higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N5

1 AUGUST 2019

This marking guideline consists of 9 pages.

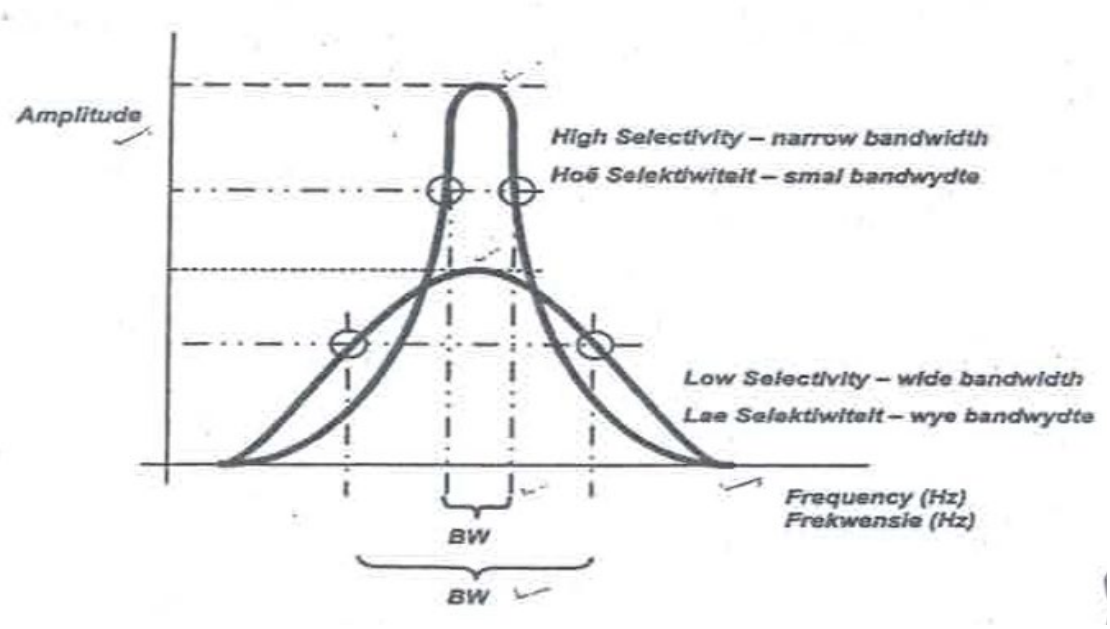
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QUESTION 1

1.1 1.1.1 A square waveform: It distorts.
1.1.2 A sine waveform: It does not distort.

(2 × 1) (2)

1.2



(5)

1.3 1.3.1

$$x_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2 \text{ x } \pi \text{ x } 50 \text{ x } 200 \text{ x } 10^{-6}}$$

