

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

INDUSTRIAL ELECTRONICS N5

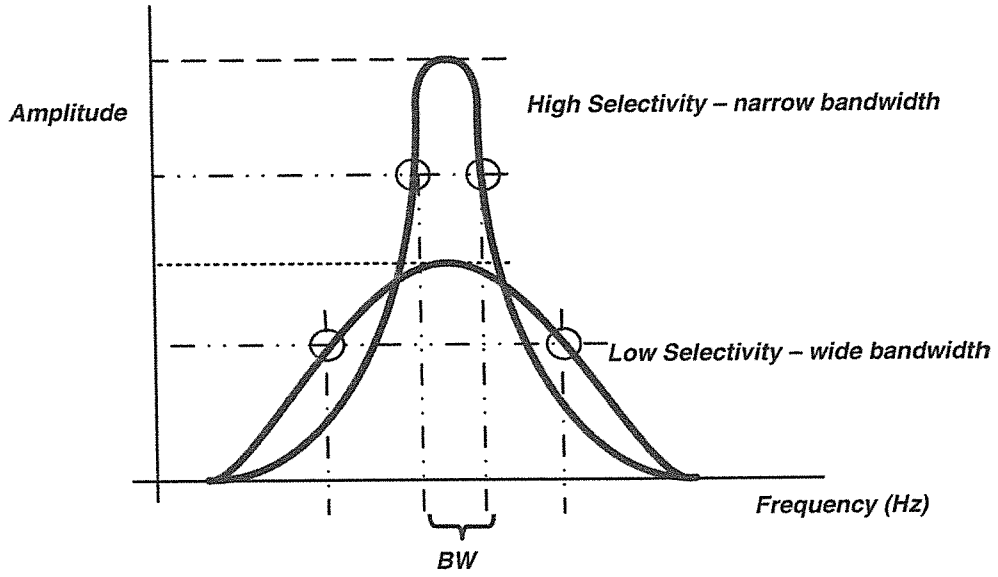
9 APRIL 2015

This marking guideline consists of 11 pages.

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QUESTION 1: ALTERNATING CURRENT THEORY

1.1



(5)

1.2 1.2.1 $Z_1 = 120 - j\,21{,}21\ \Omega = 121{,}86\angle -10{,}02^0\ \Omega$

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

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

$$Z_{//} = \frac{Z_1 \times Z_2}{Z_1 + Z_2}$$

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

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

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

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

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

$Z_T = Z_{//} + Z_3$

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

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

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

(7)

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1.2.2 $I_T = \frac{V_T}{Z_T}$

$= \frac{250\angle 0^0}{179,152\angle 14,12^0}$

$= 1,395\angle -14,12^0$ A (2)

[16]

QUESTION 2: POWER SUPPLIES

2.1 $V_{DC} = V_M - \frac{I_{DC}}{2fC}$

$= 15 - \frac{10\times10^{-3}}{2\times50\times470\times10^{-6}}$

$= 14,787$ V

OR

$V_{r(rms)} = \frac{I_{dc}}{2\sqrt{3}.F.C}$

$= \frac{10\times10^{-3}}{2\times\sqrt{3}\times50\times470\times10^{-6}}$

$= 0,123$ V

OR

$R_L = \frac{V_{dc}}{2\sqrt{3}.f.C \quad V_{r(rms)}}$

$= \frac{14,787}{2\sqrt{3}\times50\times470\times10^{-6}\times0,123}$

$R_L = 1\,478,72\ \Omega$

$\therefore R_L = \frac{Vdc}{Idc}$

OR $= \frac{14,787\ V}{10\times10^{-3}\ A}$

$= 1\,478,7\ V$

OR

$r = \frac{I_{dc}}{2\sqrt{3}.f.C.V_{dc}}$

$= \frac{10\times10^{-3}}{2\times\sqrt{3}\times50\times470\times10^{-6}\times14,787}$

