



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

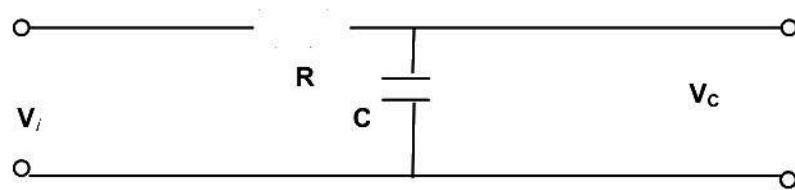
INDUSTRIAL ELECTRONICS N5

4 April 2024

This marking guideline consists of 9 pages.

QUESTION 1: ALTERNATING CURRENT THEORY

1.1



Low-pass filter

(One mark each for the resistor and capacitor, half mark each for the input and output) (3)

1.2

1.2.1

Greater

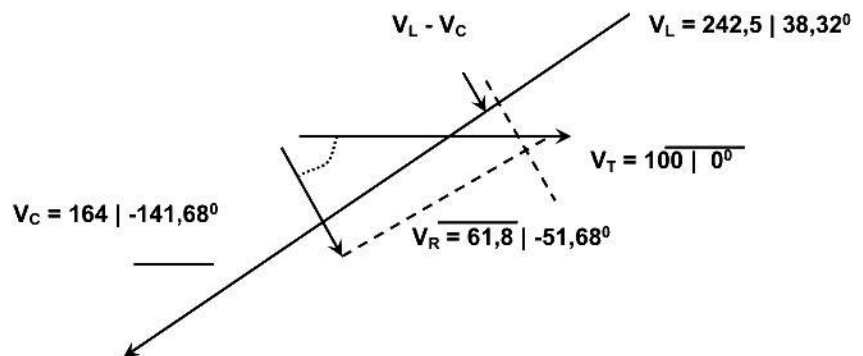
1.2.2

Square waveforms

(2 × 1) (2)

1.3

1.3.1



✓✓✓

(3)

1.3.2

A

$$\begin{aligned}
 X_L &= \frac{V_L}{I_T} \\
 &= \frac{242,5 \angle 38,32^\circ}{5,15 \angle -51,68^\circ} \checkmark \\
 &= 47,087 \angle 90^\circ \Omega \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{B} \quad X_C &= \frac{V_C}{I_T} \\
 &= \frac{164 \angle -141,68^\circ}{5,15 \angle -51,68^\circ} \checkmark \\
 &= 31,845 \angle -90^\circ \Omega \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{C} \quad R &= \frac{V_R}{I_T} \\
 &= \frac{61,8 \angle -51,68^\circ}{5,15 \angle -51,68^\circ} \checkmark \\
 &= 12 \angle 0^\circ \Omega \checkmark
 \end{aligned}$$

(3 × 2) (6)
[14]

QUESTION 2: POWER SUPPLIES

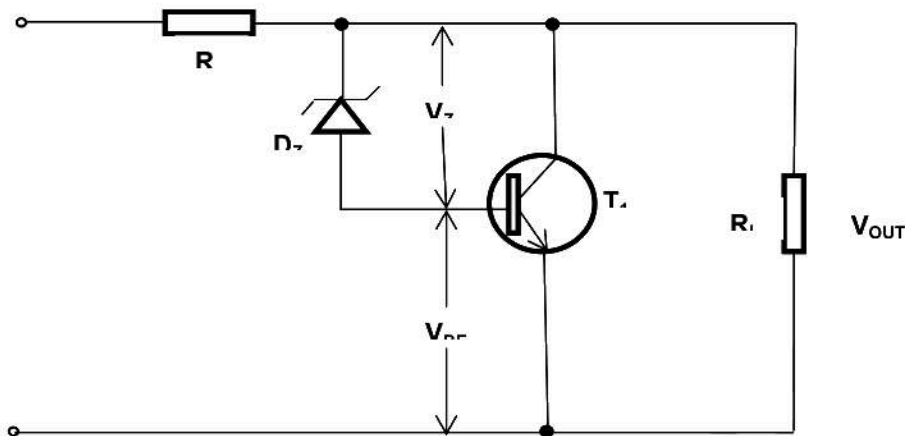
$$\begin{aligned}
 2.1 \quad V'_{dc} &= V_{dc} - I_{dc}R_1 \\
 &= 18 - 50 \times 10^{-3} \times 20 \checkmark \\
 &= 17 \text{ V} \checkmark \quad (2)
 \end{aligned}$$

