✓**

$$\therefore R_{eq} = R_A + \frac{R_B}{A_1^2} + \frac{R_c}{A_1^2 \cdot A_2^2}$$

$$= 21\times10^3 + \frac{24{,}474\times10^3}{10^2} + \frac{30\times10^6}{10^2 \times 15^2}$$

**$= 22{,}578\ k\Omega$✓** (5)

4.1.2 $E_n = \sqrt{4.K.T.\Delta f.R}$

$= \sqrt{4 \times 1{,}38\times10^{-23} \times 298 \times 9\times10^6 \times 22{,}578\times10^3}$

**$= 57{,}815\ \mu V$✓✓** (2)

4.2 $En_1 = \sqrt{4.K.T.\Delta f.R}$

$$= \sqrt{4 \times 1{,}38\times10^{-23} \times (273 + 24) \times \left(30\times10^{3} - 21\times10^{3}\right) \times 27\times10^{3}}$$

$$= \mathbf{1{,}996\ \mu V}\checkmark$$

$En_2 = \sqrt{4.K.T.\Delta f.R}$

$$= \sqrt{4 \times 1{,}38\times10^{-23} \times (273 + 18) \times 9\times10^{3} \times 27\times10^{3}}$$

$$= \mathbf{1{,}976\ \mu V}\checkmark$$

The difference in noise voltage = $\mathbf{En_1 - En_2}$
$= \mathbf{20\ nV}\checkmark$ (3)

4.3 4.3.1 The ratio of signal power to noise power at the same point in a circuit

$$S/N = \frac{E_s^{\,2}}{E_N^{\,2}}$$

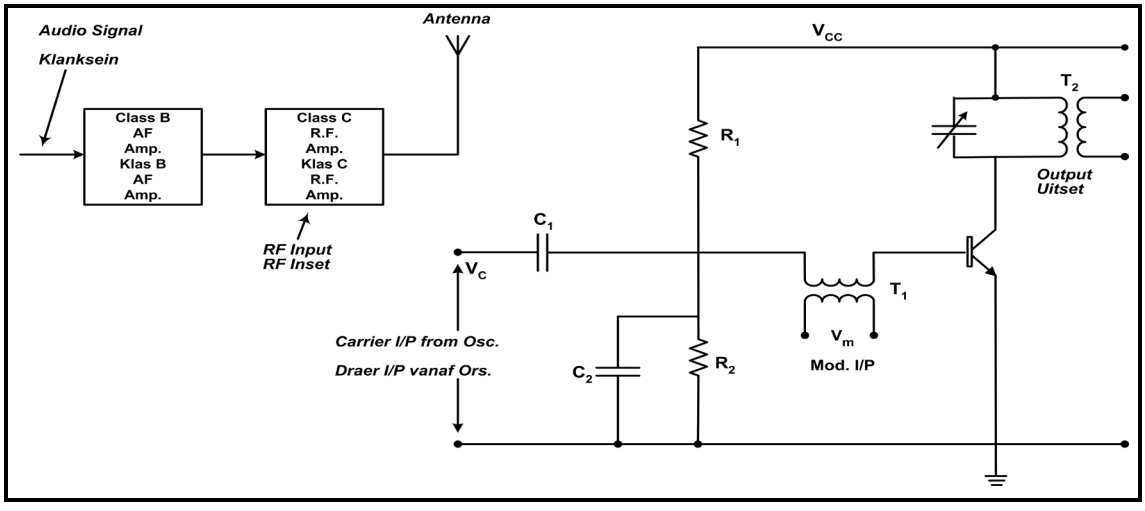
4.3.2 The ratio of signal-to-noise at the input to signal-to-noise at the output

