higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

2 August 2021 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and a formula sheet of 3 pages.

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INDUSTRIAL ELECTRONICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write neatly and legibly.

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QUESTION 1: TRANSIENTS

An initially fully charged 50-µF capacitor is connected in series with a 20-ohm resistor. This combination is then supplied by a 100-V DC source.

Show the necessary calculations and plot a labelled CAPACITOR VOLTAGE vs. TIME GRAPH during the discharge period for the capacitor. The discharge time interval is 1 second over five time constants. **[11]**

QUESTION 2: TRANSDUCERS

2.1 List FIVE elements of the analogue data acquisition system in any particular order. (5)

2.2 List SEVEN elements of the digital data acquisition system in any particular order. (7)

[12]

QUESTION 3: ULTRASONICS

3.1 The generic circuit diagrams of ultrasonic machining, ultrasonic soldering and ultrasonic welding are exactly the same, except for the parts of the tool tips.

Name, in words, the SIX main parts/units of these circuit diagrams, with the exclusion of the tool tips. (6)

3.2 Choose a description in COLUMN B that matches a concept in COLUMN A. Write only the letter (A–D) next to the QUESTION NUMBER (3.2.1–3.2.4) in the ANSWER BOOK. Each description may be used only once.

COLUMN A		COLUMN B	
3.2.1	Non-existent	A	transmission properties of ultrasonic energy through solids
3.2.2	Poor	B	transmission properties of ultrasonic energy through liquids
3.2.3	Good		
3.2.4	Excellent	C	transmission properties of ultrasonic energy through gases
		D	transmission properties of ultrasonic energy through a vacuum

(4 × 1) (4)

[10]

QUESTION 4: X-RAYS AND RADIO-ACTIVITY

4.1 Name FIVE generic parts of the Geiger-Muller counter. (5)

4.2 Draw a neat, labelled circuit diagram of the ionisation chamber as used as a gas-filled radiation detector. (5)

[10]

QUESTION 5: AUTOMATIC INSPECTION TESTING AND NDT

5.1 A straight beam test on a bar of an aluminium alloy found with a defect yields the following results:

Thickness of bar = 0,125 m
Propagation velocity = 1,5 km/s
Reflection of the used sound wave = 12,5 µs from the initial marker pulse

Calculate the following:

5.1.1 The pulse repetition rate (PRR) (4)

5.1.2 The depth of the defect (2)

5.2 List in any particular order the SEVEN parts of the block diagram of a three-way inspection system. (7)

[13]

QUESTION 6: ELECTRONIC SAFETY DEVICES

Draw a neat, fully labelled circuit diagram of the Zener barrier protection circuit. **[9]**

QUESTION 7: ELECTRONIC POWER CONTROL

7.1 Name THREE advantages of the CAD/CAM system. (3)

7.2 Name FOUR different engineering industry practical applications of CAD systems and give ONE example of each. (4 × 2) (8)

[11]

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QUESTION 8: THYRISTOR DEVICES AND SCR SPEED CONTROL

8.1 Use the following data extracted from a single-phase uncontrolled half-wave rectifier circuit to calculate the diode peak inverse voltage rating and its peak current.

Data:
AC supply = 24 V Maximum current = 1,5 A (3 × 2) (6)

8.2 Name SIX advantages of AC motors that are used for speed control. (6)
[12]

QUESTION 9: PROGRAMMABLE LOGIC CONTROLLERS

9.1 Name, in any particular order, any EIGHT parts/units of a programmable logic controller. (8)

9.2 State THREE building blocks of a programmable logic controller. (3)

9.3 What does the acronym CMOS stand for? (1)
[12]

TOTAL: 100

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$A = B \cdot \left(1 - e^{-t/\tau}\right)$

$A = B \cdot e^{-t/\tau}$

A = instantaneous value

B = maximum value

$V = E \cdot \left(1 - 2e^{-t/\tau}\right) = I \cdot R$ *volts*

$V_D = V_S \left(\frac{R_1}{R_1 + R_2} - \frac{R_3}{R_3 + R_{TH}} \right)$ *volts*

