higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N5

21 November 2022

This marking guideline consists of 10 pages.

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QUESTION 1

1.1 1.1.1 $T = \frac{L}{R}$

$\therefore L = T \times R$

$= 2 \times 10^{-6} \times 150 \times 10^{3}$ ✓

$= 0{,}3\ H$ ✓ ➡ (2)

1.1.2 $I_T = \frac{V}{R}$

$= \frac{5}{150 \times 10^{3}}$ ✓

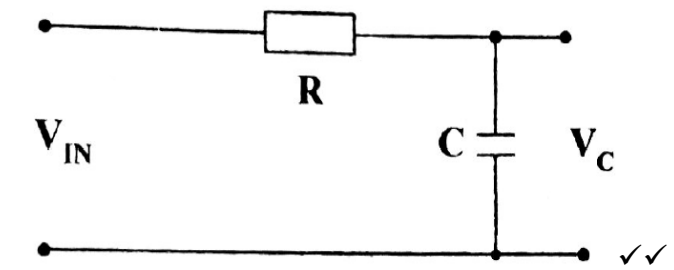
$= 33{,}33\ \mu A$

$I_L = 0{,}632 \times I_T$ ✓

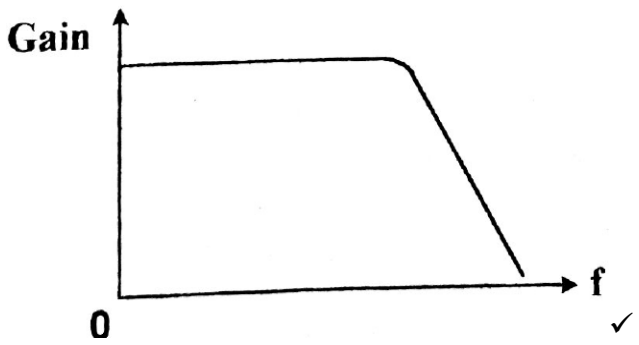
$= 0{,}632 \times 33{,}33 \times 10^{-6}$

$= 21{,}06\ \mu A$ ✓ ➡ (3)

1.2



✓✓



✓ (3)

1.3 $Z_1 = 120 - j\,21{,}21\ \Omega = 121{,}86\ \angle -10{,}02^0\ \Omega$

$Z_2 = 180 + j\,25{,}31\ \Omega = 181{,}77\ \angle 8^0\ \Omega$

$Z_3 = 100 + j\,47{,}31\ \Omega = 110{,}627\ \angle 25{,}32^0\ \Omega$

$$Z_p = \frac{Z_1 \times Z_2}{Z_1 + Z_2}$$

$$= \frac{121{,}86\ \angle -10{,}02^0 \times 181{,}77\ \angle 8^0}{120 - j\,21{,}21 + 180 + j\,25{,}31} \checkmark\checkmark$$

$$= \frac{22150{,}492\ \angle -2{,}02^0}{300 + j\,25{,}31} \checkmark$$

$$= \frac{22150.492\ \angle -2{,}02^0}{301{,}065\ \angle 4{,}8^0} \checkmark$$

$$= 73{,}573\ \angle -6{,}8^0\ \Omega \checkmark = 73{,}05 - j\,8{,}711\Omega$$

$$Z_T = \frac{Z_P \times Z_3}{Z_P + Z_3}$$

$$= \frac{73{,}573\ \angle -6{,}8^0 \times 110{,}627\ \angle 25{,}32^0}{73{,}05 - j\,8{,}711 + 100 + j\,47{,}31} \checkmark$$

$$= \frac{8139{,}160\ \angle 18{,}52^0}{173{,}74 + j\,38{,}599} \checkmark$$

$$= \frac{8139{,}160\ \angle 18{,}52^0}{177{,}976\ \angle 12{,}53} \checkmark$$

$= 45{,}73\ \angle 5{,}99^0\ \Omega \checkmark$ ⟶ (9)

[17]

