higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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APRIL EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

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9:00–12:00

This question paper consists of 6 pages and 1 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: TRANSIENTS AND TRANSDUCERS

1.1 Complete the following sentence by filling any of the words/term in the bracket below. Write only the word(s) next to the question number (1.1–1.10) in the ANSWER BOOK.

elements; transitional period; former values; transient; disturbance; voltages; new values; currents

Whenever an electronic circuit undergoes a ... either by a change in the applied voltage or a change in one of the circuit ..., there is a ... during which the branch … and …. change from their … to … after this transitional interval, known as … the circuit is said to be in a steady state (final value conditions).
(1/2 mark each) (4)

1.2 Give a detailed description of what exactly is understood by the time constant of RC circuit. (4)

1.3 Fully explain how current-to-voltage inter-phasing can be achieved. (6)

1.4 A series RL circuits consists of a 4 ohm resistor in series with a 2 Henry inductance should a step voltage of 20 V be applied. determine:

Calculate the following:

1.4.1 The instantaneous current after 0,5 seconds

1.4.2 The voltage developed across the resistor after 2 seconds

1.4.3 The maximum amount of energy stored in the magnetic field

1.4.4 Initial rate of current charge (4 × 2) (8)

1.5 Name THREE typical applications where use is made of offsetting techniques. (3)
[25]

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QUESTION 2: ULTRASONICS, X-RAYS AND RADIOACTIVITY

2.1 Explain what is meant by the term *cavitation*. (2)

2.2 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (2.2.1–2.2.5) in the ANSWER BOOK.

2.2.1 Ultrasonic energy ranges from 20 KHz to 50 KHz.

2.2.2 Ultrasonic cleaning is best suited for cleaning objects which are difficult to reach (for example the gears of a fully assembled gearbox)

2.2.3 The surface tension of the cleaning fluid used during the ultrasonic cleaning process should be high, since ultrasonic energy is best propagated through solids

2.2.4 When making use of the ultrasonic machining process, it is the tool tip that sinks the cavities into the material being machined.

2.2.5 The main advantage of using ultrasonic soldering, rather than conventional soldering is no heat is being applied thus not deforming of the materials. (5 × 2) (10)

2.3 At what frequency will X-rays radiate if its wavelength is 1 nm? (2)

2.4 State FOUR precautionary measures that must be taken when working with a radioactive material. (4)

2.5 What is the function of the auto-transformer included in the power supply of an X-ray power unit? (2)
[20]

QUESTION 3: AUTOMATIC INSPECTION AND TESTING, NDT AND ELECTRONIC SAFETY DEVICES

3.1 What are the minimum requirements to be considered for the effective operation of a typical industrial automatic inspection, testing and sorting device? (6)

3.2 A steel casting 500 mm thick, having a propagation velocity of 6×10^3 m/s.

3.2.1 Calculate its suitable pulse repetition rate

3.2.2 Calculate the depth of the flaw from the transducer if the echo is situated 50 µ seconds from the first marker pulse on the oscilloscope. (4)

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3.3 Describe the term Positive and Negative protection as applied to the electrical industries and enhance your descriptions with a practical example. (5)
[15]

QUESTION 4: SCR POWER SUPPLIES AND ELECTRONIC POWER CONTROL

4.1 With reference to rectifier circuits and devices, the control characteristics of the various circuits may be placed broadly into one of three categories.

Name and briefly explain each category. (6)

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

4.3 Name and explain briefly THREE ways which electrical braking can be achieved. (9)

4.4 In a particular application, during switch-on from cold conditions of 40 °C, a thyristor experiences a surge giving a power loss of 2 000 W for 10 ms.

Calculate the junction temperature if the transient thermal impedence for this time is 0,03 °C/W and comment on the answer. (5)
[25]

QUESTION 5: PROGAMMABLE LOGIC CONTROLLERS (PLC's)

5.1 Define the following terms with specific reference to PLC terminology:

5.1.1 Counter

5.1.2 Logic element

5.1.3 Diagnostic

5.1.4 Edit

5.1.5 Timer

(5 × 1) (5)

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5.2 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (5.2.1–5.2.5) in the ANSWER BOOK. Motivate your answer in each case.

5.2.1 Watch-dog timers built into the CPU will shut the CPU off should the scan time exceed a certain predetermined time.

5.2.2 The CPU of a PLC contains circuitry that performs logical decision making functions.

5.2.3 Erasable programmable read-only memories (EPROM) and electrically erasable programmable read-only memories (EEPROM) are fast and retentive memories, upon loss power.

5.2.4 Complementary metal oxide semiconductor random memories (CMOS RAM memory), the most common memories used in PLC's, are volatile memories.

5.2.5 The programmable unit of a PLC always receives the power from the controller unit. (5 × 2) (10)

[15]

TOTAL: 100

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INDUSTRIAL ELECTRONICS N6

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

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

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*

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

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

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

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

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

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