2.2 It blocks AC signals and passes DC signals. (2)

2.3 25 V = No-load voltage

$$\begin{aligned}
 \%VR &= \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 \\
 0,08 \times V_{FL} &= 25 - V_{FL} \checkmark \checkmark \\
 V_{FL} &= 23,15 \text{ V} \checkmark \quad (3)
 \end{aligned}$$

2.4



Half a mark for each correct component and a full mark for correctness of the sketch.

How the supply voltage is regulated:

- The value of the Zener diode (D_Z) is selected in such a way that the bias (V_{be}) of the transistor (T_1) is low enough to keep the transistor in an unsaturated condition. ✓✓
- If the supply voltage increases, the Zener voltage (V_Z) will remain constant, but the base bias (V_{be}) will increase. ✓✓
- This causes the transistor to be driven to greater saturation in order to let the collector voltage drop. ✓✓
- This fall compensates for the increase in supply voltage and in this way the output voltage is stabilised. ✓

(7)
[14]

QUESTION 3: TRANSISTOR AMPLIFIER

- 3.1 3.1.1 Supplies voltage to the junctions of the transistors.
3.1.2 Blocks DC signals whereas AC signals are passed.

(2 × 2) (4)

3.2 3.2.1

$$R_c = \frac{V_{CC} - V_{ce}}{I_c}$$

$$V_{ce} = V_{CC} + R_c I_c \therefore \checkmark$$

$$= 20 + 1000 \times 14 \times 10^{-3} \checkmark$$

$$= 34 \text{ V} \checkmark$$

(3)

3.2.2

$$R_b = \frac{V_{CC} - V_{be}}{I_b}$$

$$\therefore I_b = \frac{V_{CC} - V_{be}}{R_b} \checkmark$$

$$= \frac{20 - 0,7}{800 \times 10^3} \checkmark$$

$$= 24,125 \mu \checkmark$$

(3)

$$\begin{aligned}
 3.2.3 \quad \beta &= \frac{I_C}{I_B} \\
 &= \frac{14 \times 10^{-3}}{24,125 \times 10^{-6}} \checkmark \\
 &= 580,311
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 3.3 \quad Z_2 &= \frac{1}{h_{oe} - \frac{h_{oe} h_{re}}{h_{ie} + R_s}} \\
 &= \frac{1}{20 \times 10^{-6} - \frac{60 \times 2 \times 10^{-4}}{1200 + 0}} \checkmark \\
 &= 100 \text{ k}\Omega \checkmark \\
 Z_O &= \frac{R_C \times Z_2}{R_C + Z_2} \\
 Z_O (R_C + Z_2) &= R_C \times Z_2 \\
 1960 (R_C + 100000) &= R_C \times 100000 \\
 1960R_C + 196000000 &= 100000R_C \checkmark \\
 R_C (100000 + 1960) &= 196000000 \\
 R_C &= \frac{196000000}{98040} \\
 R_C &= 1999,184 \text{ }\Omega \checkmark \\
 Z_i &= h_{ie} - \frac{h_{fe} h_{fe} Z_L}{1 + h_{oe} Z_L} \\
 Z_i &= 1200 - \frac{60 \times 2 \times 10^{-4} \times 1999,184}{1 + (20 \times 10^{-6} \times 1999,184)} \checkmark \\
 &= 1176,932 \text{ k}\Omega \checkmark \\
 Z_i &= \frac{R_b \times Z_1}{R_b + Z_1} \\
 Z_i (R_b + Z_1) &= R_b \times Z_1 \\
 1169 (R_b + 1176,932) &= R_b \times 1176,932 \\
 1169R_b + 1375833,66 &= R_b \times 1176,932 \\
 R_b (1176,932 + 1169) &= 1375833,66 \checkmark \\
 R_b &= \frac{1375833,66}{7,932} \\
 &= 173,5 \text{ k}\Omega \checkmark
 \end{aligned}$$

