



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

4 August 2026

This marking guideline consists of 6 pages.

QUESTION 1: TRANSIENTS

- 1.1 $V_c = E_m(1 - e^{-\frac{t}{T}})$ & $T = R.C$
- $$\frac{dV_c}{dt} = \frac{Vm}{T} = 50300 \times 40 \times 10^{-6}$$
- $$= \frac{60}{2,012}$$
- $$= 29,821 \text{ V s}^{-1}$$
- (4)
- 1.2 $V_R = V_m \cdot e^{-\frac{t}{T}}$ but 30% of 60 V = 18 V ✓
- $$18 = 60e^{-\frac{t}{2,012}}$$
- $$t = -1,204 \times -2,012$$
- $$= 2,4233 \text{ seconds}$$
- (4)
- 1.3 $I_m = \frac{V}{R}$
- $$= \frac{60}{50300}$$
- $$= 0.001193 \text{ A}$$
- $$i = I_m e^{-\frac{t}{T}}$$
- $$= 0.001193 e^{-\frac{2,4233}{2,012}}$$
- $$= 0.358 \text{ mA or } 357.739 \mu\text{A}$$
- (4)

[12]

QUESTION 2: TRANSDUCERS

- 2.1 $V_o = -V_i \cdot \frac{R_2}{R_1 + R_L}$ ✓
- $$40 \times 10^{-3} = -(-5 \cdot \frac{100K}{100K + R_D})$$
- $$\therefore R_D = 125 \Omega$$
- (5)
- 2.2
- Records digital information on computer, perforated paper tape, magnetic tape, typewritten pages, pen recorders or a combination of these systems. ✓✓
 - The digital recorder may be preceded by a coupling unit that translates the digital information to the proper form for entry into the particular recorder selected. ✓✓
- (4)
- 2.3 Translates physical parameters to electrical signal acceptable by an acquisition system. ✓✓✓
- (3)

QUESTION 3: ULTRASONIC

- 3.1
- The cleaning fluid should be one that is generally used to dissolve dirt from that particular object/part.✓
 - It should hold the dirt in suspension to prevent re-depositing the dirt on the object surface.✓
 - It should possess good wetting properties to ensure thorough physical contact with the surface to be cleaned.✓
 - It should have a low viscosity, yet minimising attenuation in the propagation of the generated ultrasonic energy.✓
 - The surface tension should be low to ensure easier cavitation.✓
- (5)
- 3.2
- 3.2.1 True✓
- 3.2.2 True✓
- 3.2.3 True✓
- 3.2.4 False✓
- 3.2.5 False✓

(5 × 1) (5)
[10]

QUESTION 4: X-RAYS AND RADIO ACTIVITY

- 4.1
- $$\lambda = \frac{h \times c}{E \times q}$$
- $$= \frac{(6.626 \times 10^{-34} \times 3 \times 10^8)}{(150 \times 10^3 \times 1.602 \times 10^{-19})} \checkmark$$
- $$= \frac{1.986 \times 10^{-25}}{2.403 \times 10^{-14}} \checkmark$$
- $$= 8.1485 \times 10^{-12} \checkmark$$
- (3)
- 4.2
- % efficiency of tube = $1.4 \times 10^{-9} \times Z \times V \times 100 \checkmark$
- $$= 1.4 \times 10^{-9} \times 42 \times 150 \times 10^3 \times 100 \checkmark$$
- $$= 0.882\% \checkmark$$
- (3)
- 4.3
- Current drawn by tube = Number of electrons emitted per sec. q
- $$= 1 \times 10^{17} \times 1.602 \times 10^{-19} \checkmark$$
- $$= 16.02 \text{ mA} \checkmark$$
- & Total power supplied to tube = $V \times I$
- $$= 150 \times 10^3 \times 16.02 \times 10^{-3} \checkmark$$
- $$= 2403 \text{ W} \checkmark$$
- $$= 2.403 \text{ KW} \checkmark$$
- X-ray power (power used) = Total Power $\times \eta$
- $$= 1602 \times 0.00882 \checkmark$$
- $$= 14.12964 \text{ W} \checkmark$$
- (4)
- 4.4
- Power dissipated = Total power - power used
- $$= 1602 - 14.12964 \checkmark$$
- $$= 1585.8704 \text{ W} \checkmark$$
- (2)

