higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N5

30 July 2021

This marking guideline consists of 10 pages.

Copyright reserved

QUESTION 1: ALTERNATING CURRENT THEORY

1.1 Selectivity is the ability of an amplifier to distinguish between signals whose frequencies are very close to one another.

OR

A high 'Q' offers a sharper peak and will discriminate in favour of frequencies close to f_r.✓✓ (2)

1.2

$$V_{R3} = I_{R3}R_3$$
$$= 15 \text{ x } 10$$
$$= 150 \text{ V } ✓$$
$$V_{//} = V_T - V_{R3}$$
$$= 300 - 150$$
$$= 150 \text{ V } ✓✓$$
$$I_{R1} = \frac{V_{//}}{R_1}$$
$$= \frac{150}{20}$$
$$= 7{,}5 \text{ A } ✓✓$$
$$I_{R2} = I_{R3} - I_{R1}$$
$$= 15 - 7{,}5$$
$$= 7{,}5 \text{ A } ✓$$
$$R_2 = \frac{V_{//}}{I_{R2}}$$
$$= \frac{150}{7{,}5}$$
$$= 20 \Omega \text{ } ✓✓ \longrightarrow$$ (8)

1.3 $X_L = 2\pi fL$

$= 2 \text{ x } \pi \text{ x } 50 \text{ x } 0{,}01$

$= 3{,}142\ \Omega$

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

$= \frac{1}{2 \text{ x } \pi \text{ x } 50 \text{ x } 100 \text{ x } 10^{-6}}$

$= 31{,}831\ \Omega$

$Z_1 = 0 - j\,31{,}831 = 31{,}831 \llcorner -90^0\ \Omega$ ✓

$Z_2 = 5 + j\,3{,}142 = 5{,}905 < 32{,}145^0\ \Omega$ ✓

$Z_T = \frac{Z_1 \text{ x } Z_2}{Z_1 + Z_2}$

$= \frac{31{,}831 \llcorner -90^0 \text{ x } 5{,}905 \llcorner 32{,}145^0}{0 - j\,31{,}831 + 5 + j\,3{,}142}$ ✓

$= \frac{187{,}962 \llcorner -57{,}855^0}{5 - j\,28{,}689}$

$= \frac{187{,}962 \llcorner -57{,}855^0}{29{,}121 \llcorner 80{,}114^0}$ ✓

$= 6{,}523 \llcorner -137{,}963^0\ \Omega$ ✓ → (5)

[15]

QUESTION 2: POWER SUPPLIES

2.1

$$r = \frac{V_{r(rms)}}{V_{DC}}$$

$$\therefore V_{r(rms)} = V_{dc}.r$$

$$= 0{,}05 \text{ x } 40 \checkmark$$

$$= 2 \text{ V} \checkmark$$

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

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

$$= 0{,}03 \text{ x } 50 \checkmark$$

$$= 1{,}5 \text{ V} \checkmark$$

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

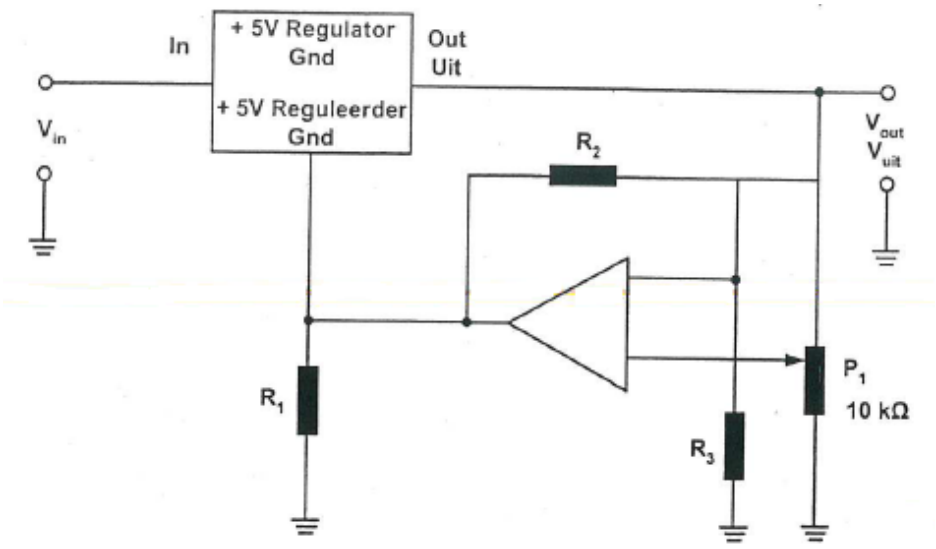
$$\therefore C = \frac{V_{r(rms)}}{(4\pi f)^2 L.V'_{r(rms)}}$$