(6)
[18]

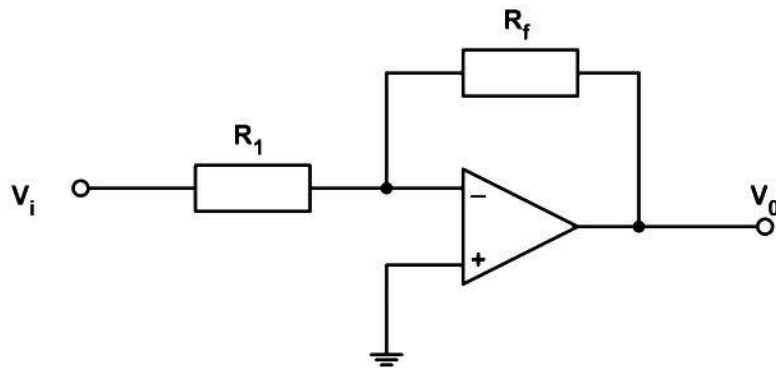
QUESTION 4: OPERATIONAL AMPLIFIERS

4.1 4.1.1 The necessary difference between bias voltages at the input to obtain zero output voltages.

4.1.2 Input terminal of a differential amplifier, which produces an anti-phase output when a signal is applied.

(2 × 2) (4)

4.2 4.2.1



(ONE mark for each component) (3)

4.2.2 $V_o = \frac{-R_f}{R_1} \times V_{in}$

$$R_f = \frac{V_o \times R_1}{V_{in}} \checkmark$$

$$= \frac{20 \times 15000}{2} \checkmark$$

$$= \underline{150 \text{ k}\Omega} \checkmark$$

(3)
[10]

QUESTION 5: INTEGRATED CIRCUITS

5.1 All unutilised inputs must be connected to V_{DD} or V_{SS}

(2)

5.2 5.2.1 False

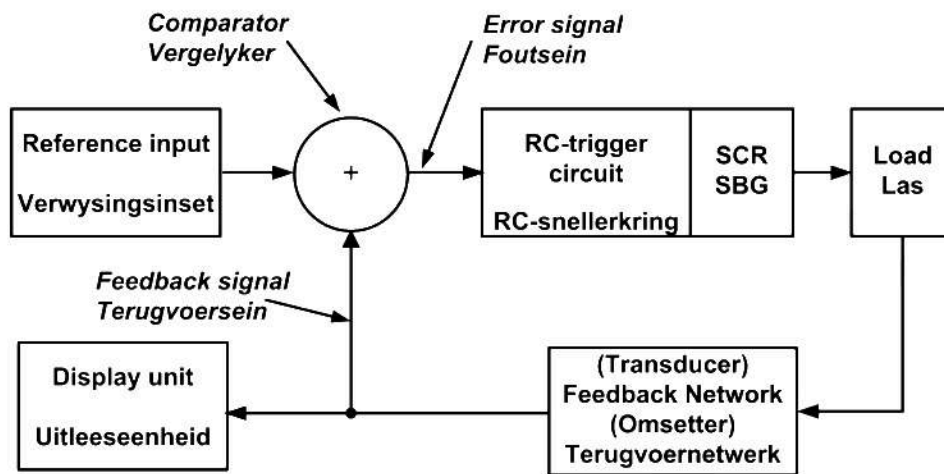
5.2.2 False

5.2.3 False

(3 × 1) (3)
[5]

