higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSRIAL ELECTRONICS N5

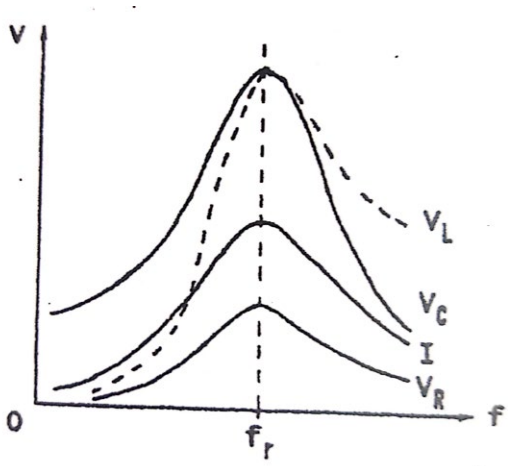
27 November 2023

This marking guideline consists of 12 pages.

Copyright reserved

QUESTION 1: ALTERNATING CURRENT THEORY

1.1



(½ mark for each correct label for a total of 3 marks) (3)

1.2 1.2.1

$$f_r = \frac{f_1 + f_2}{2}$$

$$= \frac{(199{,}5 + 200{,}5)}{2} \text{ kHz} \checkmark$$

$$\therefore f_r = \underline{200 \text{ kHz}} \checkmark$$

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

$$(2 \cdot \pi \cdot f_r)^2 \cdot LC = 1$$

$$\therefore C = \frac{1}{4 \cdot \pi^2 \cdot f_r^2 \cdot L} \checkmark$$

$$= \frac{1}{4\pi (200 \times 10^3)^2 (0{,}015)} \checkmark$$

$$= \underline{42{,}217 \text{ pf}} \checkmark$$ (5)

1.2.2 $X_L = X_C$

then $I_T = \frac{V_T}{R}$

$= \frac{20}{10}$

$= \underline{2\ A}$✓

$V_L = j.I_T.X_L$

$= j2 \times 2\pi \times 200 \times 10^3 \times 0{,}015$

$= \underline{37\,699{,}122\ \angle 90°\ V}$ ✓

$V_C = -j.I_T.X_C$

$= -j2 \times \frac{1}{2\pi \times 200 \times 10^3 \times 42{,}217 \times 10^{-12}}$ ✓

$= \underline{37\,699{,}112\ \angle 90°\ V}$ ✓

$V_R = j.I_T.R$

$= j2 \times 10$

$= \underline{20\ \angle 0^0\ V}$✓ (6)

1.2.3 Q-factor = $\frac{X_L}{R}$

$= \frac{2 \times \pi \times 200 \times 10^3 \times 0{,}015}{10}$

$= \underline{1\,884{,}956}$✓ (2)

[16]

Copyright reserved

QUESTION 2: POWER SUPPLIES

2.1 2.1.1

$$V'_{DC} = \frac{R_L}{R + R_L} \times V_{DC}$$

$$\therefore V_{DC} = \frac{R + R_L}{R_L} \times V'_{DC} \checkmark$$

$$= \frac{10 + 300}{300} \times 12 \checkmark$$

$$= 12{,}4 \text{ V} \checkmark \quad (3)$$

2.1.2

$$V'_{r(rms)} = \frac{X_C}{\sqrt{R^2 + X_C^2}} \times V_{r(rms)}$$

$$\therefore V_{r(rms)} = \frac{\sqrt{R^2 + X_C^2}}{X_C} \times V'_{r(rms)} \checkmark$$

