higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T800**(E)**(J31)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

31 July 2018 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 3 pages.

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N6
TIME: 3 HOURS
MARKS: 100

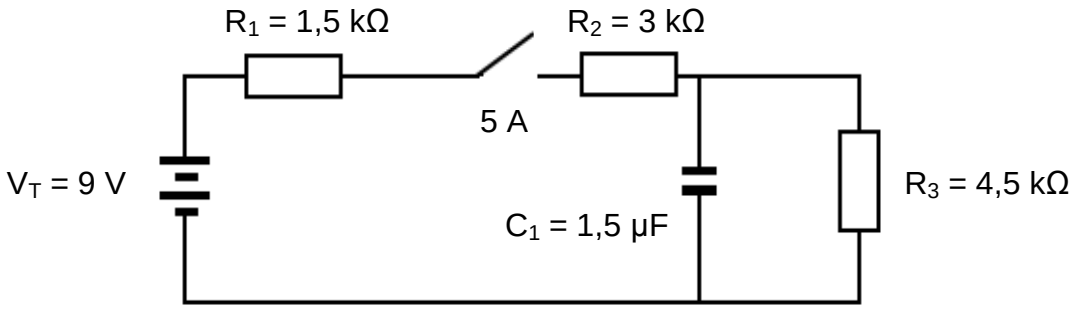
INSTRUCTIONS AND INFORMATION

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.

Copyright reserved

QUESTION 1: TRANSIENTS

1.1 Analyse the R-C transient circuit for an initially uncharged capacitor and answer the questions.



1.1.1 Which voltage value will be measured across C_1 at t < 0 s (before switch-on)? (2)

1.1.2 Maximum current flows in the circuit at t = 0 s (at switch on).

State the relationship between the voltage values V_{R3} and V_{C1} at this instant. (1)

1.1.3 Calculate the value of V_{C1} at t = 0 s. (4)

1.2 Briefly explain the term *damping* and name THREE typical damping techniques. (2 + 3) (5)

[12]

QUESTION 2: TRANSDUCERS

2.1 Data-acquisition systems can be categorised into either analogue or digital systems.

Name THREE of the five elements that a typical analogue data-acquisition system comprises. (3)

2.2 The following data is available for an amplification simulation using an amplifier-multiplier circuit:

Thermocouple output:	10 mV per 10 °C
Temperature range of oven:	50 °C to 500 °C
Standard amplifier-output range:	1 V to 5 V
Metering resistance:	10 kΩ

Copyright reserved

Calculate:

2.2.1 The value of R_F if the amplifier is connected in an inverting mode (6)

2.2.2 The value of R_F if the amplifier is connected in a noninverting mode (3)
[12]

QUESTION 3: ULTRASONICS

3.1 Ultrasonic cleaning is suitable for removing dirt from delicate mechanisms.

Draw a neat, fully labelled generic block diagram that shows the different parts of an ultrasonic cleaning apparatus. (6)

3.2 Describe in ONE word the propagation properties of ultrasonic energy through each of the following forms of matter:

3.2.1 Vacuum

3.2.2 Gas

3.2.3 Liquid

3.2.4 Solid

(4 × 1) (4)
[10]

QUESTION 4: X-RAYS AND RADIO ACTIVITY

4.1 Electromagnetic radiation is the energy waves produced by the oscillation of an electric charge.

Give, in any particular order, SEVEN components that make up the electromagnetic spectrum of rays. (7)

4.2 The shortest wavelength of X-rays produced by an X-ray tube is determined by the following formula: $\lambda = \frac{h \times C}{E \times q}$.

