higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N5

30 JULY 2018

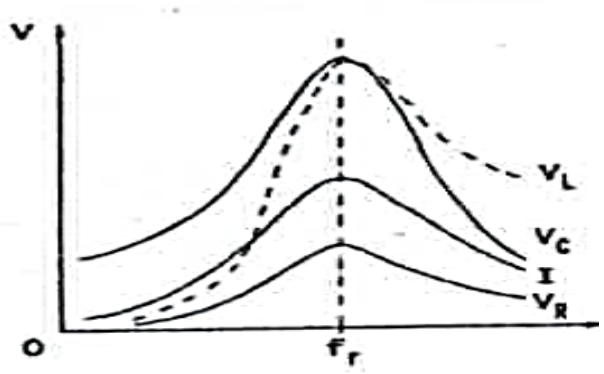
This marking guideline consists of 9 pages.

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QUESTION 1: ALTERNATING CURRENT THEORY

1.1 As soon as the perfect square waveform is sent through a faulty circuit, the existence of an error as well as an indication of the type of error that exists will be indicated while sine waves often only indicate the existence of an error. (3)

1.2



(3)

1.3 $Z_1 = 120 - j21{,}21\ \Omega = 121{,}86\ \angle -10{,}02^o\ \Omega$

$Z_2 = 180 + j25{,}31\ \Omega = 181{,}77\ \angle 8^o\ \Omega$

$Z_3 = 100 + j47{,}31\ \Omega = 110{,}6272\ \angle 5{,}32^o\ \Omega$

$$= \frac{121{,}86\angle -10{,}02^0 \times 181{,}77\angle 8^0}{120 - j21{,}21 + 180 + j25{,}31}$$

$$= \frac{22150{,}584\angle -2{,}02^0}{300 + j4{,}1}$$

$$= \frac{22150{,}584\angle -2{,}02^0}{300{,}03\angle 0{,}78^0}$$

$$= 72{,}828\angle -2{,}8^0\ \Omega$$

$$= 73{,}74 - j\,3{,}606\ \Omega$$

$$Z_T = Z_{//} + Z_3$$

$$= 73{,}74 - j\,3{,}606 + 100 + j\,47{,}31$$

$$= 173{,}74 + j\,43{,}7\ \Omega$$

$$= 179{,}152\angle 14{,}12^0\ \Omega$$

(8)
[14]

QUESTION 2: POWER SUPPLIES

2.1 2.1.1

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

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

$$= \frac{100+1\,000}{1\,000} \times 26{,}4 \checkmark$$

$$= 29{,}04 \text{ V} \checkmark \longrightarrow \quad (3)$$

2.1.2

$$V'_{R(RMS)} = \frac{V_{R(RMS)}}{(4\pi f)^2 LC}$$

$$V_{R(RMS)} = V'_{R(RMS)}(4\pi f)^2 LC \checkmark$$

$$= 2{,}5\ ((4.\pi.50))^2.0{,}2.100 \times 10^{-6} \checkmark$$

$$= 19{,}73 \text{ V} \checkmark \longrightarrow \quad (3)$$

2.1.3

$$r = \frac{V_{R(RMS)}}{V_{DC}}$$

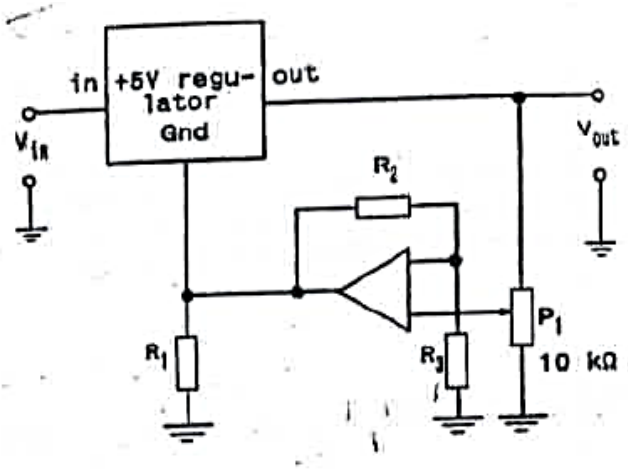
$$= \frac{19{,}73}{29{,}04} \checkmark$$

$$= 0{,}67 \checkmark \longrightarrow \quad (2)$$

2.2 It is used as soon as a higher voltage is required from a transformer secondary voltage. (2)

2.3 Potentiometer P_2 is adjusted during a normal load current so that transistor T_1 is not biased forward sufficiently and therefore off.✓ An increase in load current will cause an increase in voltage drop across P_2.✓ During overload conditions the increased voltage drop across P_2 will switch transistor T_2 on to conduct a part of the base current of transistor T_1 and limit the increase in load current to a safe value.✓ (3)