$$= 15{,}916\ \Omega \checkmark$$

$$Z_B = 8 - \text{j } 15{,}916\ \Omega = 17{,}813 \angle -63{,}0314^0\ \Omega$$

$$X_L = 2\pi fL$$

$$= 2 \text{ x } \pi \text{ x } 50 \text{ x } 0{,}02$$

$$= 6{,}283\ \Omega \checkmark$$

$$Z_C = 4 + \text{j}6{,}283\ \Omega = 7{,}448 \angle 57{,}52^0\ \Omega$$

$$I_A = \frac{V_T}{Z_A}$$

$$= \frac{100 \angle 0^0}{10 \angle 0^0} \checkmark$$

$$= 10 \angle 0^0 \text{ A} \checkmark \longrightarrow$$

$$I_B = \frac{V_T}{Z_B}$$

$$= \frac{100 \angle 0^0}{17{,}813 \angle -63{,}0314^0} \checkmark$$

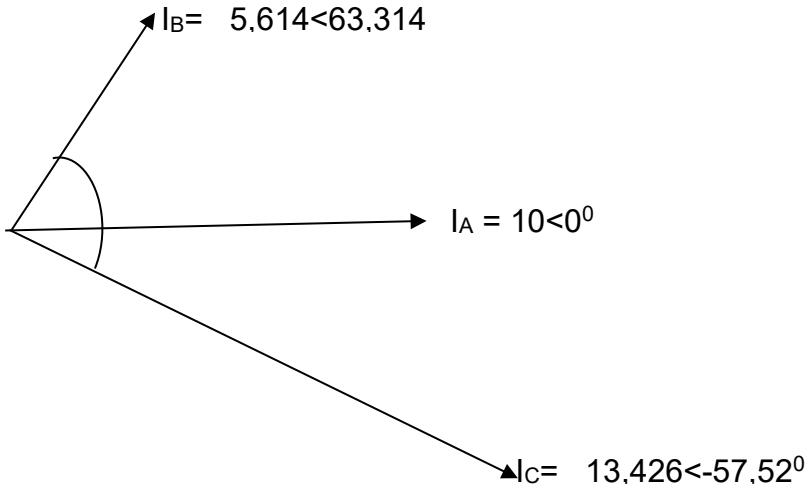
$$= 5{,}614 \angle 63{,}314^0 \text{ A} \checkmark \longrightarrow$$

$$I_C = \frac{V_T}{Z_C}$$

$$= \frac{100 \angle 0^0}{7{,}448 \angle 57{,}52^0} \checkmark$$

$$= 13{,}426 \angle -57{,}52^0 \text{ A} \checkmark \longrightarrow$$ (8)

1.3.2



(2)
[17]

QUESTION 2

2.1 $$V'_{r(rms)} = \frac{X_C}{\sqrt{R^2 + X_C^2}} \times V_{r(rms)}$$

$$0,8 = \frac{X_C}{\sqrt{20^2 + X_C^2}} \times 1,5 \checkmark$$

$$\left(0,8 \times \sqrt{20^2 + X_C^2}\right)^2 = (X_C \times 1,5)^2 \checkmark\checkmark$$

$$X_C = 159,006\ \Omega \checkmark$$

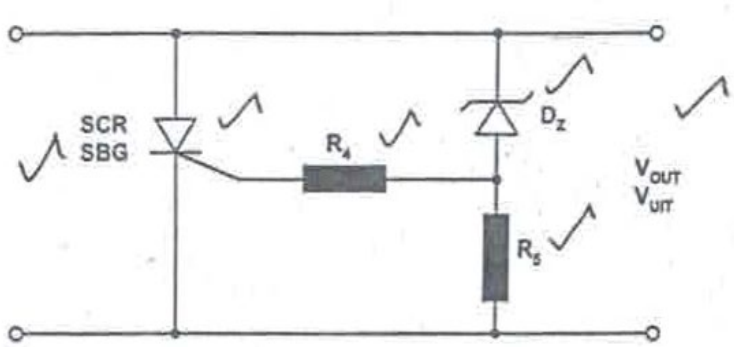
$$x_C = \frac{1}{2\pi fC}$$

$$\therefore C = \frac{1}{2\pi f X_C}$$

$$= \frac{1}{2 \times \pi \times 50 \times 159,006} \checkmark$$

$$= 252,43\ \mu f \checkmark \longrightarrow$$ (6)

2.2



OVER-VOLTAGE PROTECTION CIRCUIT (3)

2.3 The voltage limit of the circuit is determined by the reverse breakthrough voltage of the Zener diode.✓ As soon as the output voltage is high enough to drive the Zener diode conduction, a pulse will be supplied to the gate of the SCR.✓ The SCR will start conducting and therefore provides a virtual short circuit across the output terminals.✓

OR

Under normal operating conditions, the voltage drop across R1 is too low to switch the SCR on. If the output voltage exceeds the limit set by the Zener diode, it will conduct. The voltage across the resistor R1 will rise, the SCR switches on and the power rails are short circuited, which in turn could blow the power fuse. (3)