Give the name of each of the FOUR quantities represented on the right side of the equals sign in the formula. (4)
[11]

Copyright reserved

QUESTION 5: AUTOMATIC TESTING AND NDT

5.1 The following data is obtained from a specimen-testing simulation:

Specimen thickness:	1 080 mm
Pulse repetition time:	552 µs
Position of flaw from the first marker pulse:	0,42 ms

Calculate:

5.1.1 The propagation velocity (3)

5.1.2 The frequency (2)

5.1.3 The depth of flaw (2)

5.2 Name SIX practical examples of industries where metal detectors are used. (6)
[13]

QUESTION 6: ELECTRONIC POWER CONTROL

6.1 There are two basic categories of process control in any manufacturing process.

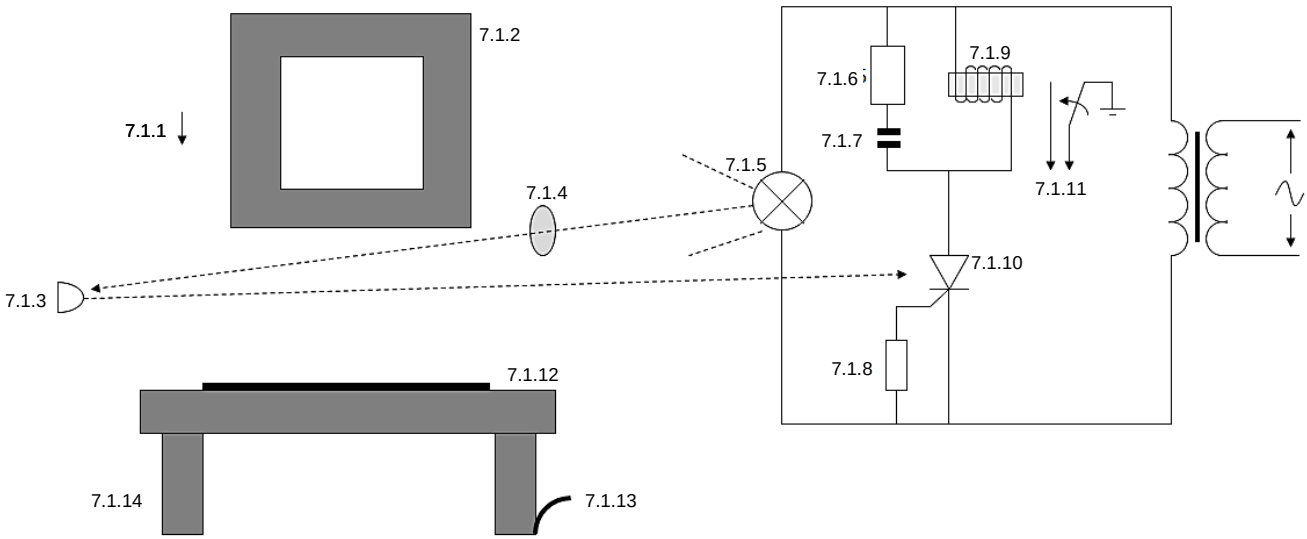
Give the name of the error-actuated category. (1)

6.2 Describe, by means of a labelled block diagram, the error-actuated process-control category named in QUESTION 6.1. (9)
[10]

Copyright reserved

QUESTION 7: ELECTRONIC SAFETY DEVICES

7.1 The figure below depicts a generic industrial punch press with an electronic safety circuit attached to ensure safe operation. Label the parts by writing the answer next to the question number (7.1.1–7.1.14) in the ANSWER BOOK.



(7)

7.2 Briefly describe, in point form, the operation of the electronic safety circuit in QUESTION 7.1 to ensure the safe operation of the industrial punch press. (5)

[12]

QUESTION 8: THYRISTOR DEVICES AND SCR SPEED CONTROL

A 200 V DC motor running at 1 200 r/min is separately excited and controlled by a three-phase 158 V/50 Hz supply. The armature has a resistance of 0,29 Ω with a rated current of 30 A.

Calculate:

8.1 The firing angle for the rated voltage (5)

8.2 The firing angle for a starting current of 50 A (9)

[14]

QUESTION 9: PROGRAMMABLE LOGIC CONTROLLERS

Briefly define each of the following terms used in PLC terminology:

9.1 Hard wiring

9.2 Soft wiring

9.3 Watchdog timer

(3 × 2) **[6]**

TOTAL: 100

Copyright reserved

FORMULA SHEET

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

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

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*

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

Copyright reserved

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

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

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

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

Copyright reserved

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

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

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

Copyright reserved