



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

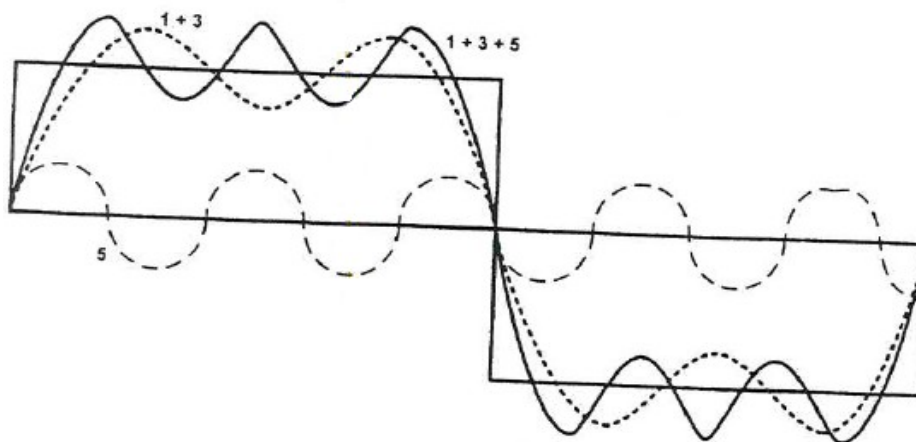
NATIONAL CERTIFICATE INDUSTRIAL ELECTRONICS N5

4 July 2022

This marking guideline consists of 9 pages.

QUESTION 1

1.1

Third (3rd) and fifth (5th) harmonics ✓✓✓✓

(4)

1.2

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$\therefore C = \frac{1}{(2\pi f_r)^2 L} \checkmark$$

$$\hat{=} \frac{1}{(2 \times \pi \times 1500)^2 \times 0,2}$$

$$\hat{=} 11 \text{ nF} \checkmark \longrightarrow$$

(3)

1.3

Low-pass filter:

The circuit that offers a low reactance at high-frequency signals and passes low-frequency signals. ✓✓

(2)

1.4

$$R = \frac{V}{I}$$

$$\hat{=} \frac{20 \times 10^{-3}}{120 \times 10^{-3}}$$

$$\hat{=} 0,167 \Omega$$

$$Q = \frac{X_C}{R}$$

$$\therefore X_C = Q \cdot R$$

$$\hat{=} 120 \times 0,167$$

$$\hat{=} 20,04 \Omega$$

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

$$\therefore C = \frac{1}{2\pi fX_C}$$

$$\hookrightarrow \frac{1}{2 \times \pi \times 5,550 \times 10^3 \times 20,04}$$

$$\hookrightarrow 1430,966 \mu f$$

$X_L = X_C$ At resonant, I is at max

$$X_L = 2\pi fL$$

$$\therefore L = \frac{X_L}{2\pi f}$$

$$\hookrightarrow \frac{20,04}{2 \times \pi \times 5,550 \times 10^3}$$

$$\hookrightarrow 574,67 \text{ mH} \longrightarrow$$

(7)
[16]

QUESTION 2

- 2.1 Total voltage drop across a full-wave voltage doubler is obtained:
During the positive half-cycle across the transformer, diode D_1 conducts and diode D_2 is off. Capacitor C_1 charges to a voltage of V_m . During the negative half-cycle diode D_2 will conduct and diode D_1 is off. Capacitor C_2 will then charge to a voltage of V_m . The total voltage drop across both capacitors will therefore be $2 V_m$. ✓✓✓✓

(4)

2.2 2.2.1 $V'_{dc} = I'_{dc} \times R_L$

$$\hookrightarrow 2 \times 10 \checkmark$$

$$\hookrightarrow 20 \text{ V } \checkmark \longrightarrow$$

(2)