$$= \frac{\sqrt{10^2 + 8^2}}{8} \times 0{,}8 \checkmark$$

$$= 1{,}281 \text{ V} \checkmark \quad (3)$$

2.1.3

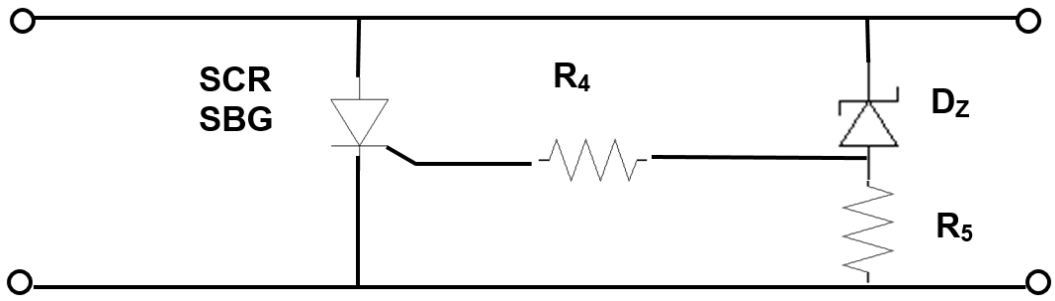
$$r' = \frac{V'_{r(rms)}}{V'_{DC}}$$

$$= \frac{0{,}8}{12} \checkmark$$

$$= 0{,}067 \checkmark \quad (2)$$

Copyright reserved

2.2



(1 mark for SCR and D_Z; ½ mark for R_4 and R_5 for a total of 3 marks)

- Under normal output voltages, voltage across R5 will be low, thus SCR will be off.✓
- When maximum allowed voltage is exceeded, voltage drop across R5 increases and SCR is switched on.✓
- The SCR causes a short circuit and the output voltage drops to zero.✓ (6)

[14]

QUESTION 3: TRANSISTOR AMPLIFIERS

3.1 (a) $V_e = \frac{1}{10} \times V_{CC}$

$= \frac{1}{10} \times 12$

$=$ **1,2 V** ✓

(b) $I_C \cong I_E$

$\therefore I_E = \frac{V_E}{R_E}$

$I_C = \frac{V_E}{R_E}$

$I_C = \frac{1,2}{120}$

$=$ 10 mA ✓

(c) $I_C = \beta . I_B$

$I_B = \frac{I_C}{\beta}$

$= \frac{10 \times 10^{-3}}{250}$

$=$ 40 μA ✓

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

$V_{CE} = V_{CC} - V_E - (I_C \cdot R_C)$

$= 12 - 1{,}2 - (10 \times 10^{-3} \times 480)$

$\therefore V_{CE} = 6\ V$✓

OR

(e) $V_B = \frac{R_{B_2}}{R_{B_2} + R_{B_1}} \times V_{CC}$

$= \frac{3\,000}{3\,000 + 15\,947} \times 12$ ✓

$= 1{,}9\ V$✓

$V_B = V_E + V_{BE}$

$= 1{,}2 + 0{,}7$✓

$= 1{,}9\ V$✓

(5 × 2) (10)

3.2 $Z_1 = h_{ie}$

$= 1{,}2\ k\Omega$✓

But $Z_i = R_{BT} \,||\, Z_1$

$R_{BT} = \frac{R_{B_1} \times R_{B_2}}{R_{B_1} + R_{B_2}}$

$= \frac{15\,947 \times 3\,000}{15\,947 + 3\,000}$

$R_{BT} = 2\,524{,}991\ \Omega$✓

$Z_I = \frac{2\,524{,}9908 \times 1\,200}{2\,524{,}9908 + 1\,200}$

$= 813{,}42\ \Omega$✓

$Z_2 = \frac{1}{h_{oe}}$

$= \frac{1}{20 \times 10^{-6}}$

$= 50\ k\Omega$✓

$$Z_O = \frac{R_C \times Z_2}{R_C + Z_2}$$

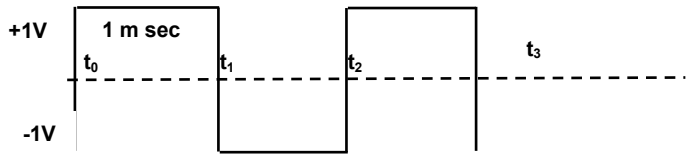
$$= \frac{480 \times 50\,000}{480 + 50\,000}$$

= 475,436 Ω✓ (5)

[15]

QUESTION 4: OPERATIONAL AMPLIFIERS

4.1



$t = \frac{1}{f}$ = $\frac{1}{500}$ = 2 m sec

∴ 360° = 2 m sec thus 180^0 = 1 m sec

$V_{O(t_1)} = -\frac{1}{RC} \int_{t0}^{t1} V dt$ + initial condition of capacitor