QUESTION 6: ELECTRONIC PHASE CONTROL

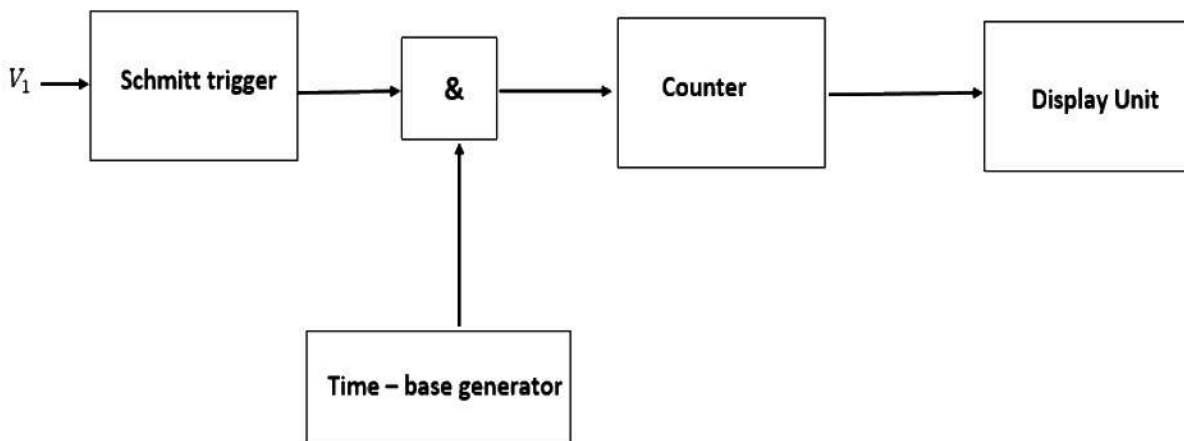
ELECTRONIC PHASE CONTROL



The comparator compares the feedback signal from the load with the reference signal.✓
 As soon as the load deviates, an error signal appears on the output of the comparator,✓
 which is used by the control circuit in order to bring the load condition back to normal.✓
 (ONE for each correct block labelled)

[8]

QUESTION 7: TEST EQUIPMENT



(ONE for each correct block label)

[5]

QUESTION 8: OSCILLATORS

8.1

$$f_r = \frac{1}{2\pi\sqrt{L_T \cdot C}}$$

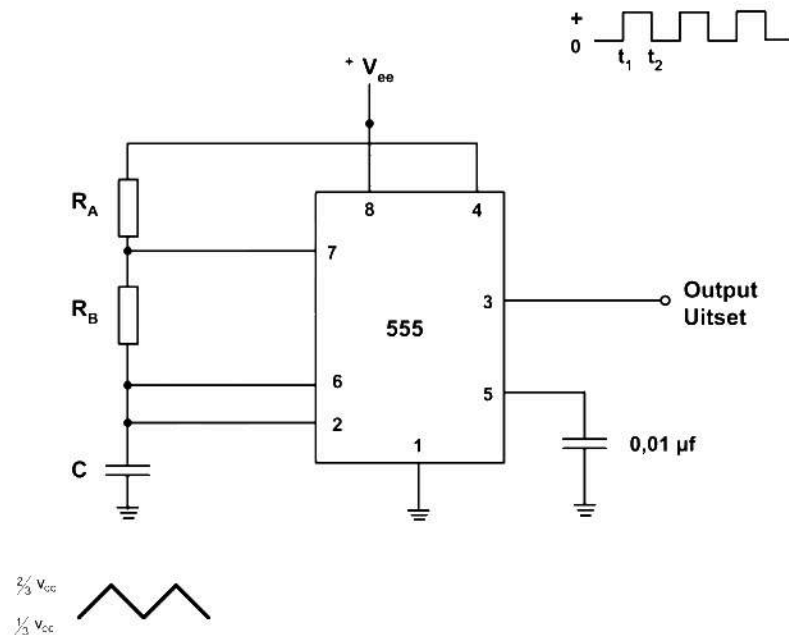
$$\therefore C = \frac{1}{(2 \cdot \pi \cdot f_r)^2 \cdot L_T} \checkmark$$

$$= \frac{1}{(2 \times \pi \times 300 \times 10^3)^2 \cdot 10 \times 10^{-3}} \checkmark$$

$$= 28.145 \text{ pf} \checkmark$$

(3)

8.2



(½ mark for each correct label for a total of 4 marks)

(4)

8.3

$$f_o = \frac{1,443}{(R_A + 2R_B) \cdot C}$$

$$= \frac{1,443}{[90000 + (2 \times 60000)] \times 1 \times 10^{-6}} \checkmark \checkmark$$

$$= 6,871 \text{ Hz} \checkmark$$

(3)

