



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

26 MARCH 2018

This marking guideline consists of 7 pages.

QUESTION 1

- 1.1
- Replace all voltage sources except one with a short circuit. If the voltage source has internal resistance replace it with its internal resistance.
 - From the resulting series-parallel circuit combination calculate the magnitude and direction of the current through appropriate resistors.
 - Repeat steps 1 and 2 for each active voltage source.
 - Algebraically add all the currents (or voltage props) recorded in step 2 to determine the resultant current.
- (4)

1.2

Short circuit V1

$$R_{p1} = (10 \times 8)/(10 + 8) \\ = 4,444 \Omega$$

$$R_{S1} = 4,444 + 12 \\ = 16,444 \Omega$$

$$R_{P2} = (16,444 \times 15)/(16,444 + 15) \\ = 7,844 \Omega$$

$$R_T = 7,844 + 10,5 \\ = 18,344 \Omega$$

Using current divider rule

$$I_{TA} = V_2/R_T \\ = 30/18,344 \\ = 1,635 \text{ A}$$

$$I_{15\Omega} = R_{S1}/(R_{S1}+15) \times I_{TA} \\ = 16,444/(16,444 + 15) \times 1,635 \\ = 0,855 \text{ A}$$

Short circuit V2

$$R_{p1} = (10,5 \times 15)/(10,5 + 15) \\ = 6,176 \Omega$$

$$R_{S1} = 6,176 + 12 \\ = 18,176 \Omega$$

$$R_{P2} = (18,176 \times 8)/(18,176 + 8) \\ = 5,555 \Omega$$

$$R_T = 5,555 + 10 \\ = 15,555 \Omega$$

$$I_{TA} = V_2/R_T \\ = 20/15,555 \\ = 1,286 \text{ A}$$

Using the current divider rule

$$I_1 = 8/(8 + 18,176) \times 1,286$$

$$= 0,393 \text{ A}$$

$$I_{15\Omega} = 10,5/(10,5 + 15) \times 0,393$$

$$= 0,162 \text{ A}$$

$$I_{15\Omega T} = 0,855 + 0,162$$

$$= 1,017 \text{ A}$$

(8)
[12]

QUESTION 2

- 2.1 2.1.1 $X_L = 2 \times \pi \times 50 \times 120 \times 10^{-3}$
 $= 37,699 \Omega$
- $X_{C1} = 1/(2 \times \pi \times 50 \times 240 \times 10^{-6})$
 $= 13,262 \Omega$
- $X_{C2} = 1/(2 \times \pi \times 50 \times 300 \times 10^{-6})$
 $= 10,610 \Omega$
- $Z_1 = 108 + j24,438$
 $= 110,730 \angle 12,749^\circ \Omega$
- $Z_2 = 0 - j10,61$
 $= 10,61 \angle -90^\circ \Omega$
- $Z_T = (110,730 \angle 12,749^\circ \times 10,61 \angle -90^\circ)/(108 + j24,438) + (0 - j10,61)$
 $= 1174,843 \angle -77,251^\circ / 108,882 \angle 7,296^\circ$
 $= 10,790 \angle -84,547^\circ \Omega$
- (6)
- 2.1.2 $I_T = V_T/Z_T$
 $= 230 \angle 0^\circ / 10,790 \angle -84,547^\circ$
 $= 21,316 \angle 84,547^\circ \text{ A}$
- (2)
- 2.2 2.2.1 It is the impedance of a circuit having an inductance and a capacitance in parallel at the frequency at which this impedance has a maximum value. It is also known as rejector impedance.
- 2.2.2 It is a measure of the quality of a resonant circuit. A higher value for this figure of merit corresponds to a narrower bandwidth which is desirable in many applications.
- (2 × 2) (4)
[12]

QUESTION 3

- 3.1 3.1.1 D
 3.1.2 C
 3.1.3 E
 3.1.4 F
 3.1.5 A

(5 × 1) (5)

3.2 $V = KT/q \times \ln(I/I_s + 1)$
 $= 303/11\,600 \times \ln(5 \times 10^{-6}/15 \times 10^{-9} + 1)$
 $= 0,026 \times 333,333$
 $= 8,667 \text{ V}$

(5)
[10]**QUESTION 4**

- 4.1 4.1.1 Deviation of the load voltage from its dc value
 4.1.2 Measure of the smoothness of the dc output of a rectifier

(2 × 2) (4)

4.2 $X_C = 1/2\pi fC$
 $= 1/(2 \times \pi \times 60 \times 120 \times 10^{-6})$
 $= 22,105 \, \Omega$

$$V_{r(rms)} = X_L / \sqrt{R^2 + X_C^2} \times V_{r(rms)}$$

$$= 22,105 / \sqrt{200^2 + 22,105^2} \times 4$$

$$= 0,4394 \text{ V}$$

(4)

- 4.3 • Ineffective with half-wave rectifiers
 • Not good for light loads
 • Ripple increases with decrease in load current
 • Lowers output voltage

(Any 3 × 1) (3)
[11]

QUESTION 5

5.1 Voltage gain = $20 \log V_{out}/V_{in}$
 $= 20 \log \times 75/6$
 $= 21,938 \text{ db}$

$$I_{out} = P_{out}/V_{out}$$

$$= 40/75$$

$$= 0,533 \text{ A}$$

Current gain = $20 \log 25/0,533$
 $= 33,424 \text{ db}$

Power gain (A_p) = $10 \log P_{out}/P_{in}$
 $= 10 \log 40/150$
 $= 5,74 \text{ db}$

(5)

- 5.2
- Relatively immune to radiation
 - Can be operated to provide a great deal of thermal stability
 - No offset voltage when used as a switch
 - Extremely high input resistance
 - Less noisy than the transistor for input of low-level amplifiers
 - Relatively small-gain bandwidth compared to the transistor
- (Any 5 × 1) (5)