$= -\frac{1}{RC} \int_{10}^{t1} V_i(t_1) + V_C(t_0)$ but $t_0 = 0$✓

$= \left(\frac{1}{10\times10^{6}\times0{,}01\times10^{-6}}\right) \int_{t0}^{t1} (1)(0{,}001) + 0$ ✓

$= -\frac{1}{0{,}01}\int_{t0}^{t1} 0{,}001$ ✓

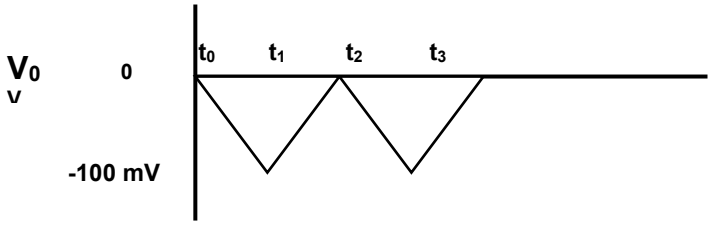
$= \quad -0{,}1\,V \quad \text{or} \quad -100\ mV$ ✓

$V_{O(t_1)} = -1/RC \int_{11}^{t2} V_i(t_2) + V_C(t_1)$

$= (-100) \int_{t1}^{t2} (-1)(0{,}001) + (-0{,}1)$ ✓

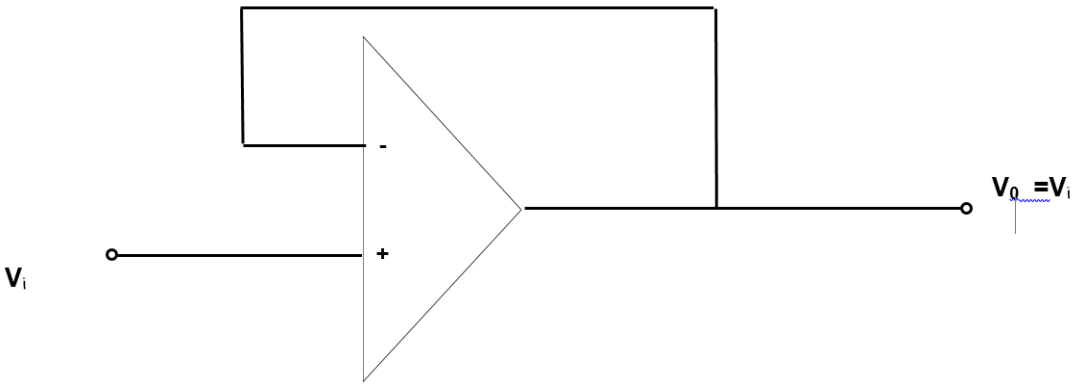
= + 0,1 - 0,1

= 0 V ✓



✓✓ (9)

4.2

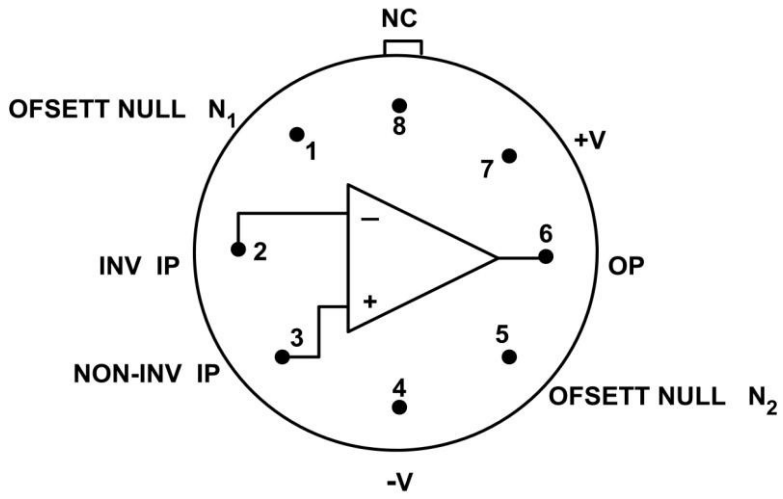


The voltage follower

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

[13]

