higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOV5EMBER EXAMINATION

INDUSTRIAL ELECTRONICS N6

NOVEMBER 2016

This marking guideline consists of 8 pages.

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QUESTION 1: TRANSIENTS

1.1 Step 01: Calculate the value of the highest resistance required to allow oscillations to take place.

$$\textbf{let } \frac{1}{LC} = \frac{R^2}{4L^2} \quad ✓$$

$$R^2 = \frac{4L}{C}$$

$$R = \sqrt{\frac{4L}{C}} \quad ✓$$

$$= \sqrt{\frac{4(32.25 \times 10^{-3})}{22.75 \times 10^{-6}}} \quad ✓$$

$$R = 75.302\ \Omega \quad ✓$$

$$\mathrm{R} = 75\ \Omega \quad ✓$$

Step 02: Calculate fn:

$$f_n = \frac{1}{2\pi} \times \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

$$= \frac{1}{2\pi} \times \sqrt{\frac{1}{32{,}25 \times 10^{-3}(22{,}75 \times 10^{-6})} ✓ - \frac{75^2}{4(32{,}25 \times 10^{-3})^2} ✓}$$

$$= (0{,}1592) \times (104{,}383) \quad ✓✓$$

$$f(n) = 16{,}618Hz \quad ✓$$ (10)

1.2
- Under damping.
- Over damping. (2)

[12]

QUESTION 2: TRANSDUCERS

2.1 Standard Current Range = 4 mA to 20 mA✓ (1)

2.2 Step 01: Calculate Vi (MAX).

$$℃_{MAX} = V_{i(MAX)} \div \frac{V}{℃}$$

$$V_{i(MAX)} = ℃_{MAX} \times \frac{V}{℃} \quad ✓$$

$$V_{i(MAX)} = 555 \times \frac{1{,}55 \times 10^{-3}}{10} \quad ✓✓$$

$$V_{i(MAX)} = 86{,}025\ mV \quad ✓$$

STEP 2: Calculate RF:

$$V_i = \frac{V_O \times R_M}{R_M + R_f}$$

$$(R_M + R_f)(V_i) = V_O \times R_M \quad ✓$$

$$(R_M + R_f) = \frac{V_O \times R_M}{V_i} \quad ✓$$

$$R_f = \frac{V_O \times R_M}{V_i} - R_M \quad ✓$$

$$= R_M \left[\left(\frac{V_O}{V_i}\right) - 1\right] \quad ✓$$

$$= 1{,}55 \times 10^{-3} \left[\frac{1{,}55 \times 10^{-3}}{86{,}025 \times 10^{-3}} - 1\right] \quad ✓$$

$$= 1{,}522K\Omega \quad ✓$$

(9)
[10]

QUESTION 3: ULTRASONICS, X – RAYS AND RADIO ACTIVITY

3.1
- The energy can be transmitted in the form of a narrow beam.
- The energy can be generated at high intensities and at high frequencies. (2)

3.2 3.2.1 Slurry (1)

3.2.2
- It keeps the work piece cool.
- It quenches any sparks that may exist.
- It washes away any burs which may form on the work piece.
- It serves as the transport medium for the abrasive particles in the cutting fluid. (4)

3.3 The materials being welded together do not become deformed on the surfaces due to the external heat. (1)

3.4 3.4.1

$$Amplification = S^N = 7^6 \checkmark$$
$$= 117649 \checkmark$$ (2)

3.4.2

$$Tube\ Sensintivy = Cathode\ Sentivity \times A$$
$$= 45 \times 10^{-6} \times 117649 \checkmark$$
$$= 5{,}294\ A/lumen \checkmark$$ (2)

3.4.3

$$Max\ Safe\ illumination = \frac{I_{MAX}}{Tube\ Sensitivity} \checkmark$$

$$= \frac{5{,}5 \times 10^{-3}}{5{,}294} \checkmark$$

$$1{,}039 \times 10^{-3}\ lumen \checkmark$$ (3)

3.5
- The cathode sensitivity
- The emission factor
- The number of stages (3)

[18]

QUESTION 4: AUTOMATIC INSPECTION, TESTING AND NDT

4.1 4.1.1 To check whether the articles do in fact conform to production specifications. (1)

4.1.2
- Two-way systems (GO-NOGO)
- Three-way systems (HI-GO-LOW) (2)

4.1.3
- The two-way system, during sorting, only accepts or rejects articles based on whether they do or they do not conform to the required specifications.✓
- The three-way system, during sorting, identifies articles as those which do conform to the required specifications,✓ and in the case of rejected articles, this system further identifies articles that can be re-worked on,✓ and those that have to be scraped completely.✓ (4)

4.2
- Direct viewing method
- Indirect viewing method
- Image intensifier viewing (3)

[10]