2.4



(½ for each component) (5)
[18]

QUESTION 3: TRANSISTORS AMPLIFIERS

3.1 3.1.1

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

$$\therefore \quad V_E = I_C.R_E$$

$$= 20 \times 10^{-3} \times 250 \checkmark$$

$$= 5\ V \checkmark$$

$$V_{CC} = 10.V_E$$

$$= 10 \times 5 \checkmark$$

$$= 50\ V \checkmark \Longrightarrow \quad (4)$$

3.1.2

$$C_e = \frac{10}{2\pi F R_e}$$

$$f = \frac{10}{2\pi R_e C_e} \checkmark$$

$$= \frac{10}{2.\pi.250.20 \times 10^{-6}} \checkmark$$

$$= 318{,}31\ Hz \checkmark \Longrightarrow \quad (3)$$

3.2 3.2.1

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

$$= 2\,200 - \frac{100 \times 2 \times 10^{-4} \times 10\,000}{1 + 20 \times 10^{-6} \times 10\,000} \checkmark$$

$$= 2\,200 - 198{,}8$$

$$= 2\,001{,}2 \checkmark$$

$$R_{bt} = R_{b1} // R_{b2}$$

$$= \frac{65\,000 \times 6\,500}{65\,000 + 6\,500} \checkmark$$

$$= 5\,909{,}1\ \Omega \checkmark$$

$$A_i = \left(\frac{h_{fe}}{1 + h_{oe} Z_L}\right)\left(\frac{R_{bT}}{R_{bT} + z_1}\right)$$

$$= \left(\frac{100}{1 + 20 \times 10^{-6}.10\,000}\right)\left(\frac{5\,909{,}1}{5\,909{,}1 + 2\,001{,}2}\right) \checkmark$$

$$= (83{,}333)(0{,}747) \checkmark$$

$$= 98{,}6 \checkmark \longrightarrow \quad (7)$$

3.2.2 $$Z_i = R_{bt} // Z_1$$

$$= \frac{5\,909{,}1 \times 2\,001{,}2}{5\,909{,}1 + 2\,001{,}2} \checkmark$$

$$= 1\,494{,}92\ \Omega \checkmark \longrightarrow \quad (2)$$

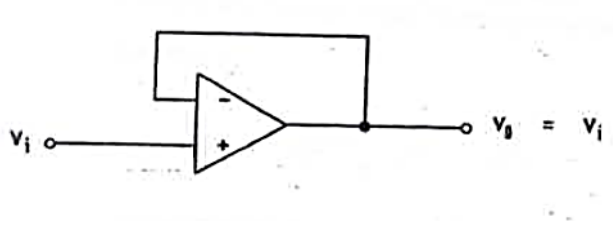
3.3 The amplified output signal of an amplifier ought to be similar to the input signal; therefore, if the output signal does not adopt the format of the input signal, the output signal is distorted. (2)

[18]

QUESTION 4: OPERATIONAL AMPLIFIERS

4.1
- Very high input impedance that causes almost no current load for circuits
- Very high voltage gain suitable to amplify very small signals
- Very low output impedance not affected easily by other loads (3)

4.2



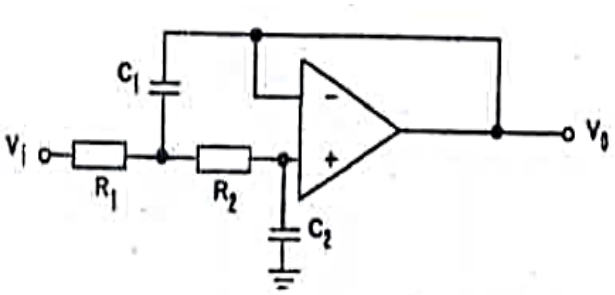
(voltage follower ½ for input + ½ for output + ½ for components + ½ for connection) (2)