$$= \frac{2}{(4 \text{ x } \pi \text{ x } 50)^2 \text{ x } 0{,}5 \text{ x } 1{,}5} \checkmark$$

$$= 6{,}755 \text{ µf} \checkmark \longrightarrow$$ (6)

2.2 The voltage at which the circuit will limit 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 into conduction, a pulse will be supplied to the gate of the SCR. The SCR will start conducting and provide a virtual short circuit across the output terminals. (3)

2.3



High stable adjustable voltage regulator
IGNORE SHADED RESISTORS AND TAKE THEM AS NORMAL RESISITORS (5)
[14]

QUESTION 3: TRANSISTOR AMPLIFIERS

3.1 3.1.1

$$V_e = \frac{V_{cc}}{10}$$

$$= \frac{20}{10}$$

$$= 2\ V \checkmark$$

$$R_b = \frac{V_{cc} - V_{be} - V_e}{I_b}$$

$$\therefore I_b = \frac{V_{cc} - V_{be} - V_e}{R_b}$$

$$= \frac{20 - 0{,}7 - 2}{480 \times 10^3} \checkmark$$

$$= 3{,}604\ \mu A \checkmark$$

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

$$= \frac{15 \times 10^{-3}}{3{,}604 \times 10^{-6}} \checkmark$$

$$= 4{,}162 \checkmark \longrightarrow \quad (5)$$

3.1.2

$$Ce = \frac{10}{2\pi f R_e}$$

$$= \frac{10}{2 \times \pi \times 50 \times 133{,}33} \checkmark$$

$$= 238{,}74\ \mu f \checkmark \longrightarrow \quad (2)$$

3.2 3.2.1

$$Z_L = \frac{R_c \times R_L}{R_c + R_L}$$

$$= \frac{5000 \times 20000}{5000 + 20000} \checkmark$$

$$= 4\ k\Omega \checkmark$$

$$A_V = \frac{-h_{fb} Z_L}{h_{ib} + (h_{ib} h_{ob} - h_{fb} h_{rb}) Z_L}$$

$$= \frac{-(-0{,}95) \times 4000 \checkmark\checkmark}{50 + \{50 \times 0{,}4 \times 10^{-6} - (-0{,}95 \times 200 \times 10^{-6})\} \times 4000}$$

$$= 74{,}74 \checkmark \longrightarrow \quad (5)$$

Copyright reserved

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

$= 50 - \frac{(-0,95) \text{ x } 200 \text{ x } 10^{-6} \text{ x } 4000}{1 + 0,4 \text{ x } 10^{-6} \text{x } 4000}$ ✓

$= 50,76$ ✓

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

$= \frac{1000 \text{ x } 50,76}{1000 + 50,76}$ ✓

$= 48,308\ \Omega$ ✓ ⟶ (4)

[16]