QUESTION 2

2.1 $$I_Z = \frac{P_Z}{V_Z}$$

$$= \frac{750 \times 10^{-3}}{12} \checkmark$$

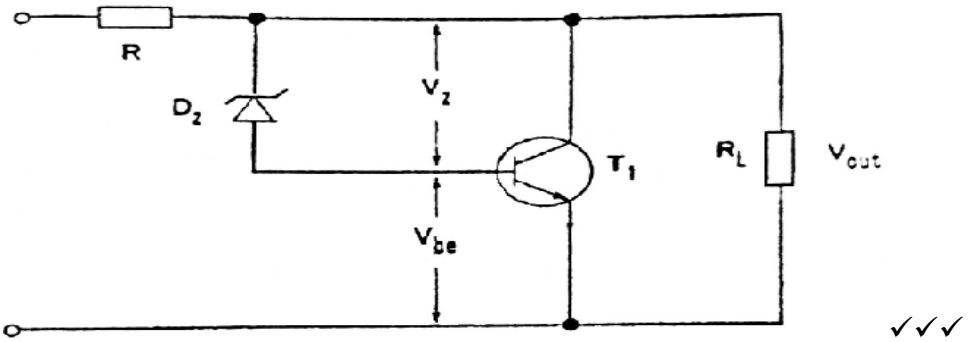
$$= 62{,}5 \text{ mA} \checkmark$$

$$R_S = \frac{Vi_{(MAX)} - V_Z}{I_Z}$$

$$= \frac{20 - 12}{62{,}5 \times 10^{-3}} \checkmark$$

$$= 128\ \Omega \checkmark$$ (4)

2.2

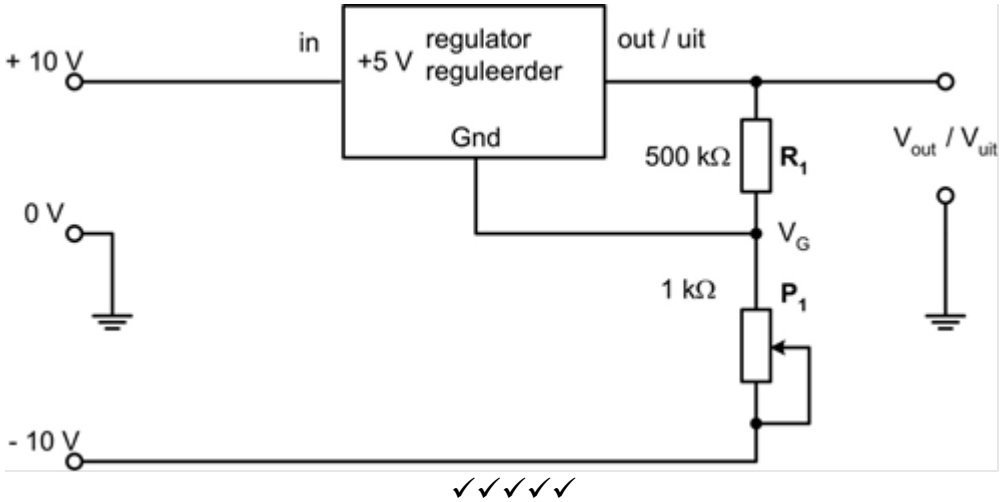


✓✓✓

How the supply voltage is regulated:

The value of the Zener-diode (D_Z) is selected is 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,✓ 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)

2.3



✓✓✓✓✓ (5)

[16]

QUESTION 3

3.1 3.1.1

$$V_E = \frac{V_{CC}}{10}$$

$$\therefore V_{CC} = 10 \times V_E$$

$$= 10 \times 1{,}5$$

$$= 15\ V \checkmark$$

$$I_C = \beta x I_B$$

$$= 250 \times 40 \times 10^{-6} \checkmark$$

$$= 10\ mA$$

$$R_C = \frac{V_{CC} - V_{CE} - V_E}{I_C}$$

$$\therefore V_{CE} = V_{CC} - V_E - R_C . I_C \checkmark$$

$$= 15 - 1{,}5 - 750 \times 10 \times 10^{-3} \checkmark$$

$$= 6\ 1{,}5V \checkmark \longrightarrow$$ (5)

3.1.2

$$R_{B2} = \frac{1}{10} \beta R_e$$

$$= \frac{1}{10} \times 250 \times 120 \checkmark$$

$$= 3\ k\Omega \checkmark$$

$$R_{B1} = \frac{R_{B2}(V_{CC} - V_B)}{V_B}$$

$$= \frac{3\ 000(15 - 0{,}6)}{0{,}6} \checkmark$$

$$= 72\ k\Omega \checkmark \longrightarrow$$ (4)