2.4 $I_Z = \frac{P_Z}{V_Z}$

$= \frac{6\,000\ x\ 10^{-3}}{12}$ ✓

$= 0{,}5\ A$ ✓

$R_S = \frac{V_{in} - V_Z}{I_Z}$

$= \frac{18 - 12}{0{,}5}$ ✓

$= 12\ \Omega$ ✓ ⟶ (4)

[16]

QUESTION 3

3.1 (a) $V_e = \frac{1}{10} \text{x } V_{cc}$

$= \frac{1}{10} \text{x } 30$ ✓

$= 3\text{ V}$ ✓ ⟶

(b) $I_C \equiv I_E$

$I_C = \frac{V_e}{R_e}$

$= \frac{3}{2\,200}$ ✓

$= 1{,}364\text{ mA}$ ✓ ⟶

(c) $I_B = \frac{I_C}{\beta}$

$= \frac{1{,}364 \text{ x } 10^{-3}}{300}$ ✓

$= 4{,}556\ \mu\text{A}$ ✓ ⟶

(d) $R_C = \frac{V_{cc} - V_{ce} - V_e}{I_C}$

$\therefore V_{ce} = V_{cc} - V_e - R_C . I_C$ ✓

$= 30 - 3 - 4\,700 \text{ x } 1{,}364 \text{ x } 10^{-3}$ ✓

$= 20{,}6 \text{ V}$ ✓ ⟶

(e) $V_b = \frac{R_{b_2}}{R_{b_2} + R_{b_1}} \text{ x } V_{CC}$ **OR** $V_b = V_e + V_{be}$

$= \frac{5\,000}{5\,000 + 35\,541} \text{ x } 30$ ✓ $= 3 + 0{,}7$

$= 3{,}7 \text{ V}$ ✓ ⟶ $= 3{,}7 \text{ V}$ (11)

3.2 3.2.1 $\frac{1}{Z_L} = \frac{1}{R_C} + \frac{1}{R_L}$

$\therefore \frac{1}{R_L} = \frac{1}{Z_L} - \frac{1}{R_C}$ ✓

$\therefore R_L = \frac{1}{\frac{1}{4\,000} - \frac{1}{5\,000}}$ ✓

$= 20 \text{ k}\Omega$ ✓ ⟶ (3)

3.2.2 $Z_1 = h_{ib} - \frac{h_{fb} . h_{rb} . Z_L}{1 + h_{ob} . Z_L}$

$= 40 - \frac{(-0{,}98) \text{ x } 200 \text{ x } 10^{-6} \text{ x } 4\,000}{1 + 0{,}4 \text{ x } 10^{-6} \text{ x } 4\,000}$ ✓

$= 40{,}783$ ✓ ⟶ (2)

3.2.3 $Z_i = \frac{R_e \text{ x } Z_1}{R_e + Z_1}$

$= \frac{1\,000 \text{ x } 40{,}783}{1\,000 + 40{,}783}$ ✓

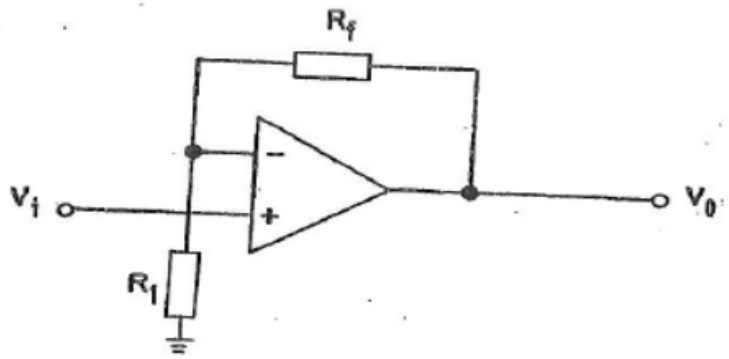
$= 39{,}2 \ \Omega$ ✓ ⟶ (2)