QUESTION 4: OPERATIONAL AMPLIFIERS

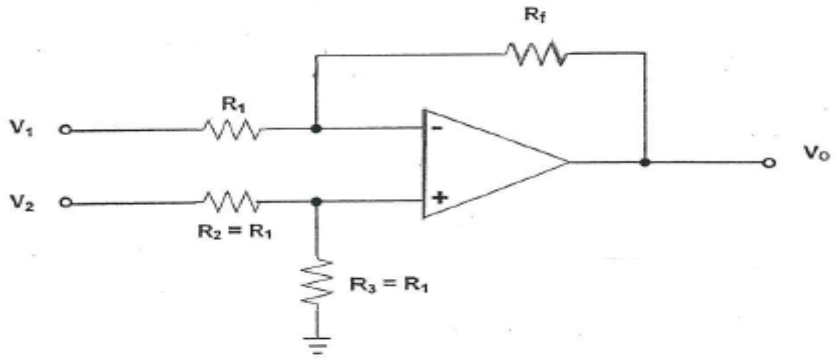
4.1

$$V_O = -R_f\left(\frac{V_1}{R_1}+\frac{V_2}{R_2}+\frac{V_3}{R_3}\right)$$

$$= -30 \times 10^3\left(\frac{6}{120 \times 10^3}+\frac{6}{240 \times 10^3}+\frac{6}{360 \times 10^3}\right) ✓✓$$

$$= 2{,}7501 \text{ V} ✓ \longrightarrow$$ (3)

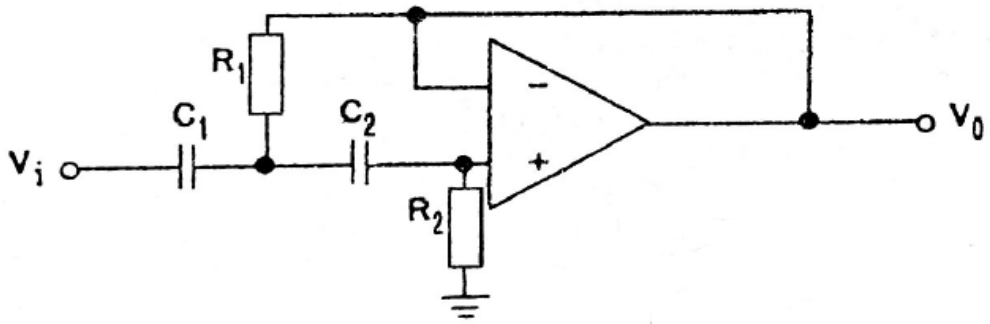
4.2



Differential amplifier (3)

4.3
- Electric analog computers
- Servo systems
- Linear mixers
- Level shifting (Any 1 × 1) (1)

4.4



High-pass filter (3)
[10]

QUESTION 5: INTEGRATED CIRCUITS

- Earth soldering tips
- Use earthed wristbands
- Earth all test equipment
- Switch the power off as soon as you work on the circuit
- Connect unused inputs to V_{DD} or V_{SS} (5 × 1) **[5]**

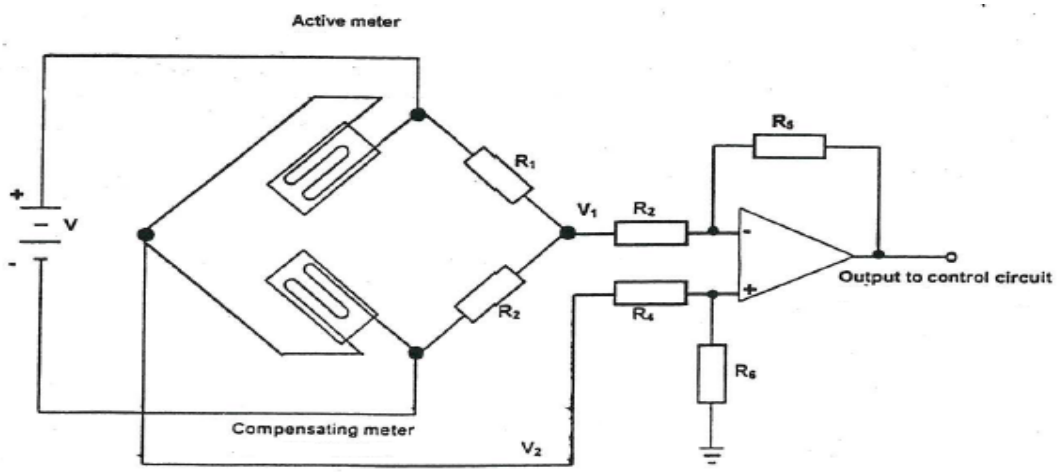
QUESTION 6: TRANSDUCERS

6.1 The resolution of a potentiometer can be defined as the relation of the voltage drop across two adjacent turns to the total drop.