4.3
$$V_O = \frac{R_f}{R_{in}}(V_2 - V_1)$$

$$= \frac{200 \times 10^3}{200 \times 10^3}(5 - 4)\checkmark\checkmark$$

$$= 1\text{ V}\checkmark\Longrightarrow$$ (3)

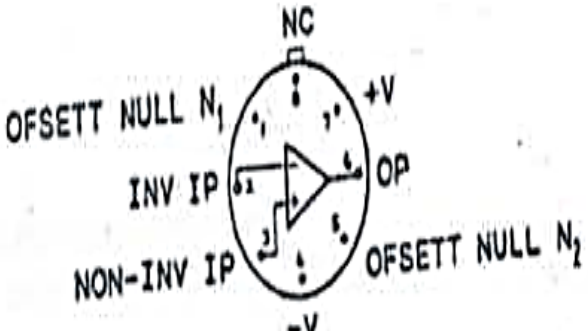
4.4



(½ mark for each component) (3)
[11]

QUESTION 5: INTEGRATED CIRCUITS

5.1

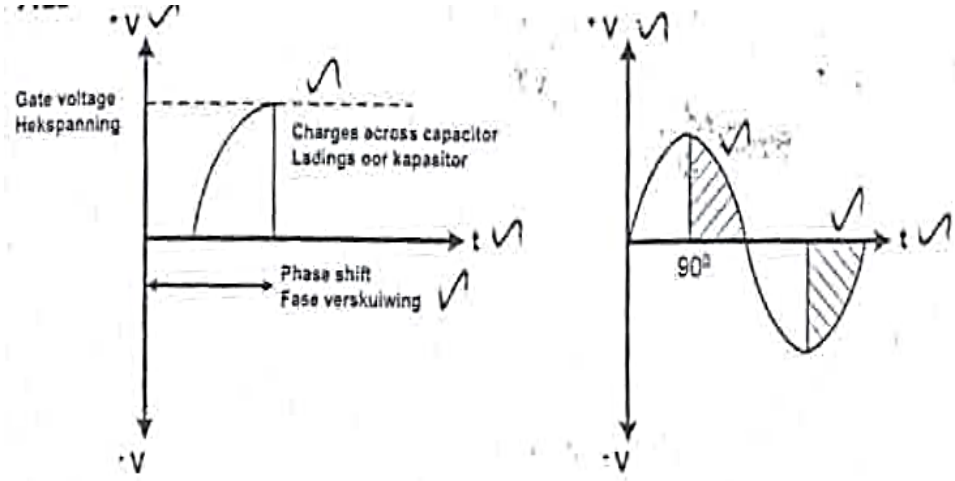


(4)

5.2 5 V (1)

[5]

QUESTION 6: ELECTRONIC PHASE CONTROL



[4]