2.1.2 $X_C = \frac{1}{4\pi fC}$

$$\therefore C = \frac{1}{4\pi fX_C}$$

$$\hookrightarrow \frac{1}{4 \times \pi \times 50 \times 20}$$

$$\hookrightarrow 79,577 \mu f$$

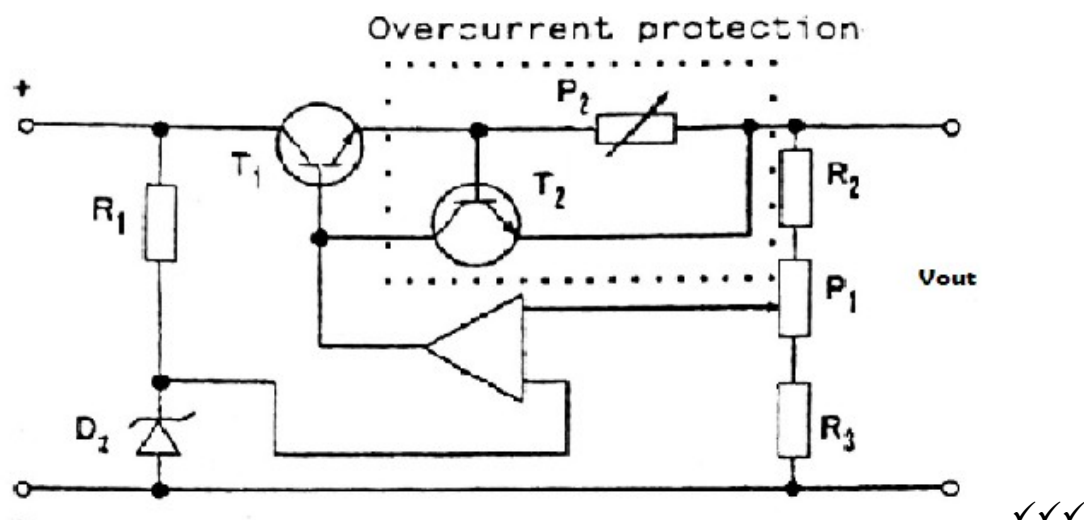
$$V'_{r(rms)} = \frac{V_{r(rms)}}{(4\pi f)^2 LC}$$

$$= \frac{1,5}{(4 \times \pi \times 50)^2 \times 0,1 \times 79,577 \times 10^{-6}}$$

$$= 0,477 \text{ V} \longrightarrow$$

(5)

2.3



Operation of over-current protection:

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. ✓✓✓

3 Marks for the discussion
1 = State problem
1 = Remedy
1 = Result

(6)
[17]

QUESTION 3

3.1 Stabilisation:

The process of making the operating point independent of temperature changes or variations in transistor parameters. ✓✓

(2)

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

$$= \frac{8200 \times 12000}{8200 + 12000}$$

$$= 4871,287 \Omega$$

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

$$\therefore 28 - \frac{(-0,98) \times 5 \times 10^{-4} \times 4871,287}{1 + 0,34 \times 10^{-6} \times 4871,287}$$

$$\therefore 30,383$$

$$A_i = \left(\frac{h_{fb}}{1 + h_{ob} \cdot Z_L} \right) \left(\frac{R_e}{R_e + Z_1} \right) \left(\frac{R_C}{R_C + R_L} \right)$$

$$\therefore \left(\frac{-0,98}{1 + 0,34 \times 10^{-6} \times 4871,287} \right) \left(\frac{1200}{1200 + 30,383} \right) \left(\frac{8200}{8200 + 12000} \right)$$

$$\therefore (-0,978)(0,975)(0,406)$$

$$\therefore -0,384 \longrightarrow \quad (10)$$

3.2.2

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

$$\therefore \frac{1200 \times 30,383}{1200 + 30,383}$$

$$\therefore 29,633 \, \Omega \longrightarrow \quad (2)$$

3.3 THREE factors that may cause distortion in an amplifier:

- Input amplitude too high
- Work point of circuit faulty
- Circuit output and load mismatch
- Input characteristic not linear