QUESTION 5: AUTOMATIC INSPECTION, TESTING & NDT

- The transformer ratio arm bridge utilises a current balance technique.✓✓
- One winding on a transformer core receives alternating current (I_1) produced by a known voltage and unknown impedance.✓✓
- A second core winding is driven by balancing current (I_f) produced by a known variable voltage and known standards of resistance and capacitance.✓✓
- A further core winding acts as a search coil to allow determination of a null in the core flux.✓✓
- The multi winding current transformer acts as a current balance detector.✓✓
- The output of the search coil is amplified to provide a bridge balancing voltage which is applied through a resistance to the feedback winding.✓✓
- The initial current(I_1) derived from the voltage transformer and unknown impedance is opposed by the feedback current and the condition of equality is limited only by the finite(limited) gain to the amplifier and stability consideration.✓✓
- The amplifier output is also connected to two phase sensitive detectors one of which incorporates a unity gain, 90° phase shift network.✓✓
- A stable oscillator provides the signal for the bridge and reference voltage for detectors.✓✓
- Analogue detector voltage outputs are formed which independently show the amount of variation of the resistive and reactive terms from the value set by the standard impedance and can represent capacitance, inductance or resistance according to the type of bridge network used.✓✓

(Any 6 × 2)

[12]

QUESTION 6: ELECTRONIC SAFETY DEVICES

- 6.1
- Two light sensitive transducers, A and B, are coupled to differential amplifiers.✓
 - A light source illuminates both cells by optical means such as optical fibres, mirrors, lenses or prisms.✓
 - Any brightness variation from the transmitter will therefore act similarly on both channels and thus cancel at the output.✓
 - The presence of smoke may be detected if the smoke intercepts the light path transmitted by only one channel.✓
 - The second light path is protected by screening it off against outer interference with the aid of a protective sleeve.✓
 - It would thus be possible to measure the light intensity difference of two light signals transmitted from a single light source and received by two light-sensitive transducers.✓

(6)

- 6.2
- | | |
|-------|--------|
| 6.2.1 | True✓ |
| 6.2.2 | False✓ |
| 6.2.3 | True✓ |
| 6.2.4 | True✓ |

(4 × 1)

(4)

[16]

QUESTION 7: ELECTRONIC POWER CONTROL

- 7.1 7.1.1 Task✓
 7.1.2 Design concept✓
 7.1.3 Computer✓
 7.1.4 Print design✓
 7.1.5 Store design✓
 7.1.6 Prototype✓
 7.1.7 Final test✓
 7.1.8 Manufacture product✓

(8 × 1) (8)

- 7.2 Can be defined as any system that uses a central control computer, also called a host, linked to other intelligent devices in a manufacturing environment✓✓✓

(3)
[11]

QUESTION 8: THYRISTOR DEVICES & SCR SPEED CONTROL

8.1 $Z_{TH} = \frac{\text{Temperature difference(rise)}}{\text{Power loss in device over defined time}}$

$Z_{TH} = \frac{T_{rise}}{P_{loss}}$ ✓

$T_{rise} = Z_{TH} \times P_{loss}$

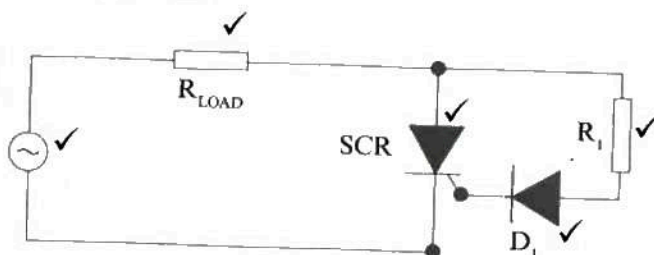
$= 0.03 \times 1500$ ✓

$= 45 \text{ } ^\circ\text{C}$ ✓

Junction temp. = $T_a(\text{ambient temp.}) + T_{rise}$ ✓
 $= 60 + 45$ ✓
 $= 105 \text{ } ^\circ\text{C}$ ✓

(6)

8.2



(5)
[11]

QUESTION 9: PROGRAMMABLE LOGIC CONTROLLERS(PLC)

- The CPU is a microprocessor containing circuitry that performs logical decision-making functions.✓✓
- It reads the status of the control system, makes (a) decision(s) based upon the logic that has been programmed and then provides the actuating portion of the control system with its decisions. ✓✓
- In order to ensure reliable operation, the CPU performs a self-test of its internal operation which is done by a circuit referred to as a watch-dog timer.✓✓
- The purpose of this timer is to ensure that internal circuit and memory faults do not cause the CPU to enter an endless loop because of hardware failure.✓✓
- Watch-dog timers are built into all CPUs and will shut off and shut down the I/O modules if the scan time exceeds a certain predetermined time.✓✓ (5 × 2)

[10]

TOTAL: 100