$= 8,307\times10^{-3}$

OR

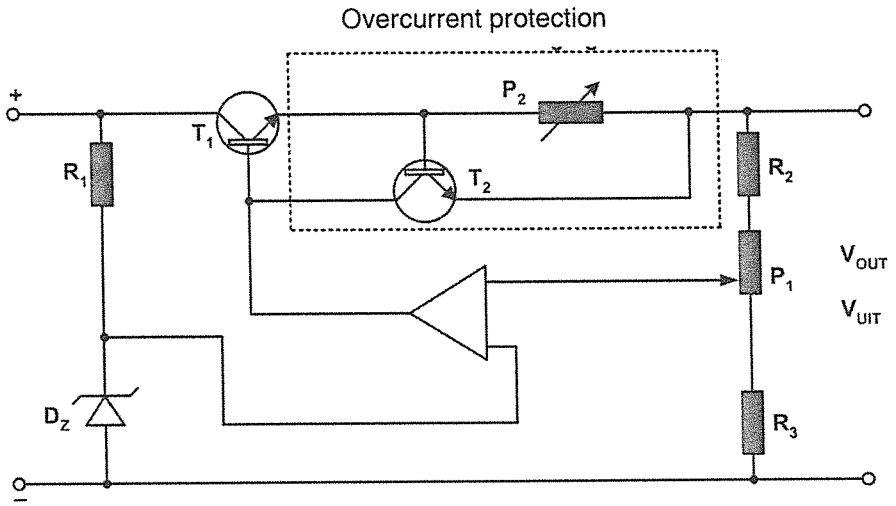
$R_L = \frac{1}{2\sqrt{3}.f.C.x.r}$

$= \frac{1}{2\sqrt{3}\times50\times470\times10^{-6}\times8,307\times10^{-3}}$

$R_L = 1\,478,72\ \Omega$

(6)

2.2



Potentiometer P_2 is adjusted during a normal load current so that transistor T_2 is not biased forward sufficiently and therefore is 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 limits the increase in load current to a safe value. (6)

2.3 $$0{,}05 = \frac{15\,V - V_{FL}}{V_{FL}}$$

$$\therefore V_{FL} = 14{,}286\,V$$

$$Drop: = V_{NL} - V_{FL}$$
$$= 15\,V - 14{,}286\,V$$
$$= 0{,}714\,V$$

(3)
[15]

QUESTION 3: TRANSISTOR AMPLIFIERS

3.1
- Inverse saturating current, I_{CO}, which doubles for each 10 °C increase in temperature
- Base/emitter voltage, V_{BE}, which decreases with 2,5 mV/°C
- Current gain, β, which increases with temperature

(3)

3.2 $V_e = \frac{1}{10} \times V_{CC}$

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

$= \underline{1{,}2\ V}$

$I_C \cong I_E$

$\therefore I_E = V_E / R_E$

$I_C = V_E / R_E$

$I_C = 1,2 / 120$

$= \underline{10\ mA} \rightarrow$

$I_C = \beta . I_B$

$I_B = I_C / \beta$

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

$= \underline{40\ \mu A} \rightarrow$

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

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

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

$\therefore V_{CE} = \underline{6\ V} \rightarrow$

OR

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

$= \frac{3000}{3000 + 15947} \times 12$

$= \underline{1,9\ V} \rightarrow$

OR

$V_B = V_E + V_{BE}$
$= 1,2 + 0,7$
$= \underline{1,9\ V} \rightarrow$

(10)

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3.3 $Z_1 = h_{ie}$

$= \underline{1,2\ k\Omega}$

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

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

$$= \frac{15947 \times 3000}{15947 + 3000}$$

$R_{BT} = \underline{2\,524,991\ \Omega}$

$$Z_i = \frac{2524,9908 \times 1200}{2524,9908 + 1200}$$

$= \underline{813,42\ \Omega}$

$$Z_2 = {}^{1}\!/_{h_{oe}}$$

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

$= \underline{50\ k\Omega}$

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

$$= \frac{480 \times 50000}{480 + 50000}$$

$= \underline{475,436\ \Omega}$ (5)
[18]