[18]

QUESTION 4

4.1
- Temperature variations
- Unstable power supply
- Changing of load conditions
- Ageing of components
- Parameter variations of components (Any 3 × 1) (3)

4.2 4.2.1



NON-INVERTING (3)

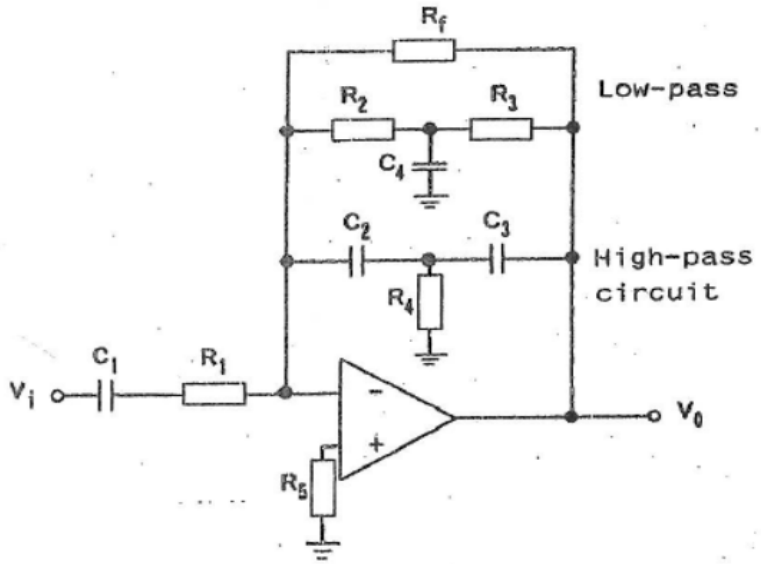
4.2.2 $V_O = \left(\frac{R_f}{R_1} + 1\right) V_i$

$\therefore R_f = \left(\frac{V_O}{V_i} - 1\right) R_i$

$= \left(\frac{11}{3} - 1\right) x\ 1{,}5\ x\ 10^3$ ✓

$= 4\ k\Omega$ ✓ ⟶ (2)

4.3



BAND-PASS FILTER (4)

[12]

QUESTION 5

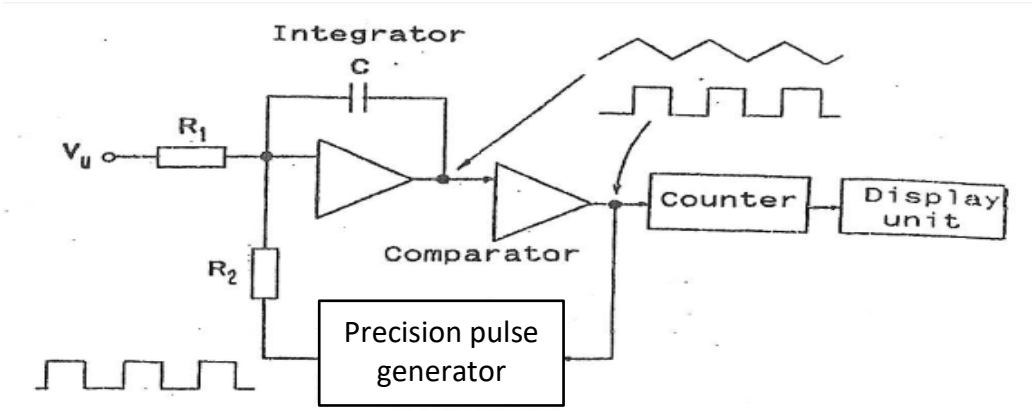
- Use earth soldering iron tips.
- Use earthed wristbands.
- Earth all test equipment.
- Switch off the power before you work on the circuit.
- All unused inputs must be connected to V_{DD} or V_{SS}.
- Store unutilised units in a conductive sponge or container. (Any 5 × 1) **[5]**

