higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

26 November 2024 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used

This question paper consists of 6 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. Use only a black or blue pen.
5. Write neatly and legibly.

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QUESTION 1: TRANSIENTS

1.1 Use the following data from a DC powered relay coil transient circuit and answer the questions that follow:

DATA: Time Constant = 4,25 ms Supply Voltage = 120 V

If at the end of 5,25 ms from switch on, the current through the coil increases to 0,425 A, calculate the following:

1.1.1 The steady state current. (5)

1.1.2 The value of the resistance. (4)

1.1.3 The value of the inductance of the coil. (3)

1.2 Give ONE advantage and ONE disadvantage of a ringing RLC circuit. (2)
[14]

QUESTION 2: TRANSDUCERS

2.1 Look at the picture below and answer the questions that follow.



2.1 A portable PA system is a practical example of the transduction process in action. Sort, from the picture, the items under the following headings:

2.1.1 The input device

2.1.2 The processing device

2.1.3 The output device

2.1.4 The interface device

(4 × 1) (4)

2.2 State the type/name of the energy on the input and on the output of each of the following elements of the transduction process in the picture.

2.2.1 The input device

2.2.2 The processing device

2.2.3 The output device

(3 × 2) (6)

2.3 Briefly describe what an analogue comparator does. (2)

[12]

QUESTION 3: ULTRASONICS

3.1 FIGURE 1 below is a piezo-electric crystal. Label the parts (3.1.1–3.1.4) in the ANSWER BOOK.

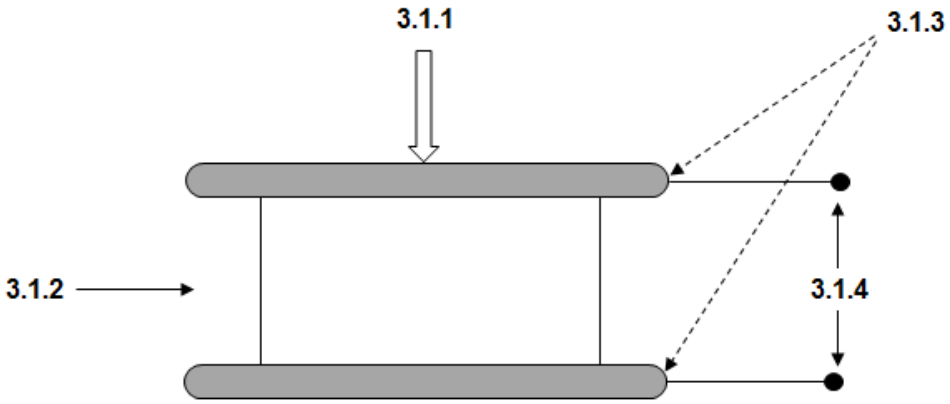


FIGURE 1 (4)

3.2 Choose the correct term from those in brackets. Write only the answer next to the question number (3.2.1–3.2.5) in the ANSWER BOOK.

3.2.1 Ultrasonic energy waveforms have (long/short) wavelengths.

3.2.2 During the ultrasonic machining process, it is the (tool tip/abrasive particles) that does sinking of the cavity onto the surface being machined.

3.2.3 The ultrasonic soldering process uses a (heated/soft) tool tip.

3.2.4 The ultrasonic welding process is used mainly for the welding of (metallic/plastic) surfaces.

3.2.5 The ultrasonic cleaning process uses a (perforated/non-perforated) container for holding the items to be cleaned.

(5 × 1) (5)

[9]

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QUESTION 4: X-RAYS AND RADIO ACTIVITY

4.1 State TWO factors upon which the absorption of X-radiation by living cells depend. (2)

4.2 The power supply unit of an X-ray tube supplies voltage in the KV range.

Name FOUR electronic circuit units that are the sub-units of the power supply of an X-ray tube. (4)

4.3 Name THREE factors that determine the efficiency of an X-ray tube. (3)

4.4 Name THREE factors that determine the sensitivity of a photomultiplier tube. (3)
[12]

QUESTION 5: AUTOMATIC INSPECTION TESTING AND NDT

5.1 Draw and label the block diagram of an automatic inspection testing and grading system. (7)

5.2 Draw and label the block diagram of a generic metal detector system. (4)
[11]

QUESTION 6: ELECTRONIC SAFETY DEVICES

6.1 Name the FIVE steps that must be adhered to when determining intrinsic safety. (5)

6.2 Shunt protective elements make use of three different electronic circuit components for shunting of the inductance.

Name these THREE components. (3)
[8]

QUESTION 7: ELECTRONIC POWER CONTROL

7.1 Draw a neat, labelled block diagram of a certain process control system whereby the controller does not have any reference data concerning the variable being controlled. Also, state the category name of this process control system. (7)

7.2 Name THREE damping techniques that describe the different types of controller loop gain. (3)
[10]

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QUESTION 8: THYRISTOR DEVICES AND SCR SPEED CONTROL

8.1 Analyse the data given below and then answer the questions that follow:

DATA:

Steady Power Loss = 40,25 W
Junction to Heat Sink Thermal Resistance = 1,08 ºC/W
Ambient Temperature = 30 ºC
Junction Temperature Limit = 125 ºC

Calculate the following:

8.1.1 Total Thermal Resistance (Thyristor)

8.1.2 Thermal Resistance of Heat Sink

8.1.3 Base Temperature (Thyristor)

(3 × 3) (9)

8.2 State THREE ways through which electrical braking can be achieved. (3)

[12]

QUESTION 9: PROGRAMMABLE LOGIC CONTROLLERS

Design, using ladder logic, a lighting control system, for a single backyard room, that will conform to the following prescripts:

1. It must be controlled by a total of THREE switches, namely A_{01}, A_{02} and A_{03}.

2. If any of the TWO switches A_{01} and A_{02}, is switched ON, the light must turn ON, but both switches must be OFF before the light will turn off.

3. The third switch is a master control switch. If it is on, the light must be off and none of the other two switches have any control of the light. **[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 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*

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

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

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

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

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

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