3.2 $$Z_2 = \frac{1}{h_{oe} - \frac{h_{fe}.h_{re}}{h_{ie}+R_S}}$$

$$= \frac{1}{20 \times 10^{-6} - \frac{100 \times 2 \times 10^{-4}}{12000+0}}$$ ✓

$$= 54{,}55\ \text{k}\Omega$$ ✓

But $$Z_0 = \frac{R_C \times Z_2}{R_C + Z_2}$$

$$\therefore Z_0(R_C + Z_2) = R_C \times Z_2$$

$$2\,500(R_C + 54\,550) = R_C \times 54\,550$$

$$2\,500R_C + 136375000 = 54550R_C$$ ✓

$$R_C(54550 + 2500) = 136375000$$

$$R_C = \frac{136375000}{57050}$$

$$= 2390{,}447\ \Omega$$ ✓

$$Z_1 = h_{ie} - \frac{h_{fe}.h_{re}.Z_L}{1 + h_{oe}.Z_L}$$

$$= 1\,200 - \frac{100 \times 2 \times 10^{-4} \times 2390{,}447}{1 + 20 \times 10^{-6} \times 2390{,}477}$$ ✓

$$= 1199{,}80\ \Omega$$ ✓

$$Z_i = \frac{R_B \times Z_1}{R_B + Z_1}$$

$$\therefore (R_B + Z_1) = \times Z_1$$

$$2\,000(R_B + 1199{,}80) = R_B \times 1199{,}80$$

$$2000R_B + 2399{,}600 = 1199{,}80R_B$$

$$R_B(1199{,}80 + 2000) = 2399{,}600$$ ✓

$$R_B = \frac{2399{,}600}{3199{,}8}$$

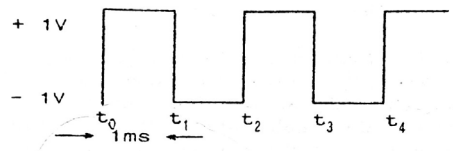
$$= 0{,}749\ \Omega$$ ✓ (8)

[17]

QUESTION 4

4.1 It is the ability of an amplifier to reject common-mode signals. (2)

4.2



$$t = {}^{1}/_{f} = {}^{1}/_{500} = 2\text{ m sec}$$

$$\therefore 360^0 = 2\text{ m sec} \quad \text{thus } 180^0 \quad 1\text{ m sec} \checkmark$$

$$= {}^{-1}/_{RC} \int_{t_0}^{t_1} V_{dt} + \textit{ initial condition a capacitor}$$

$$V_{O(t_1)} = {}^{-1}/_{RC} \int_{t_0}^{t_1} V_{i(t_1)} + V_{C(t_0)} \quad but\ t_0 = 0 \checkmark$$

$$= \left(\frac{1}{10\times10^{-6}\times0{,}01\times10^{-6}}\right) \int_{t_0}^{t_1} (1).(0{,}001) + 0 \checkmark$$

$$= -\frac{1}{0{,}01} \int_{t_0}^{t_1} 0{,}001 \checkmark$$

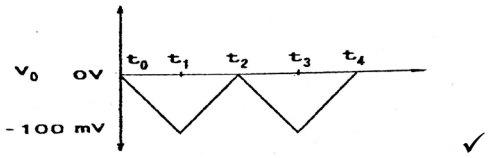
$$= -0{,}1\text{V} \text{ or } -100\text{ mV} \checkmark$$

$$V_{O(t_2)} = {}^{-1}/_{RC} \int_{t_1}^{t_2} V_{i(t_2)} + V_{C(t_1)}$$

$$= (-100) \int_{t_1}^{t_2} (-1).(0{,}001) + (-0\,,1) \checkmark$$

$$= +0{,}1 - 0{,}1\text{ V} \checkmark$$

$$= 0\text{ V} \checkmark \longrightarrow$$



✓

(9)
[11]

QUESTION 5

5.1
- Fixed positive voltage regulators
- Fixed negative voltage regulators
- Adjustable voltage regulators
- Dual-tracking voltage regulators (4)

5.2 As an electrical charge caused by an imbalance of electrons on the surface of a material. (2)

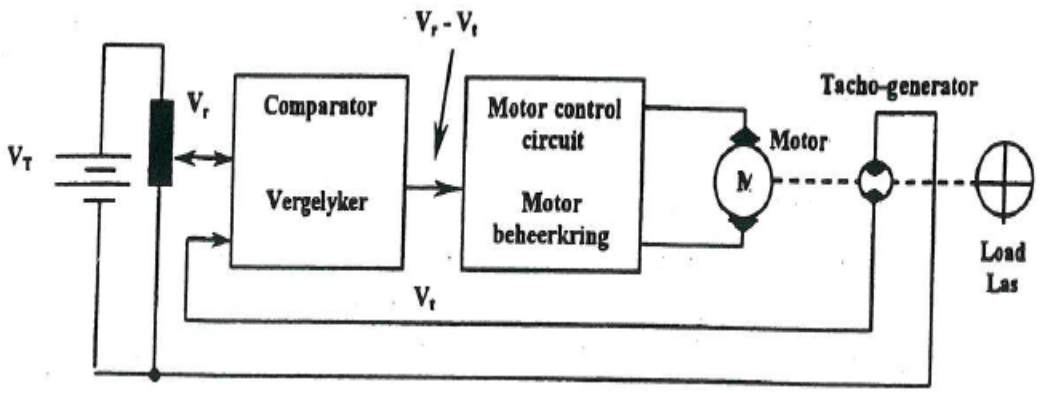
[6]

