higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T720(E)(N25)T
NOVEMVER EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

25 November 2014 (Y-Paper)
13:00–16:00

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

ENGINEERING

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.

ENGINEERING

Copyright reserved

QUESTION 1: TRANSCIENTS AND TRANSDUCERS

1.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.1–1.8) in the ANSWER BOOK.

1.1.1 Resonance on high voltage power system is known as *ringing*.

1.1.2 The effect of resonance is put to good use in wireless radio communication.

1.1.3 The following includes the typical application of offsetting when it makes use of analogue techniques to shift the reference level of a signal by predictable amount:

Measurement of small changes about a small initial value.

1.1.4 Analogue comparator circuit uses both inverting and non-inverting input of an op amp for different incoming analogue signals.

1.1.5 Infinite output impedance is one of the properties of an ideal op-amp.

1.1.6 Typical Auxiliary functions include Linearization and Limit comparison.

1.1.7 The function in (1.1.6) above may be performed by individual instruments or by a digital computer.

1.1.8 The principle of operation of a capacitor microphone is dependent on distance between the plates.

(8 x 1) (8)

1.2 Determine the time taken for a relay to operate if it pulls the armature in when the current reaches 25% of its maximum value. The coil has a time constant of 12 microseconds and a resistance of 50K Ohms when supplied from a 28 V DC source. (4)

1.3 State what can be done to correct the non-linearity of a transducer. (2)

1.4 Name THREE typical applications where use is made of offset techniques. (3)

1.5 What exactly is the function of the buffer amplifier when current-to-voltage interfacing is being used? (3)

[20]

ENGINEERING

Copyright reserved

HIERDIE VRAAG IS NIE AANGEPAS VOLGENS DIE MODERATOR SE AANWYSINGS NIE

QUESTION 2: ULTRASONICS, X-RAYS AND RADIOACTIVITY

2.1 State FOUR precautionary measures that must be taken when working with radioactive materials. (4)

2.2 Illustrate the principle of operation of an ultrasonic soldering iron and state the primary functions of the vibrating tip. (4)

2.3 State THREE factors which determine the efficiency of X-rays. (3)

2.4 List FOUR practical applications of X-rays and give ONE example for each application. (4)

[15]

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

3.1 Industries such as SA Breweries, Consol Glass and many others makes use of a TWO-way automatic inspection and sorting of their finished product.

Set up a labelled block diagram of a TWO-way system which would satisfy these manufacturer's needs? (4)

3.2 Biscom is a biscuit manufacturing company. Several reports came to the food processing division that small iron fillings were observed in the company's product.

Design a fully labelled block diagram od a metal detector that can be used to detect the iron fillings. (8)

3.3 Briefly explain the principle of operation of the block diagram set up in QUESTION 3.2. (4)

3.4 Calculate a suitable pulse repetition rate for certain steel casting 750mm thick, having a propagation velocity of 6 X 10^{-3} m/s. (4)

[20]

QUESTION 4: SCR POWER SUPPLIES AND ELECTRONIC POWER CONTROL

4.1 Briefly explain the terms below in relation to a Closed loop control system and give ONE application for each:

4.1.1 Regulator systems

4.1.2 Follow-up systems

(2 x 3) (6)

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

Copyright reserved

4.3 Draw a block diagram of a typical CAD/CAM system and state TWO advantages of the system. (6)

4.4 Calculate the firing angle of a certain RC Phase-shift network having a 10K potentiometer in series with a 0.22 µF capacitor. The circuit is fed from a 380sin377t AC supply. (2)

4.5 Determine the mean load voltage for a $\alpha = 60^{o}$ and a thyristor PIV, should a fully controlled three-phase bridge be supplied with a 311V line voltage. Assume a thyristor volt drop of 1,5V each. (4)

[23]

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

5.1 5.1.1 Which circuit does a self-test in the CPU?

5.1.2 What is the purpose of the circuit mentioned in (5.1.1) above.

(2 x 1) (2)

5.2 FIGURE 1 below is supposed to switch ON two conveyor systems simultaneously when activated and automatically switch one OFF five minutes later. The second conveyor must remain ON until manually deactivated.

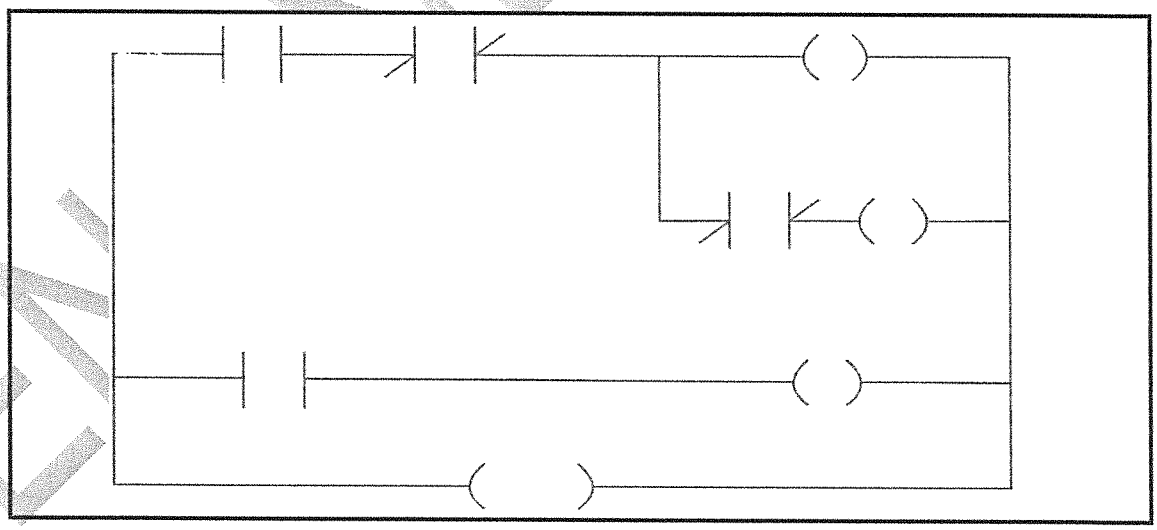


FIGURE 1 (14)

Redraw the diagram, identify the faulty rung and make amendments on your redrawn diagram also interpret the PLC design per rung

Copyright reserved

5.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (5.3.1–5.3.3) in the ANSWER BOOK.

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

5.3.2 Watch-dog timers built into the CPU will NOT shut the CPU off should the scan time exceed a certain predetermined time.

5.3.3 The programmable unit of a PLC always receives the power from the controller unit.

(2 x 3) (6)
[22]

TOTAL: 100

ENGINEERING

Copyright reserved

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*

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

ENGINEERING

Copyright reserved

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

ENGINEERING

Copyright reserved

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

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

ENGINEERING

Copyright reserved