OR

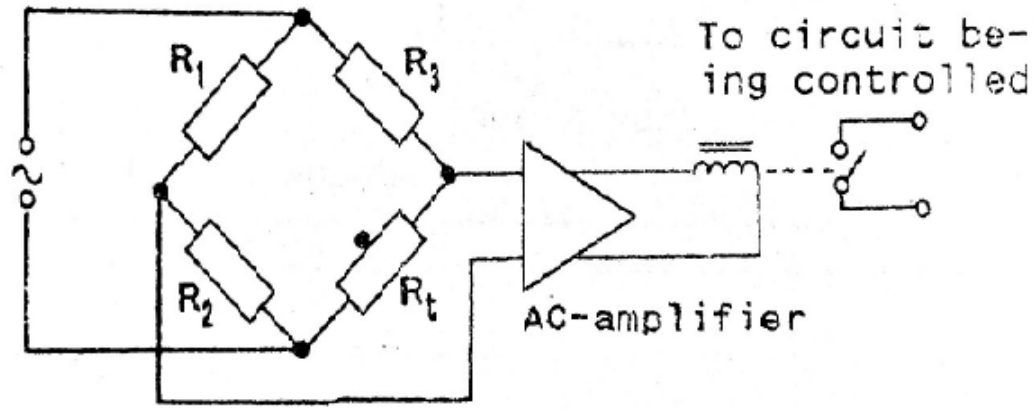
The relation of one turn to the total number of turns of the resistor. (2)

6.2



Strain gauge in a Wheatstone bridge (5)

6.3



Temperature control with the aid of a thermistor (5)

6.4 Value of a thermistor at 24 °C:

$$T = ℃ + 273$$

$$= 24℃ + 273$$

$$= 297\ \text{K}\ ✓$$

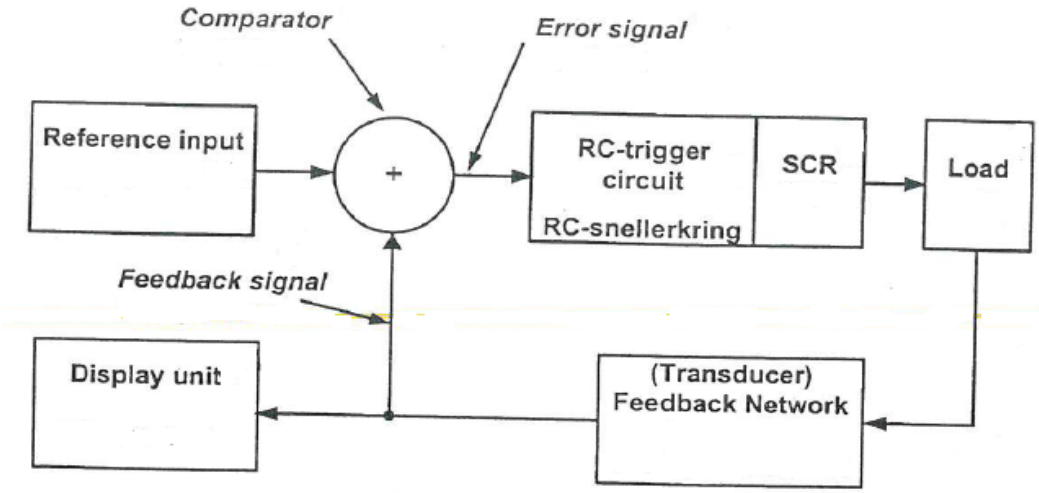
$$\therefore R_T = A.e^{\frac{B}{T}}$$

$$= 7 \times 10^{-12} \times e^{\frac{8972}{297}}$$

$$= 921{,}708\Omega\ ✓ \longrightarrow$$ (2)

[14]

QUESTION 7: ELECTRONIC PHASE CONTROL



- The comparator compares the feedback signal from the load with the reference signal. As soon as the load deviates,
- an error signal appears on the output of the comparator,
- which is used by the control circuit in order to bring the load condition back to normal. **[8]**