QUESTION 6

6.1 6.1.1 True
6.1.2 True
6.1.3 True

(3 × 1) (3)

6.2

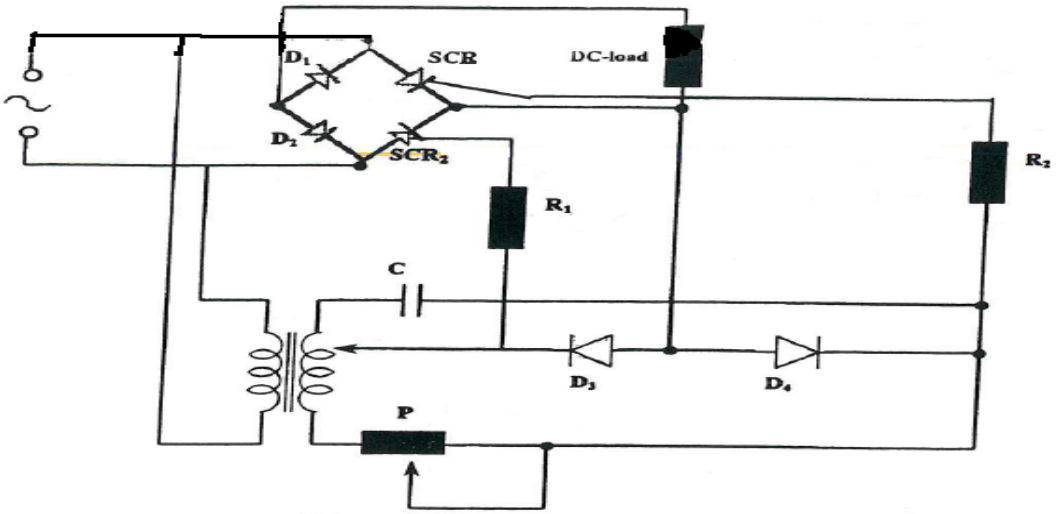


✓✓✓✓ (4)

6.3 An infrared beam is an invisible beam that can be invoked by an infrared-emitting diode with a built-in lens to concentrate the energy in a narrow beam.✓ The beam is observed by a photodiode with an infrared filter in front of it to keep off normal light.✓ The signal is amplified and can be used to control a relay.✓ This principle can be applied in alarm systems, doorbells, automatic door openers and light switches, the detection of human movement, distance control circuits, etc.✓ (4)

[11]