$V_i = \frac{I_L \cdot R_1 \cdot R_D}{R_2} = -\frac{V_o \cdot R_1}{R_2} = \frac{V_o \cdot R_M}{R_M + R_f}$ *volts*

$V_o = -RC \cdot \frac{dV_i(t)}{dt} = -\frac{1}{RC} \int V_i(t)\, dt + V_C(0)$ *volts*

$V_o = \frac{R_2 R_D I_i}{R_1} = -\left[\frac{V_1 R_f}{R_1} + \frac{V_2 R_f}{R_2} + \frac{V_3 R_f}{R_3} + ... \right]$ *volts*

Supply rating = voltage per stage × number of stages *volts*

$V_{\max} = \sqrt{2} \times V_{rms}$ *volts*

$V_{mean} = 0{,}637 \times V_{\max} = \frac{0{,}637}{2} \times V_{\max}$ *volts*

$V_{mean} = \frac{3 \cdot \sqrt{2}}{\pi} V_{line}$ *volts*

$V_{mean} = \frac{\sqrt{2}}{2 \cdot \pi} V_{rms} \times (1 + Cos\ \alpha)$ *volts*

$V_{mean} = \frac{\sqrt{2}}{\pi} V_{rms} \times (1 + Cos\ \alpha)$ *volts*

$V_{mean} = \frac{2 \cdot \sqrt{2}}{\pi} V_{rms} \times Cos\ \alpha$ *volts*

$V_{mean} = \frac{3 \cdot \sqrt{3}\sqrt{2}}{2 \quad \pi} V_{per\ phase} \times (1 + Cos\ \alpha)$ *volts*

$V_{mean} = \frac{3 \cdot \sqrt{2}}{\pi} V_{line} \times Cos\ \alpha$ *volts*

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$V_{line} = \sqrt{3} \times V_{per\ phase}$ *volts*

$V_{\max} = \sqrt{2} \times V_{line} = \sqrt{2} \times V_{rms}$ *volts*

$I_{rms} = \frac{\sqrt{2}}{2} I_{\max}$ *amps*

$I_{rms} = \frac{\sqrt{2}}{3} I_{\max}$ *amps*

$I_{rms} = \frac{0{,}707}{2} \times I_{\max}$ *amps*

$I_{rms} = I_{peak} \times \sqrt{\frac{\phi}{2 \cdot \pi}}$ *amps*

$I_{peak} = \frac{I_{mean}}{\phi} \times 2\pi$ *amps*

$I_{tube} = Number\ of\ electrons\ per\ second \times q$ *amps*

$I_{max} = Maximum\ safe\ illumination \times Tube\ sensitivity$ *amps*

$Sensitivity = cathode\ sensitivity \times A$ *amps/lumen*

$P = I^2 \cdot R = V \cdot I = V^2 / R$ *watts*

$X\text{-}ray\ power = P_T \times \eta$ *watts*

$Dissipated\ power = P_T - power\ used$ *watts*

$\Delta R = R_{TH} \times \Delta t \times temperature\ coefficient$ *ohms*

$Z_{TH} = \frac{T_{rise}}{T_{loss}}$ *ohms*

$R = \frac{T_1 - T_2}{P} = \frac{L}{\tau}$ *ohms*

$f = \frac{1}{t} = \frac{c}{\lambda} = \frac{\omega}{h} = \frac{\omega}{2\pi} = \frac{E \times q}{h}$ *hertz*

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

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$$f_n = \frac{1}{2\pi} \times \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}$$

hertz

$$\int^n = Amplification$$

hertz

$$\int = \frac{\pi \cdot R}{\omega \cdot L}$$

$$C = \frac{t}{R_L} = \frac{\tau}{R}$$

farads

metres

farad

$$d = \frac{v \cdot t}{2}$$

joules

coulombs

metre

$$\omega = 0{,}5 \times C \times V^2 = 0{,}5 \times L \times I^2$$

number of oscillations

joule

per unit

$$q = \frac{h \cdot v}{E \cdot \lambda}$$

Celsius

coulomb

$$n = t \times f = 1 + \frac{\ln 100}{\int}$$

$$\eta = 1{,}4 \cdot 10^{-9} \times E \times Z$$

$$°C_{\max} = V_{i\max} \div V / °C$$

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