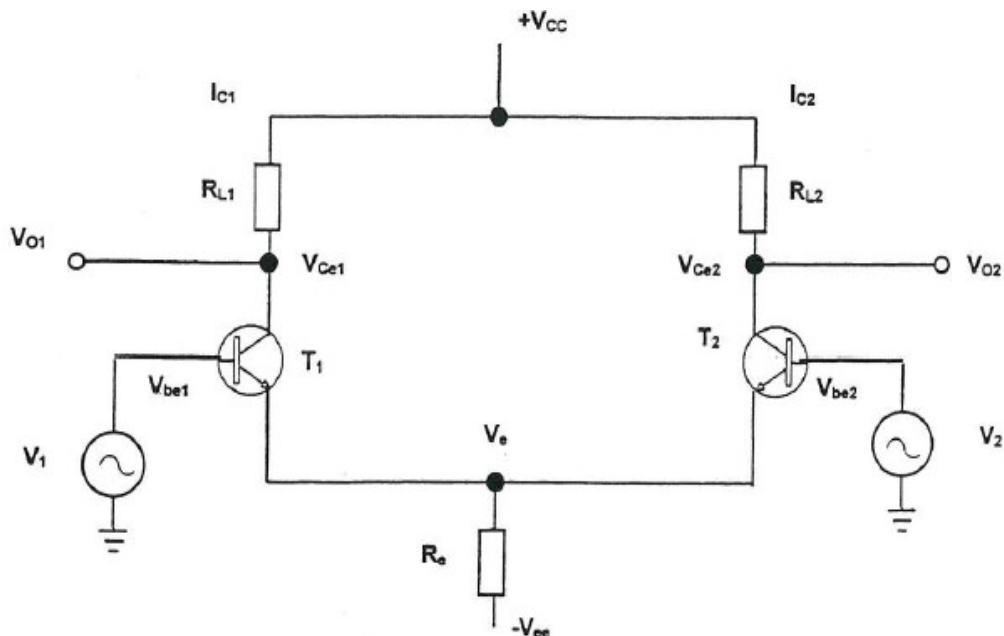
(Any 3 × 1) (3)
[17]

QUESTION 4

- 4.1 4.1.1 False
 4.1.2 True
 4.1.3 True

(3 × 1) (3)

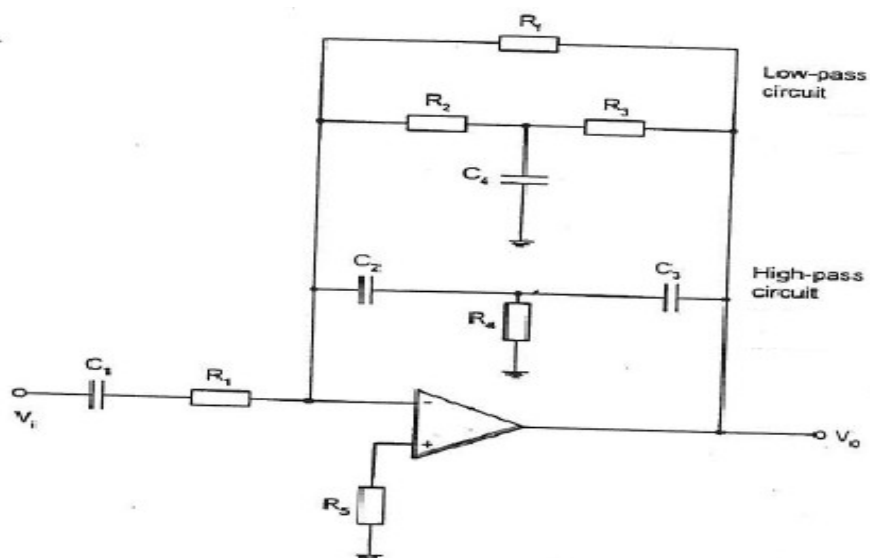
4.2



The differential amplifier✓✓✓✓

(4)