QUESTION 6

6.1 feedback
6.2 exercise
6.3 load condition
6.4 adjustment
6.5 simpler and cheaper

(5 × 1) **[5]**

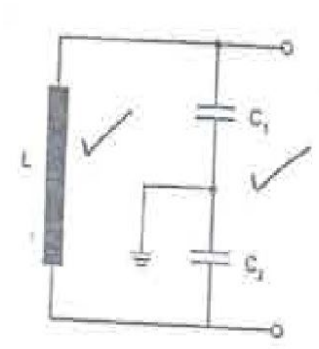
QUESTION 7



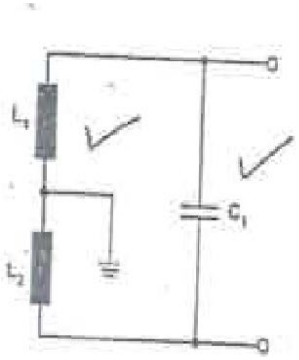
VOLTAGE-TO-FREQUENCY CONVERTER **[6]**

QUESTION 8

8.1



COLPITTS OSCILLATOR



HARTLEY OSCILLATOR

(2 × 2) (4)

8.2 8.2.1 One stable and one semistable condition
8.2.2 Two stable conditions
8.2.3 Two semistable conditions

(3 × 1) (3)

8.3 An external trigger pulse is required for the circuit to work. The circuit is in a stable state as soon as the trigger pulse is applied.✓ It switches to the semi-stable state for a period which is determined by the time constant R_2C_1.✓ After this period the circuit switches back to the stable state and remains in this state until a next trigger pulse is applied.✓ (3)

[10]

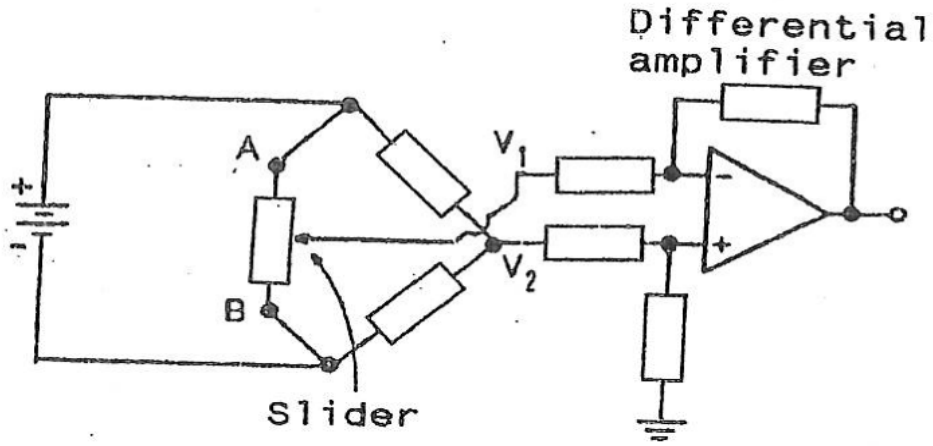
QUESTION 9

9.1 $$Resolution = \frac{1}{Number\ of\ turns}$$

$$= \frac{1}{2\,500}$$

$$= 0{,}0004$$ (2)

9.2



LINEAR POTENTIOMETER IN A WHEATSTONE BRIDGE (4)

9.3 The circuit switches the relay on as soon as the light drops below a certain intensity.✓ R_1 and R_2 form a voltage divider which produces a reference voltage to the operational comparator.✓ P is a precision potentiometer and adjusts the input voltage V_1 for different light intensities.✓ As soon as the light intensity drops, the resistance of the LDR increases and V_1, increases.✓ As soon as $V_1 < V_r$, the comparator output becomes low and switches T_1 on because of the base bias that increases across R_3. Current flows through the relay and short circuits the contacts.✓ (5)

[11]

TOTAL: 100

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