8.4

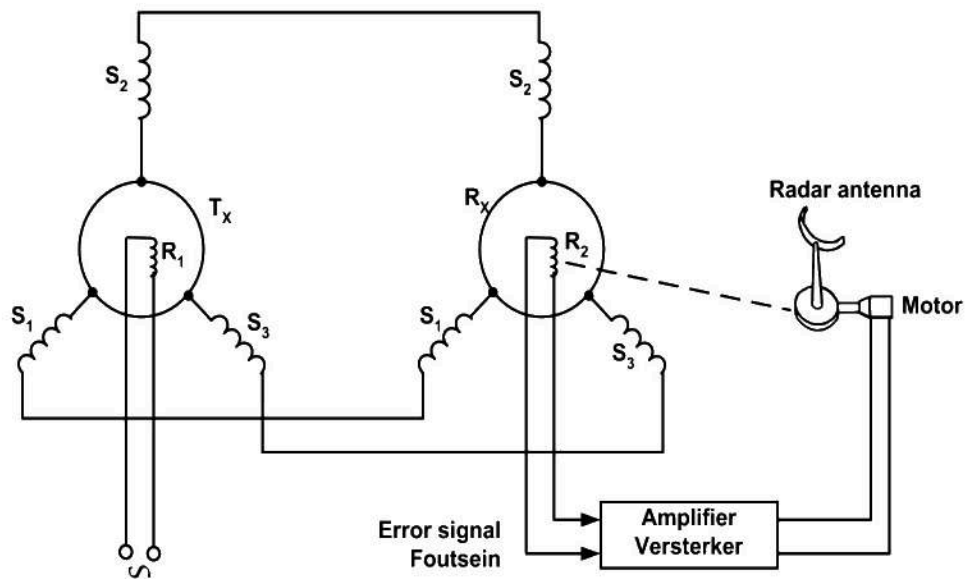
- Power supply (Change in DC)
- Output load (Change in output load)
- Temperature variations
- Operating point

(Any correct TWO)

(2)

ON 9: TRANSDUCERS

9.1 9.1.1



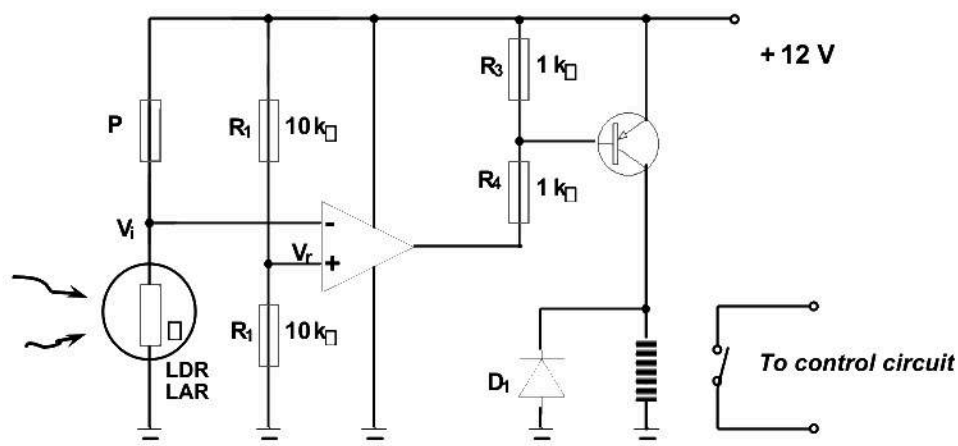
(5)

9.1.2

- The transmitter (Tx) and receiver (Rx) are in balance as soon as the rotors are at the same angle. ✓✓
- If the rotor of the transmitter turns at an angle θ , the rotor of the receiver will produce an error signal to turn the motor. ✓
- The antenna also turns the rotor of the receiver at the same angle θ so that the error signal becomes zero. ✓

(4)

9.2



(One mark each for the correct component and label)
(Ignore the shading on resistors on the marking guideline. Students to be penalised for shading resistors.)

(5)

[14]

TOTAL: 100