4.3



Band-pass filter✓✓✓✓

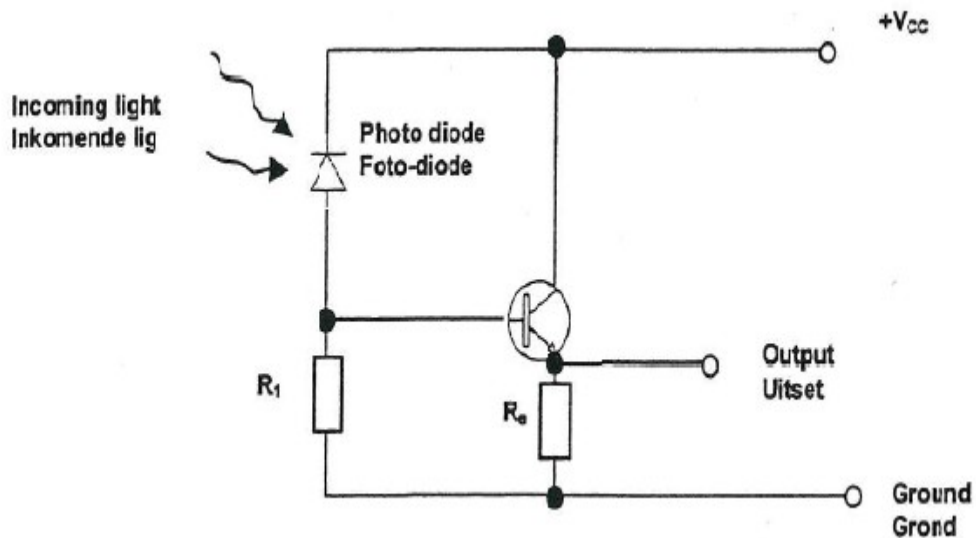
(4)
[11]

QUESTION 5

- 5.1 Fixed voltage regulator:
 • It is a voltage regulator that provides a specific output voltage.
 Adjustable voltage regulator:
 • It is a voltage regulator that provides any output voltage that is within its two specified limits. (2)
- 5.2 Uses less space (1)
- 5.3 FOUR methods to protect CMOS integrated circuits:
 a) Store in conductive sponge
 b) Store in anti-static containers
 c) Short circuit pins with wire
 d) Push into tin foil on polystyrene (4 × 1) (4)
[7]

QUESTION 6

- 6.1 FIVE factors influence the accuracy a transducer:
 a) The fundamental transducer parameters
 b) Physical conditions
 c) Environmental conditions
 d) Ratio of transducer
 e) The adaptability (5 × 1) (5)
- 6.2



✓✓✓

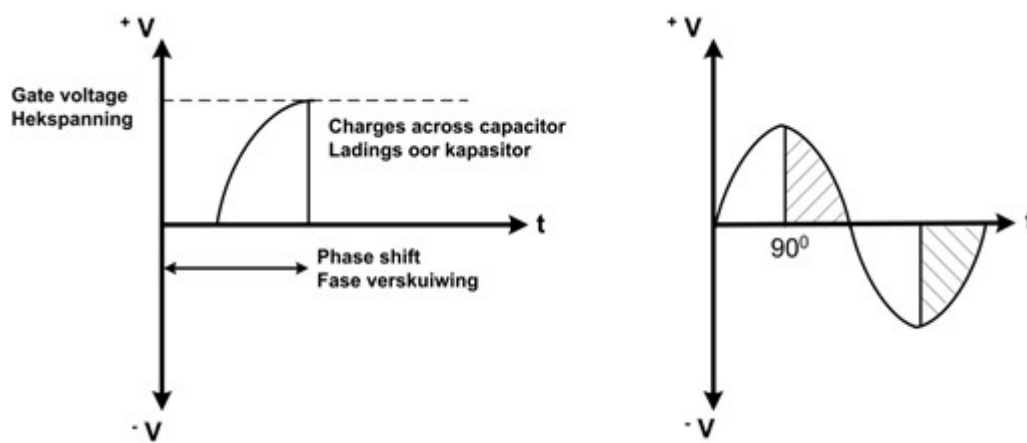
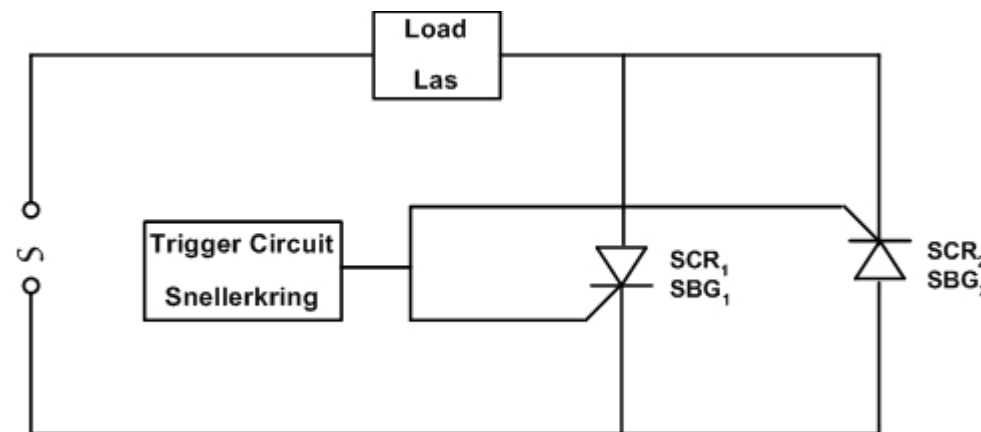
The photo diode in a common collector amplifier (3)