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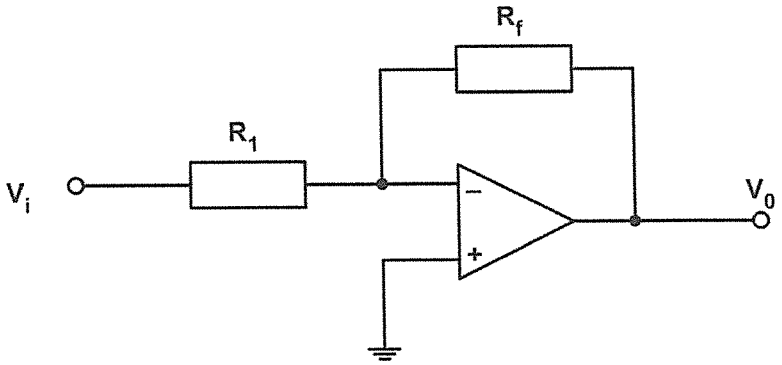
QUESTION 4: OPERATIONAL AMPLIFIERS

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



(3)

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

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

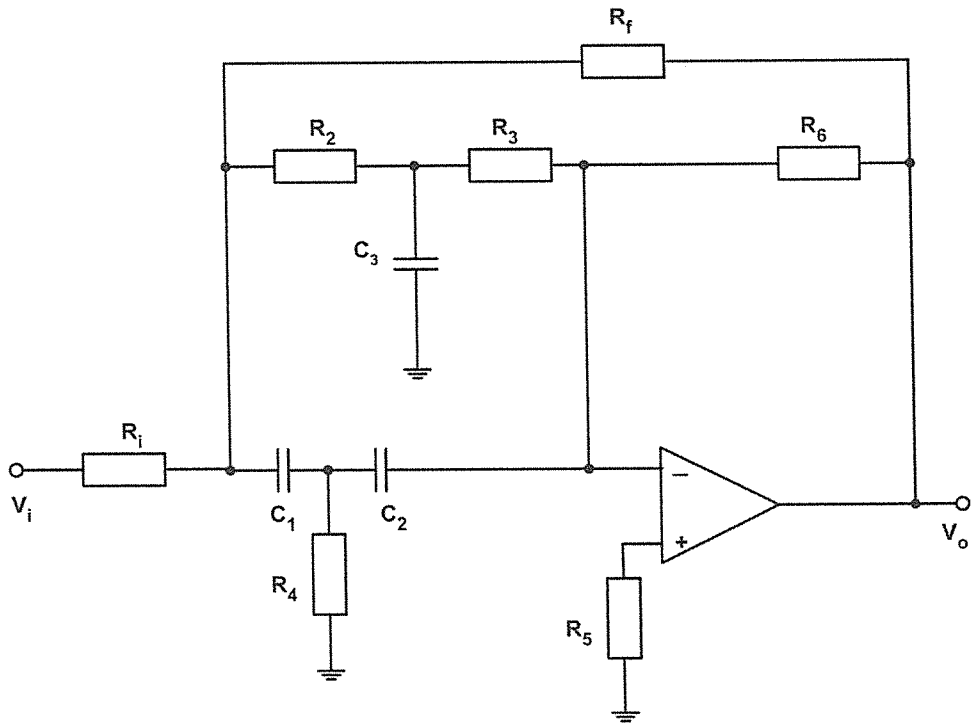
$$= \frac{20000 \times 20}{2}$$

$$= 200 \text{ k}\Omega$$

(3)

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4.3



(4)
[14]

