higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

4 April 2019 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and a formula sheet of 3 pages.

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.

QUESTION 1: TRANSIENTS

1.1 Name the TWO main elements in a transient circuit that can undergo changes as a result of disturbances. (2)

1.2 Various options are given as possible answers to the questions below. Choose the answer and write only the letter (A–D) next to the question number (1.2.1–1.2.4) in the ANSWER BOOK.

A simple RC circuit consists of a 20 µF uncharged capacitor connected in series with a 200 KΩ resistor. The supply voltage is 200 V.

1.2.1 The time constant for the simple circuit is …

A 4 s.
B 0,4 s.
C 40 s.
D 4 µs. (2)

1.2.2 When the capacitor has charged to 85% of the applied voltage, the capacitor voltage would then be …

A 1K7 V.
B 1700 mV.
C 170 V.
D 170 mV. (2)

1.2.3 The time taken for the capacitor voltage to rise to 85% of the final value will be …

A 7,589 µs.
B 7,589 s.
C 7,589 ms.
D 0,7589 s. (3)

1.2.4 The energy stored in the capacitor when it is fully charged will be …

A 0,0002 J.
B 0,2 J.
C 2 J.
D 2 mJ. (2)
[11]

QUESTION 2: TRANSDUCERS

Choose a term from column B that matches a description in column A. Write only the letter (A–E) next to the question number (2.1–2.5) in the ANSWER BOOK.

	COLUMN A		COLUMN B
2.1	Process whereby output signal is made much bigger than input signal	A	attenuation
2.2	Process which causes analogue techniques to shift the reference level of signal by predictable amount	B	amplification
2.3	Component used to isolate output signal from input signal in order to prevent shunting of dropping resistor	C	integrator
2.4	Amplifier whereby feedback is obtained by means of capacitor	D	offsetting
2.5	Process whereby output signal is made much smaller than input signal	E	buffer amplifier

(10 × 1) **[10]**

QUESTION 3: ULTRASONICS

3.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

3.1.1 Ultrasonic cleaning is a process that does not use a cleaning fluid.

3.1.2 During ultrasonic cleaning redepositing of dirt particles on the surface of the material being cleaned is not possible.

3.1.3 During ultrasonic cleaning the surface tension must be high to ensure easier cavitation.

3.1.4 During ultrasonic machining the workpiece is immersed in a suspension of abrasive powder and water.

3.1.5 During ultrasonic soldering the process of cavitation does not occur.

(5 × 1) (5)

3.2 State the function of the DC bias in the basic circuit of an ultrasonic application. (3)

3.3 Name the TWO main groups into which the piezo-electric effect is divided. (2)

[10]

QUESTION 4: X-RAYS AND RADIO ACTIVITY

The following data regarding an X-ray machine is available:

Planck's constant: $6{,}626 \times 10^{-34}$ Efficiency: $6{,}468 \times 10^{-3}$

Cathode emission: 1×10^{17} electrons per second

Electron charge: $1{,}602 \times 10^{-19}$ C Atomic number: 42

Velocity of light: 3×10^{8} m/s

Calculate the following:

4.1 Supply voltage (3)

4.2 Shortest wavelength produced (3)

4.3 Frequency of radiation (3)

4.4 Power dissipated by tube (5)
[14]

QUESTION 5: AUTOMATIC INSPECTION, TESTING AND NDT

5.1 A 3-way inspection system is also known as a high-go-low system.

Describe the output results represented by each of the following indications:

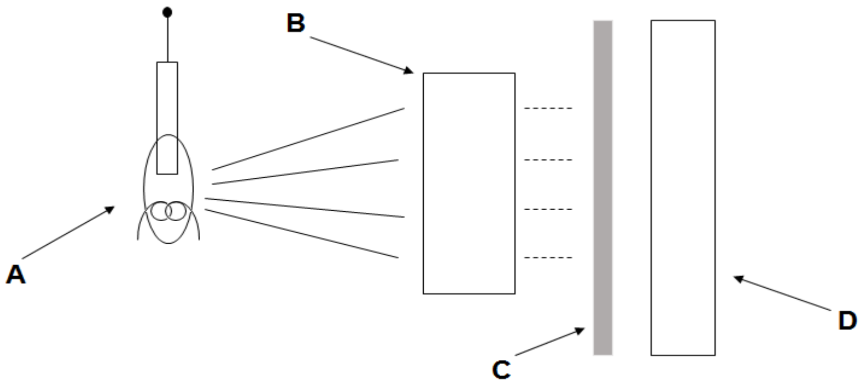
5.1.1 High

5.1.2 Go

5.1.3 Low

(3 × 1) (3)

