higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T720(**E**)(A4)T
AUGUST EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

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13:00–16:00

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
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: TRANSCIENTS AND TRANSDUCERS

1.1 A 15 µF capacitor is charged to a voltage Vc and then connected to a 20 mH inductor.

Calculate the following:

1.1.1 The highest value of resistance which will allow oscillation to take place. (3)

1.1.2 Logarithmic decrement. (3)

1.1.3 The time taken for the wave-train amplitude to decrease to 1% of the initial value. (2)

1.2 1.2.1 Offsetting makes use of analogue techniques to shift the reference level of a signal by a predictable amount.

Name THREE typical applications of offsetting. (3)

1.2.2 Enhance the answer to QUESTION 1.2.1 above with a detailed sketch. (4)

1.3 Below table shows some common transducers Copy the table in the ANSWER BOOK and fill in the gaps indicated from (1.3.1) - (1.3.4).

	ELECTRICAL PARAMETER	PRINCIPLE OF OPERATION	PRACTICAL APPLICATION
1.3.1	Potentiometer	.....	.....
1.3.2	Photo-conductive cell	.....	.....
1.3.3	Thermocouple	.....	.....
1.3.4	Ionisation chamber	.....	.....

(8)
[23]

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QUESTION 2: ULTRASONICS, X-RAYS AND TESTING

2.1 2.1.1 Describe the term *magnetostriction.* (3)

2.1.2 State the function of the DC bias applied to the magnetostrictive core. (2)

2.2 List ANY THREE minimum requirements known to you for the effective operation of an industrial automatic inspection, testing and grading system. (3)

2.3 2.3.1 Explain the operating principle of a modern X-ray tube and enhance your description with a suitable labelled sketch. (7)

2.3.2 State the specific purpose for the use of an auto-transformer in the power supply unit of an x-ray installation. (3)

2.3.3 Why in your opinion are X-ray tubes such inefficient devices? (2)
[20]

QUESTION 3: NDT AND ELECTRONIC SAFETY DEVICES

3.1 What do you understand by non-destructive testing (NDT or NDI)? (2)

3.2 State Any THREE advantages of indirect viewing with regard to nondestructive testing. (3)

3.3 Following the NDT done on a particular specimen, thickness of the material is 540 mm, having a pulse repetitive time of 220 milliseconds with the flaw indicated at 0,10 milliseconds.

Determine the following:

3.3.1 The propagation velocity

3.3.2 The pulse repetitive rate

3.3.3 The depth of the flaw

(3 × 2) (6)

3.4 Which factors should be considered when electronic safety devices are installed in an industry? (2)

3.5 Explain the following terms as applied to the electrical industries and enhance each of your answers with practical examples.

3.5.1 Negative protection

3.5.2 Positive protection

(2 × 3) (6)
[19]

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QUESTION 4: SCR POWER SUPPLIES AND ELECTRONIC POWER CONTROL

4.1 Describe without the use of any circuit diagram the technique you would employ to positively trigger a thyristor and justify why you would recommend this specific technique. (4)

4.2 State FIVE main advantages of using DC-motor speed control. (5)

4.3 Explain the terms below as related to ways electrical braking can be achieved. State ONE application in each case.

4.3.1 Plugging

4.3.2 Regenerative braking

(2 × 3) (6)

4.4 A fully controlled three-phase bridge circuit has a firing delay angle α of 45° and is supplied with a line voltage of 311 V. Assume a thyristor volt drop of 1,5 V each.

Determine:

4.4.1 The mean load voltage (2)

4.4.2 PIV (3)

[20]

QUESTION 5: AUTOMATIC INSPECTION AND PROGRAMMABLE LOGIC CONTROLLERS (PLC's)

5.1 A certain gear manufacturer requires automatic inspection and sorting of the finished product, with specific reference to tolerance. You are now requested to set up a labelled block diagram of a THREE-way system, which would satisfy the manufacturer's needs.

Draw and label such diagram. (4)

5.2 Write a program using ladder diagram logic that will simultaneously switch TWO conveyor systems ON when activated and automatically switch One OFF five minutes later. The second conveyor must remain ON until manually deactivated. Briefly describe each rung of the ladder. All outputs must remain retentive unless the inputs change. (14)

[18]

TOTAL: 100

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

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

A = Instantaneous value and

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*

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

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

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

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

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

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

$$n = t \times f = 1 + \frac{\ln 100}{\int}$$ *number of oscillations*

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

$$^{\circ}C_{\max} = V_{i\max} \div V / ^{\circ}C$$ *Celsius*

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