QUESTION 5: INTEGRATED CIRCUITS

5.1 All unutilised inputs must be connected to V_{DD} or V_{SS} (2)

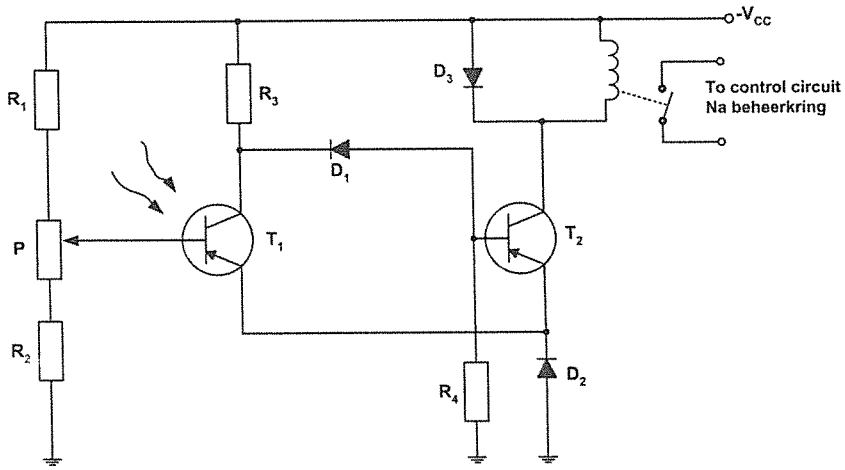
5.2 5.2.1 True
5.2.2 False
5.2.3 True

(3 × 1) (3)
[5]

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QUESTION 6: TRANSDUCERS

6.1



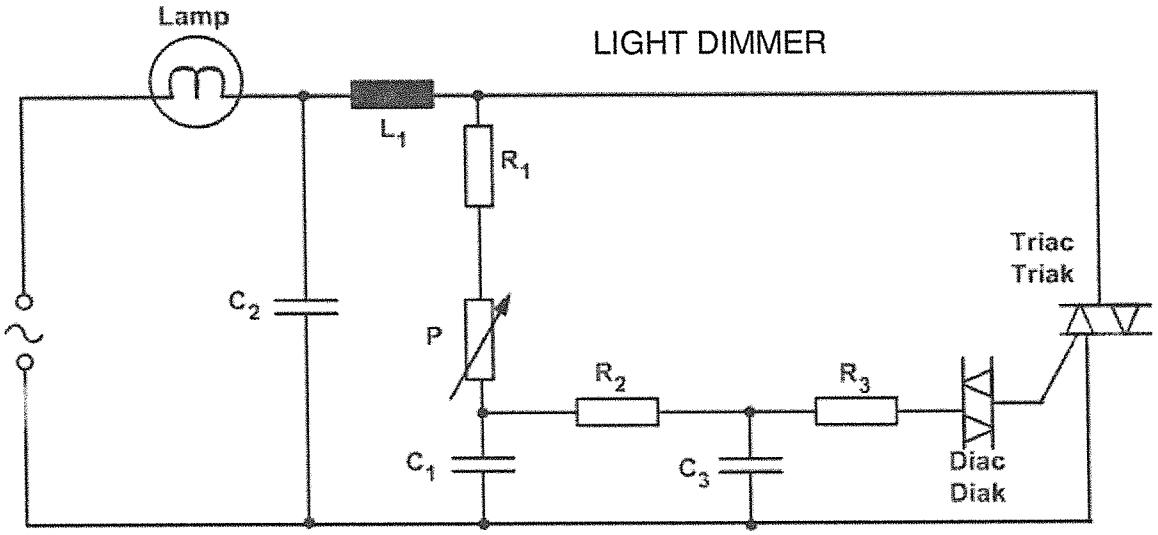
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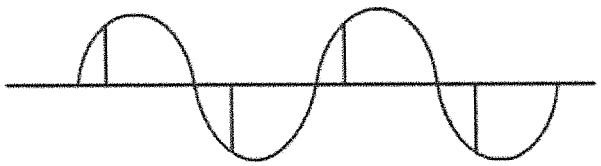
6.2 The slider of the feedback potentiometer can be adjusted mechanically by the axle of the canon turret and sends a feedback signal to the comparator. The comparator compares the feedback signal with the reference signal, which is adjusted manually. If there is a difference, the error signal is given and applied on the motor. The motor rotates the gearbox and canon respectively, which rotates the axle of the feedback potentiometer in return. As the canon nears its required position, the error signal becomes smaller. As soon as the canon reaches its required position, the error signal is zero and the motor will stop.