5.2 Study the diagram below and answer the questions.



5.2.1 Give the full name of the inspection method represented by the circuit diagram above. (1)

5.2.2 Identify the indicated parts by writing the answer next to the letter (A–D) in the ANSWER BOOK. (4)

5.2.3 Give ONE disadvantage of this inspection method. (1)
[9]

QUESTION 6: ELECTRONIC SAFETY DEVICES

6.1 Name the THREE steps to determine intrinsic safety and briefly describe each. (6)

6.2 Name the THREE components of which an optical relay should consist. (3)

6.3 State ONE purpose of fitting electronic safety devices in industry. (1)
[10]

QUESTION 7: ELECTRONIC POWER CONTROL

7.1 Name the FOUR prerequisites for a CAM system operation. (4)

7.2 Give THREE types of damping techniques and their associated controller gains. (6)
[10]

QUESTION 8: THYRISTOR DEVICES AND SCR SPEED CONTROL

8.1 A single-phase half-controlled bridge converter supplies a certain load. The input AC voltage is 230 V and the load resistance is 10 Ω while the trigger angle is at 30°.

Calculate each of the following:

8.1.1 Average output voltage (4)

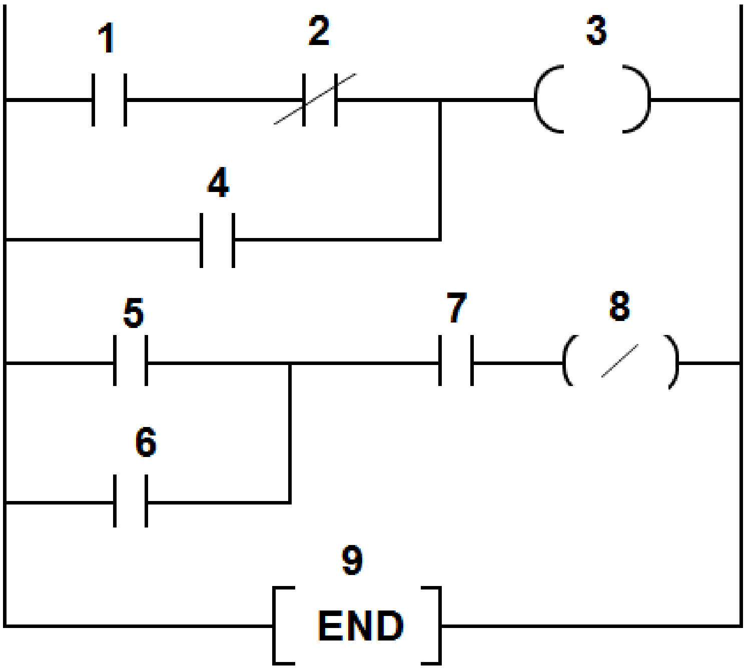
8.1.2 Average current (3)

8.2 Draw a neat, labelled circuit diagram of a rectifier circuit that uses a commutating diode. (4)

8.3 State the function of the diode in QUESTION 8.2 above. (2)
[13]

QUESTION 9: PROGRAMMABLE LOGIC CONTROLLERS

Study the ladder diagram below and answer the questions.



9.1 Identify the symbols used in parts 1, 2, 3, 8 and 9. (5)

9.2 How many rungs are represented in the ladder diagram? (1)

9.3 State the TWO groups of combinations at point 3 which is necessary for it to be ON. (4)

9.4 State the TWO conditions at point 8 which is necessary for it to be OFF. (3)
[13]

TOTAL: 100

FORMULA SHEET

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*

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

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

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

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

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

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

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

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

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

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

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

$$Sensitivity = Cathode\ sensitivity \times A \qquad amps/lumen$$

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

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

$$Dissipated\ power = P_T - Power\ used \qquad watts$$

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

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

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

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

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

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

$$\int^n = Amplificat\,ion$$ *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*