QUESTION 5: INTEGRATED CIRCUITS

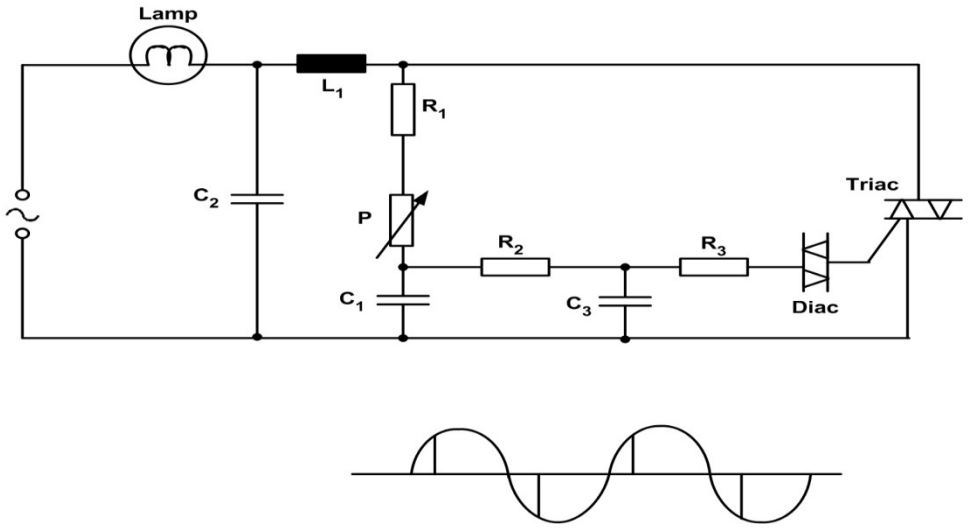


741-INTEGRATED OPERATIONAL AMPLIFIER IN A METAL CAN PACK

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

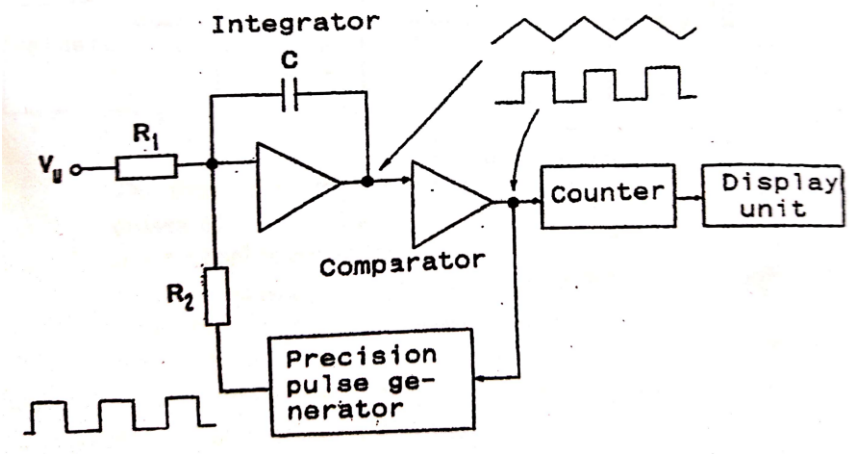
(4 × 1) **[4]**

QUESTION 6: ELECTRONIC PHASE CONTROL



(½ mark for any correct label for a total of 6 marks) **[6]**

QUESTION 7: TEST EQUIPMENT



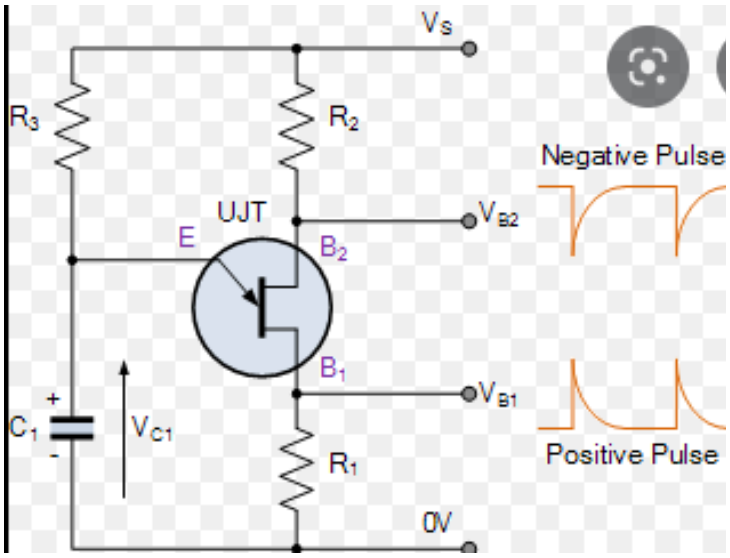
(1 mark for correct block label and ½ mark for correct components labels for a total of 6 marks) **[6]**