(5)
[11]

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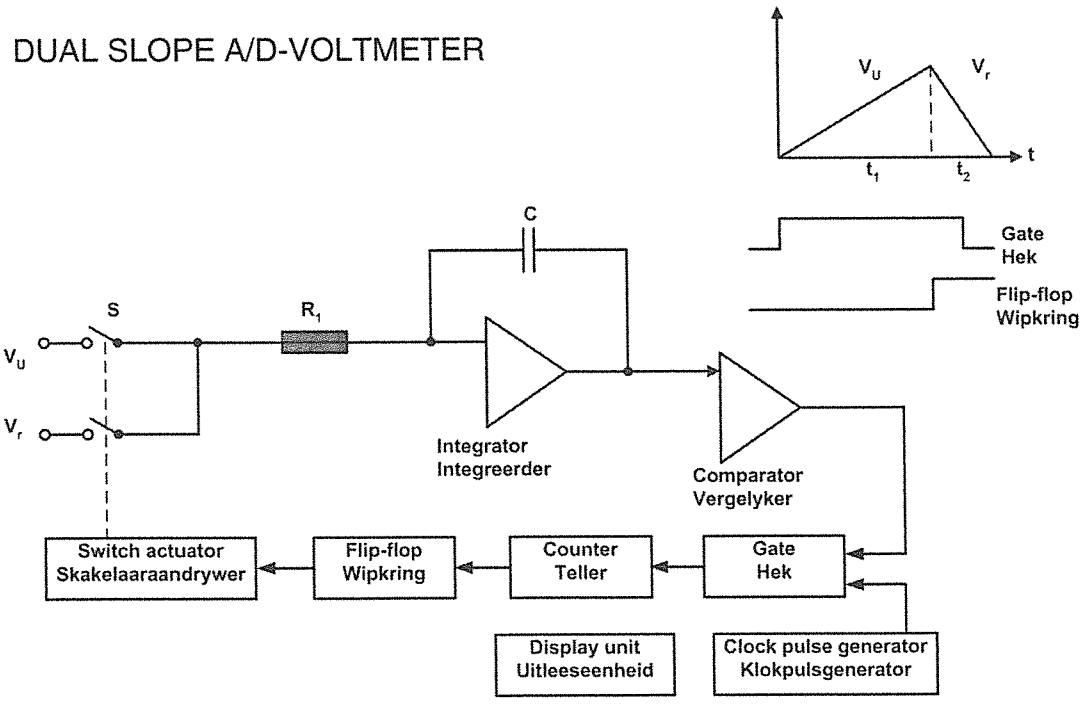
QUESTION 7: ELECTRONIC PHASE CONTROL





[6]

QUESTION 8: TEST EQUIPMENT



[6]

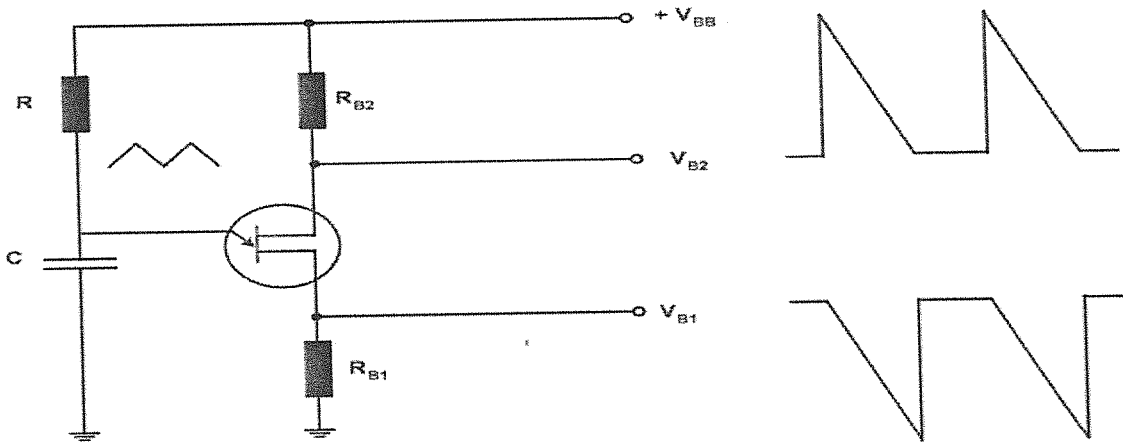
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QUESTION 9: OSCILLATORS

9.1
- Variation in the tuned circuit or transistor parameters
- Change in load conditions
- An unstable supply voltage

(3)

9.2



BASIC UJT OSCILLATOR (4)

9.3
- Sine waveform – 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 2 × 2) (4)
[11]

TOTAL: 100

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