- 6.3 Operation of a tacho-generator in a closed-loop system:
The anchor of the tacho-generator is connected to the axle of the motor mechanically and invokes a voltage V_t that is proportional to the speed of the motor. ✓ This voltage becomes feedback and compares with the reference voltage V_r . ✓ The difference between the two voltages is an error signal and is used to adapt the speed of the motor again. ✓

(3)
[11]**QUESTION 7**

- 7.1 Trigger angle:
The period that the thyristor is switched off is known as the trigger angle. (1)

7.2



Full-wave AC control ✓✓✓✓

(4)
[5]

QUESTION 8

Principle of operation of a successive approximation A/D converter:

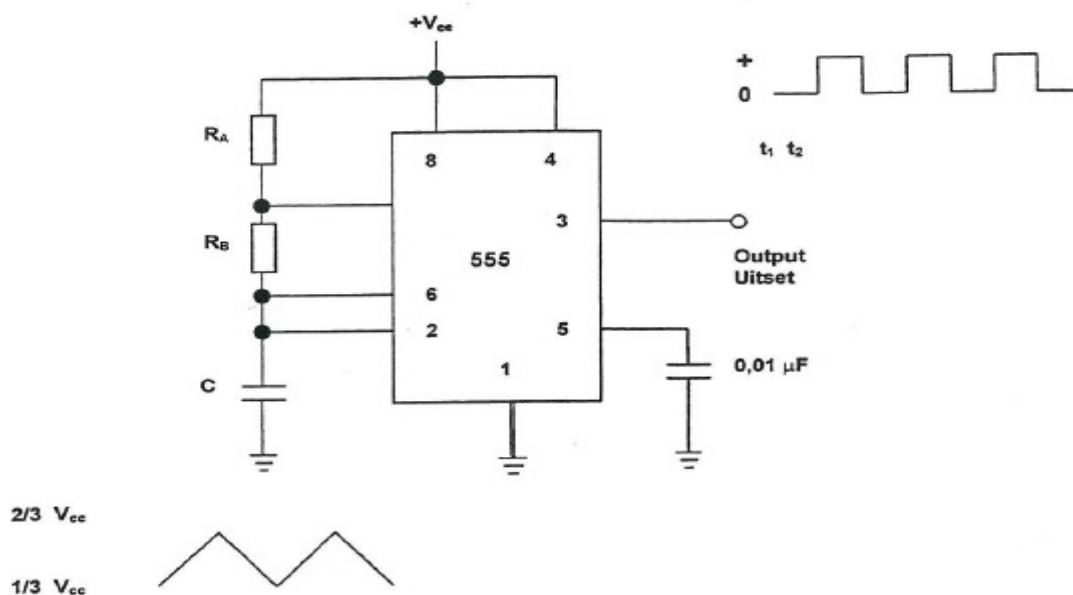
The code register is converted to an analogue reference voltage, V_r , which is compared with the unknown voltage, V_u . The comparator then enables the logic programmer to program the register with a certain code. Initially, the most significant bit is set to 1, while the other bits are 0. The equivalent analogue voltage, V_r , of this code is compared with V_u . If $V_r < V_u$, this 1 is kept in the code, but if $V_r > V_u$, the 1 is reset to 0.

[6]**QUESTION 9**

- 9.1 9.1.1 parallel
 9.1.2 amplify
 9.1.3 positive
 9.1.4 two
 9.1.5 square

(5 × 1) (5)

9.2



The 555-timer in an A-stable operation ✓✓✓✓

(4)

- 9.3 One stable and one semi-stable condition

(1)
[10]**TOTAL: 100**