$$F = \frac{S/N_{IN}}{S/N_{OUT}}$$

(2 × 3) (6)
**[16]**

## QUESTION 5

5.1

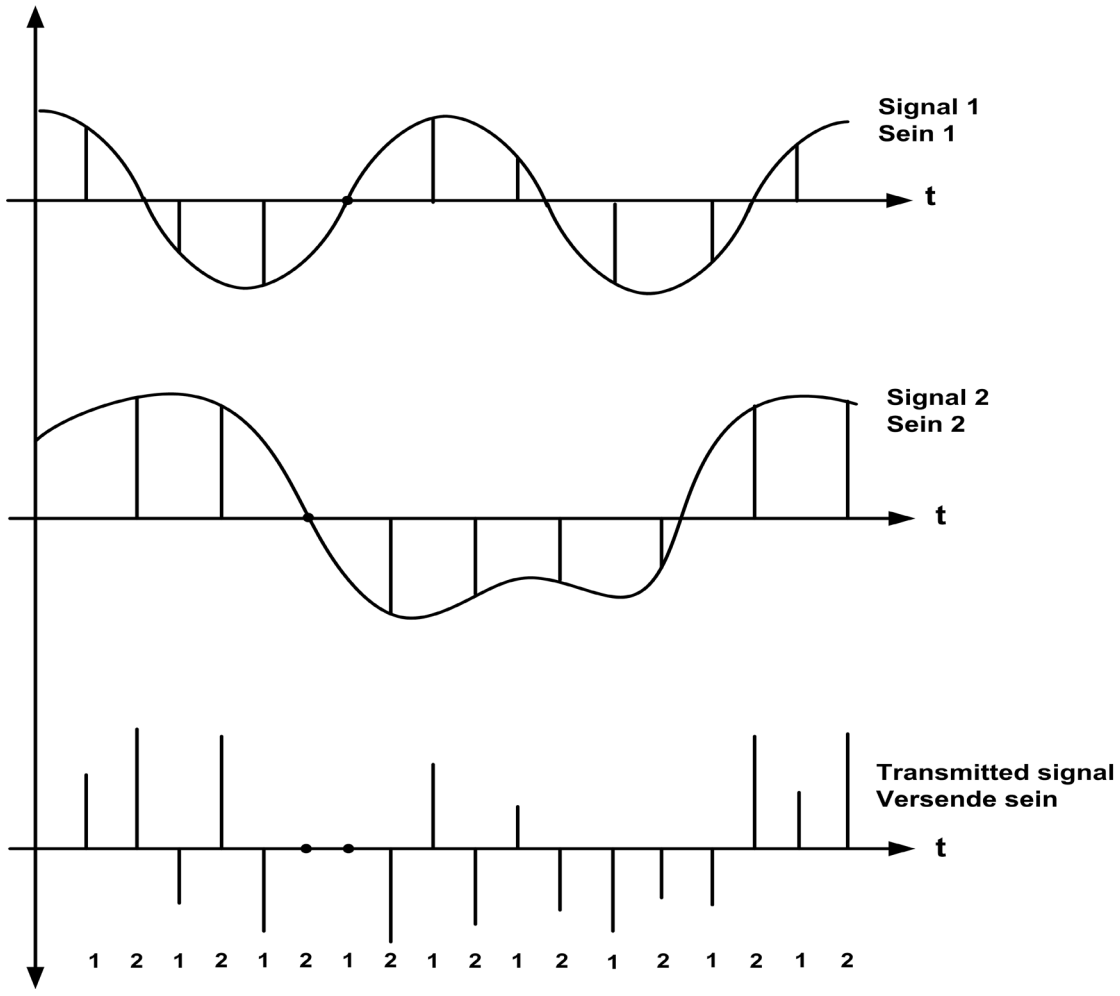



(7)

5.2 The carrier voltage $V_C$ is applied to the base of $Q_1$ and is constant in the absence of a modulating signal $V_m$. Class C bias is supplied by the ratio $R_1/R_2$. When a modulating voltage $V_m$ is applied via $T_1$ the base voltage will vary in sympathy and an AM output is obtained via $T_2$. (5)

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5.3 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)
**[18]**

## QUESTION 6

6.1 True (1)

6.2 The angular separation between the two half-power points (-3 dB) on the radiation pattern of an antenna (2)

6.3 6.3.1 The plane in which the electrical field is radiated from the antenna

6.3.2 A theoretical antenna that radiates equal energy in all directions (2 × 2) (4)

6.4 Path loss = $2 \times 100 \times 0{,}002$
**= 0,4 dB✓**

$$\text{Path loss} = \text{antilog}\ \frac{\text{dB}}{10}$$
$$= \text{antilog}\ \frac{0{,}4}{10}$$
**= 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✓✓✓** (9)
**[16]**

**TOTAL: 100**

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