QUESTION 8: OSCILLATORS

8.1
- Variation in the tuned circuit or transistor parameters
- Change in load conditions
- Unstable supply voltage

(3)

8.2 A neat, labelled circuit diagram of a uni-junction transistor oscillator.



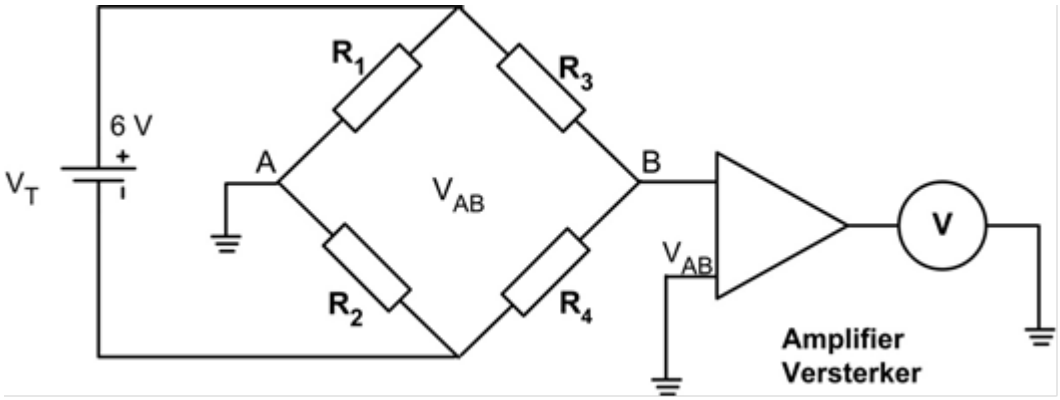
(½ mark for any correct label and graph for a total of 4 marks) (4)

8.3
- Sine waveform✓ – used for power supply for electrical equipment.✓
- Square waveform✓ – clock pulse for digital circuits, alarm systems, ultrasonic tests.✓
- Saw-tooth waveform✓ – time base in an oscilloscope.✓ (Any 3 × 2) (6)

[13]

QUESTION 9: TRANSDUCERS

9.1



THERMISTOR BRIDGE WITH A DC-BIAS

(½ mark for any correct label and graph for a total of 4 marks) (4)

9.2 $T = {}^{0}C + 273$

$= 30 + 273$

$= 303\ K$✓

9.2.1 $R_t = A \cdot e^{\frac{B}{T}}$

$= 0{,}2169\ e^{\frac{3200}{303}}$

$= 8\,372{,}747\ \Omega$✓ (2)

9.2.2 $V_{AB} = V_A - V_B$

$V_A = \frac{R_2}{R_1 + R_2} \times V_T$

$= \frac{10\ k\Omega}{10\ k\Omega + 10\ k\Omega} \times 10$✓

$= 5\ V$✓

$$V_B = \frac{R_t}{R_t + R_3}$$

$$= \frac{8\,372{,}747}{8\,372{,}747 + 10\,000} \times 10 \checkmark$$

$$= 4{,}56 \text{ V} \checkmark$$

$$V_{AB} = V_A - V_B$$

$$= 5 - 4{,}56$$

$$= 0{,}44 \text{ V} \checkmark$$

$$\text{Gain of amplifier (AV)} = \frac{V_O}{V_i}$$

$$= \frac{10}{0{,}44} \checkmark$$

$$= 22{,}73 \checkmark$$ (7)

[13]

TOTAL: 100

Copyright reserved