- 5.3 To trigger devices for an SCR (1)
[11]

QUESTION 6

6.1 6.1.1 $A_v = R_f/R_{in}$
 $= 10 \times 10^3/2 \times 10^3$
 $= 5$

$$V_o = A_v \times V_{in}$$

$$= 5 \times 0,8$$

$$= 4$$

6.1.2 $A_v = (R_1 + R_f)/R_1$
 $= (2\,000 + 1\,000)/2\,000$
 $= 6$

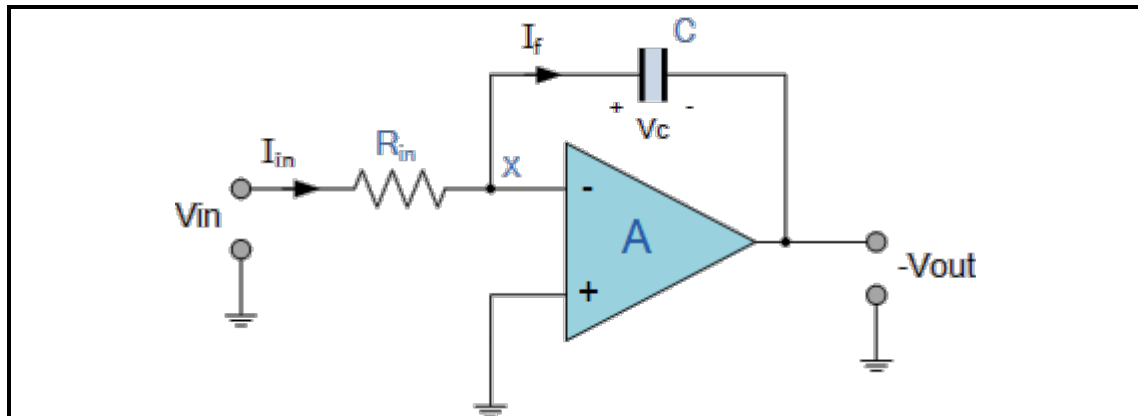
$$V_o = A_v \times V_{in}$$

$$= 6 \times 0,8$$

$$= 4,8$$

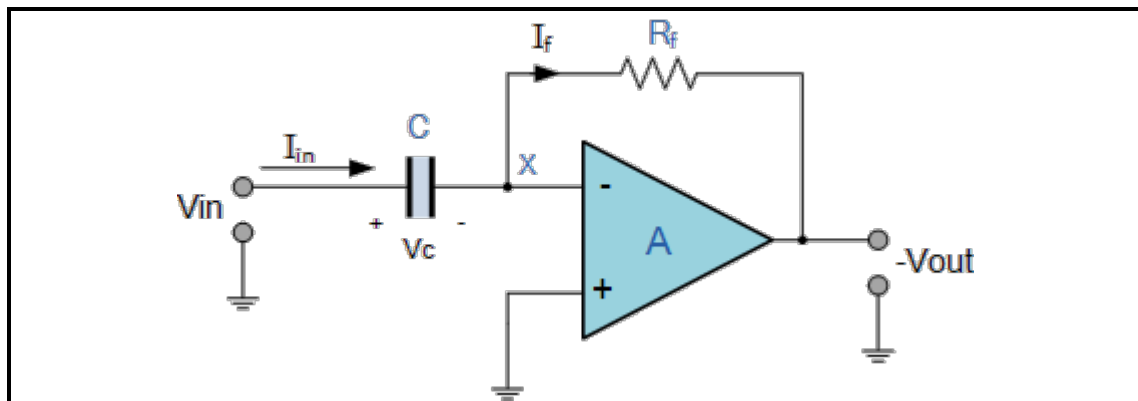
(2 × 3) (6)

6.2.1



(3)

6.2.2



(3)

[12]

QUESTION 7

- 7.1
- Generates transients
 - Noisy
 - Requires large heat sinks to control large powers
 - Needs special smoothing circuits
 - Needs special circuits to switch off under dc conditions (Any 3 × 1) (3)
- 7.2
- Reduce the current through it to less than the holding current
 - Remove the anode current (2)
- 7.3
- Logic circuits
 - Optocouplers (2)
- 7.4 Yes, ✓ because the characteristic curve of an LASCR is the same as that of an SCR. ✓ (1 + 1) (2)
- 7.5
- 7.5.1 Setting the desired value
- 7.5.2 Triggering the SCR (2 × 1) (2)
- [11]

QUESTION 8

- 8.1
- Accurate
 - Reliable
 - Stable
 - Reproducible
- (4)
- 8.2 8.2.1 Type of electrical transformer used for measuring linear displacement
- 8.2.2 Electromechanical generator capable of producing electrical power from mechanical energy
- (2 × 2) (4)
- 8.3
- Light-dependent resistor
 - Photodiode
 - Phototransistor
- (3)
[11]

QUESTION 9

- 9.1 Electrostatic deflection
 Electromagnetic deflection
- (2)
- 9.2 9.2.1 Moves the trace left or right for easier measurement or observation
- 9.2.2 Controls the rate at which the spot travels across the screen and enables the time for one complete cycle
- 9.2.3 It is used to ensure a steady trace. If the trigger level is set incorrectly uncontrolled wave forms will run across the screen. It delays the time-base sweep until the input signal is at the beginning of a new cycle.
- (3 × 2) (6)
- 9.3 $V_p = 0,736/0,637$
 $= 1,155 \text{ V}$
- $V_{rms} = 0,7071 \times 1,155$
 $= 0,817 \text{ V}$
- (2)
[10]

TOTAL: 100