QUESTION 7: TEST EQUIPMENT

Start 1: 0000✓

Step 1: 1000 (8V) V_r< Vu: sets 1 ✓

Step 2: 1101 (13V) V_r< Vu: sets 1✓

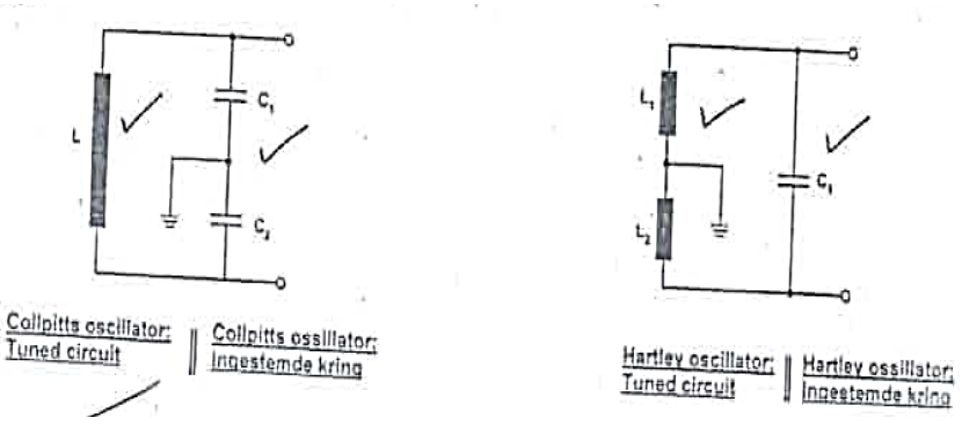
Step 3: 1100 (12V) V_r< Vu: sets 1✓

Step 4: 1111 (15V) V_r>Vu: resets 1 to 0✓ **[5]**

QUESTION 8: OSCILLATORS

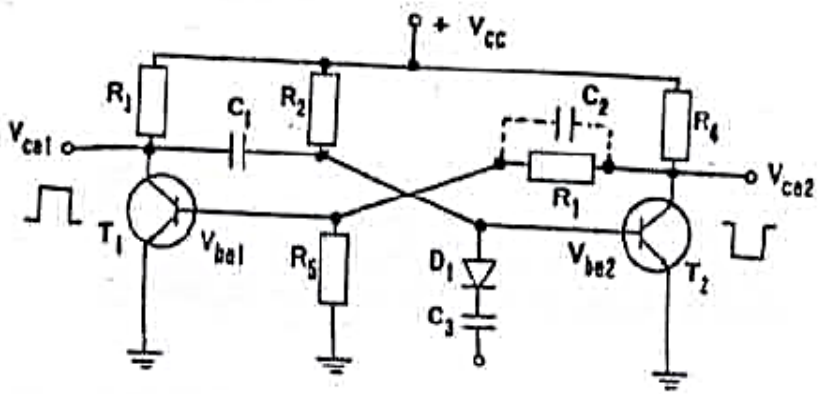
8.1
- Positive feedback
- Resonant frequency and feedback signal must be in phase
- Constant power supply needed
- Gain of circuit must be greater than one (Any 2 × 1) (2)

8.2



(4)

8.3



(4)

8.4 $f_O = \frac{1,443}{(R_A + 2R_B)C}$

$= \frac{1,443}{(100 \times 10^3 + 2,80 \times 10^3) \times 5 \times 10^{-6}}$ ✓✓

$= 1,11$ Hz✓ (3)

[13]

QUESTION 9: TRANSDUCERS

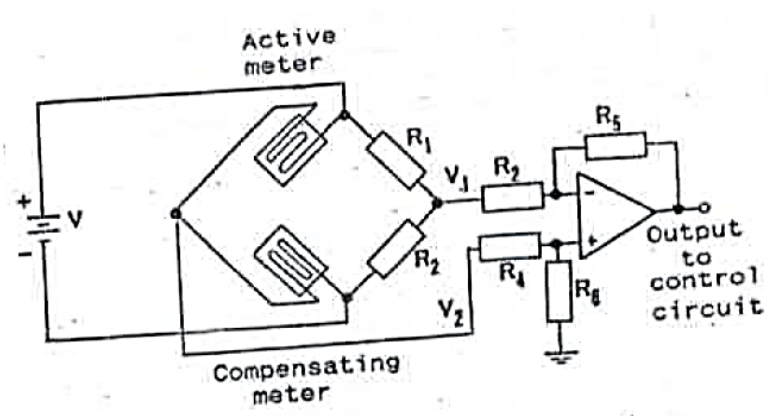
9.1 $$\text{Resolution} = \frac{\text{Voltage drop across two adjacent turns}}{\text{Total voltage drop}}$$

$$\frac{2}{100} = \frac{10 \times 10^{-3}}{\text{Total voltage drop}} \checkmark$$

$$\text{Total voltage drop} = \frac{10 \times 10^{-3}}{0{,}02} \checkmark$$

$$= 0{,}5 \text{ V} \checkmark \longrightarrow \quad (3)$$

9.2



(5)

9.3 $$\frac{R_{t_1}}{R_{t_2}} = \frac{Ae^{B/T_1}}{Ae^{B/T_2}} \quad T_1 = 273 + 10 = 283 \text{ K}$$
$$T_2 = 273 + 30 = 303 \text{ K}$$

$$\frac{12 \times 10^3}{2 \times 10^3} = \frac{Ae^{B/283}}{Ae^{B/303}}$$

$$6 = e^{B/283 - B/303} \checkmark$$

$$6 = e^{B(1/283 - 1/303)} \checkmark$$

$$\ln 6 = B\,(2{,}33 \times 10^{-4}) \checkmark$$

$$B = 7\,686{,}66 \checkmark \longrightarrow \quad (4)$$

[12]

TOTAL: 100

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