QUESTION 8: TEST EQUIPMENT

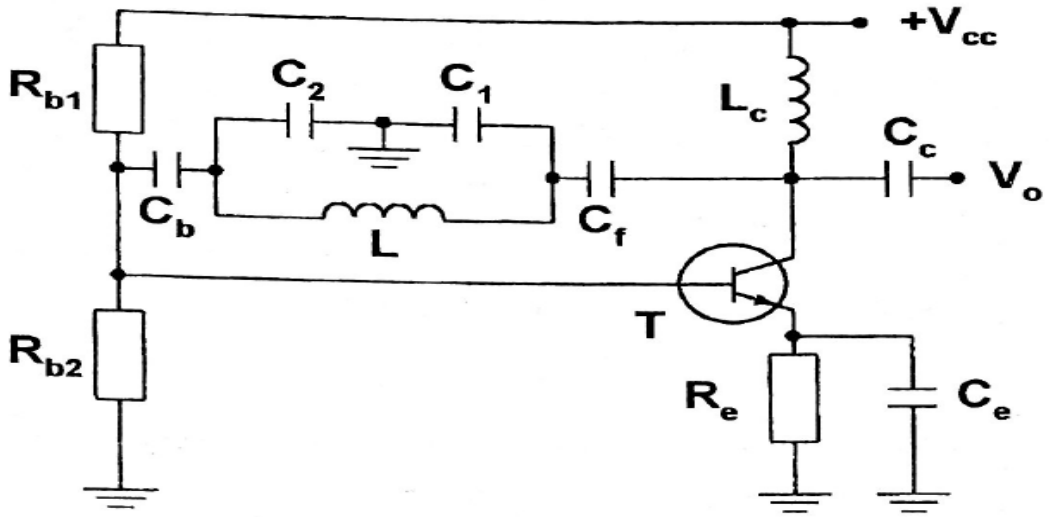
8.1
- The counter counts through its full capacity during the charging period of the capacitor.
- A carry pulse is sent to the flip-flop,
- which causes the switch 'S' to switch (Discharge through Vr and the counter counts until C is discharged).
- This count is proportional to the discharging period and also proportional to the voltage Vu. (4)

8.2 To convert an analog input signal to a digital signal. (2)

[6]

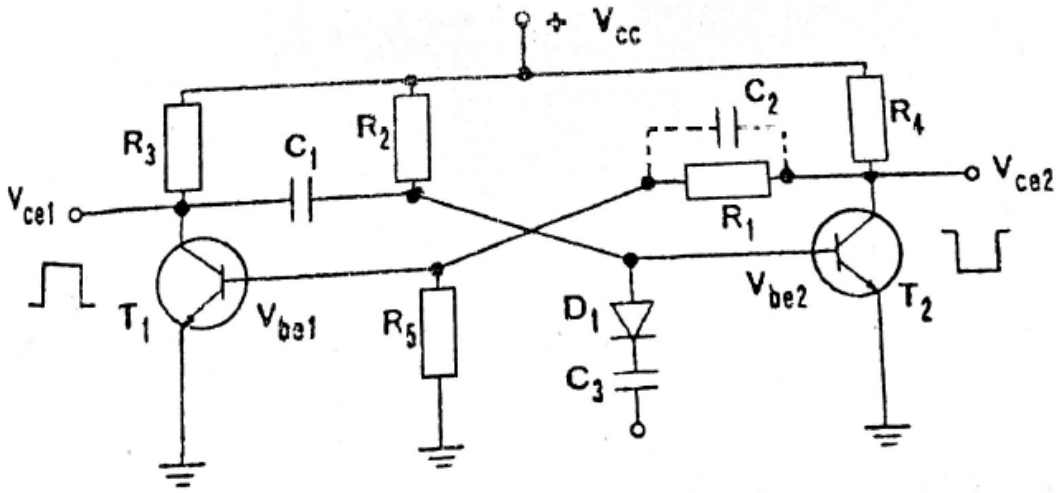
QUESTION 9: OSCILLATORS

9.1



Colpitts oscillator (4)

9.2



An external trigger pulse is required to let the circuit work. The circuit is in a stable state and 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. (8)

[12]

TOTAL: 100

Copyright reserved