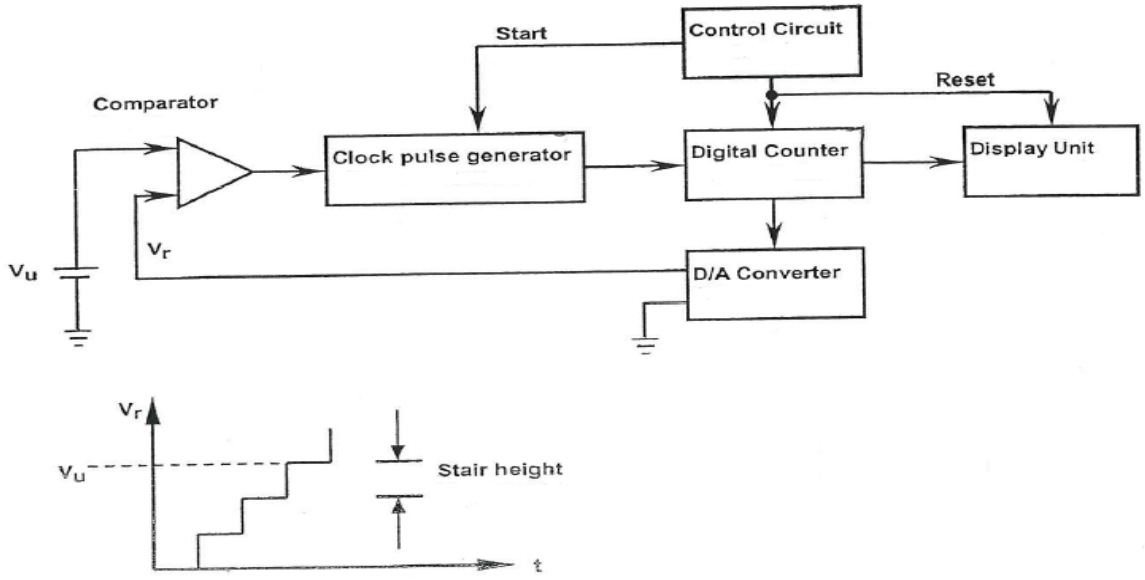
QUESTION 7



Full-wave control circuit for a DC load with two SCRs✓✓✓✓✓✓

IGNORE SHADED RESISTORS AND REGARD THEM AS NORMAL RESISTORS **[6]**

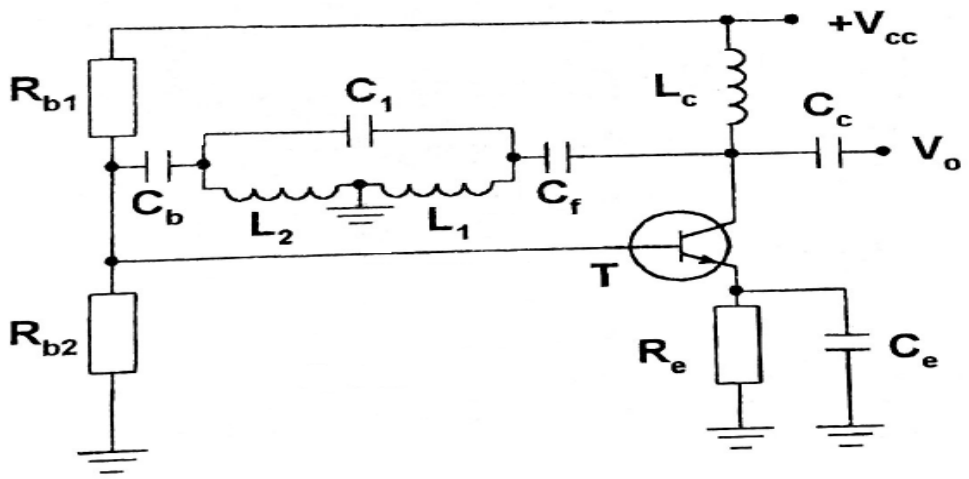
QUESTION 8



Staircase A/D voltmeter✓✓✓✓✓✓ **[6]**

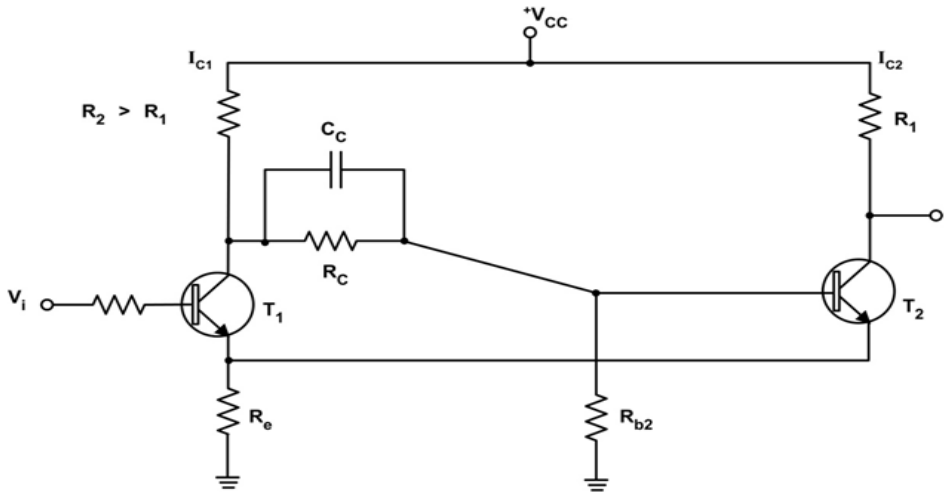
QUESTION 9

9.1



✓✓✓✓ (4)

9.2



½ mark for each component

✓✓✓✓ (4)

9.3 Rozner modification is a method employed to increase the rise time at the collector of a transistor, T_1. (2)

[10]

TOTAL: 100

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