QUESTION 5: ELECTRONIC SAFETY DEVICES AND ELECTRONIC POWER CONTROL

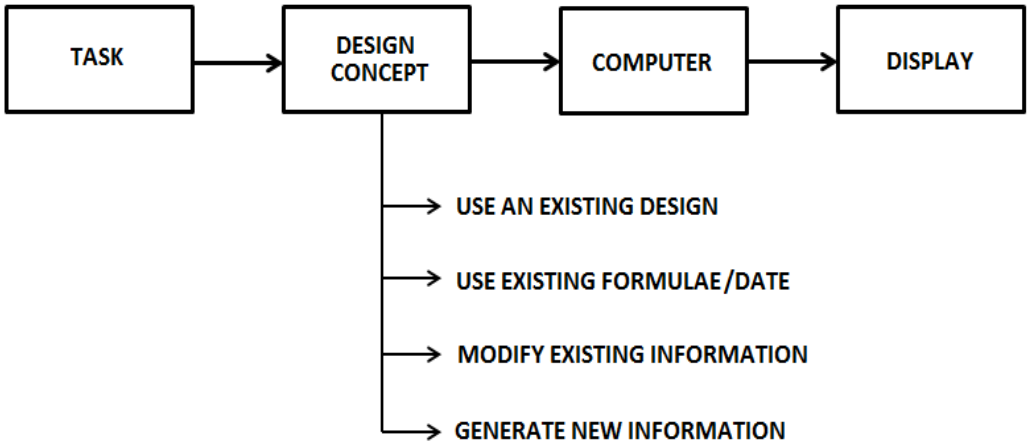
5.1 With regards to positive protection:
- The safe operation of a machine can only be achieved if ALL its safety conditions are fulfilled simultaneously.
- The machine and all of its safety devices are connected in a serial mode connection.5
- Positive protection uses a logic AND function.

With regards to negative protection:
- The safe operation of a machine can be achieved if ANY ONE or all safety conditions are fulfilled at a time.
- The machine and all its safety devices are connected using parallel mode connection.
- Negative protection uses a logic OR function. (3 × 2) (6)

5.2 Intrinsic safety refers to explosion protection techniques which prevents faults in low power measurement and control systems from igniting flammable atmospheres in hazardous areas. (3)

5.3 Regulator Systems✓ – These are feedback control systems whereby the set point is rarely adjusted.✓
Follow Up Systems✓ – These are feedback control systems where the set point is frequently adjusted.✓ (4)

5.4



(6)
[19]

QUESTION 6: THYRISTOR DEVICES AND SCR SPEED CONTROL

6.1 6.1.1

$$V_{MEAN}\ at\ 0° = \frac{\sqrt{2}}{2\pi} \times V_{RMS} \times (1 + cos\alpha)$$

$$= \frac{\sqrt{2}}{2\pi} \times 240(1 + \cos\alpha) \quad ✓✓$$

$$= 108{,}038\ V \quad ✓$$

$$V_{MEAN}\ at\ 90° = \frac{\sqrt{2}}{2\pi} \times V_{RMS} \times (1 + cos\alpha)$$

$$= \frac{\sqrt{2}}{2\pi} + 240(1 + cos\ 90) \quad ✓$$

$$= 54{,}019\ V \quad ✓$$

(3 × 2) (6)

6.1.2

$$V_{max} = \sqrt{2} \times V_{rms}$$

$$= \sqrt{2} \times 240 \quad ✓$$

$$= 339{,}411\ V \quad ✓$$

(2)

6.1.3

$$I_{RMS} = \frac{\sqrt{2}}{2} \times I_{MAX}$$

$$= \frac{\sqrt{2}}{2} \times (15) \quad ✓$$

$$= 10{,}607\ A \quad ✓$$

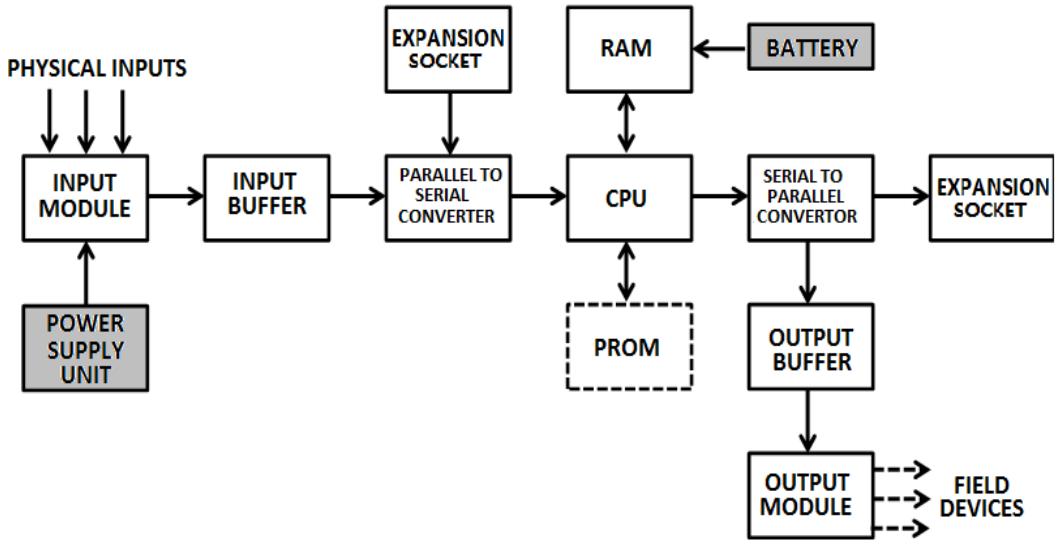
(2)

6.2
- A wide range of speed control is possible
- Can operate constant or variable torque conditions
- Rapid acceleration, deceleration and reversing
- Can operate under regenerative conditions
- Ranges from fractional KW to 7500 KW
- Open- or closed-loop operation. (6)

[16]

QUESTION 7: PROGRAMMABLE LOGIC CONTROLLERS

7.1



(7)

7.2 7.1.1 Edit – to intentionally modify the user program in a PLC.

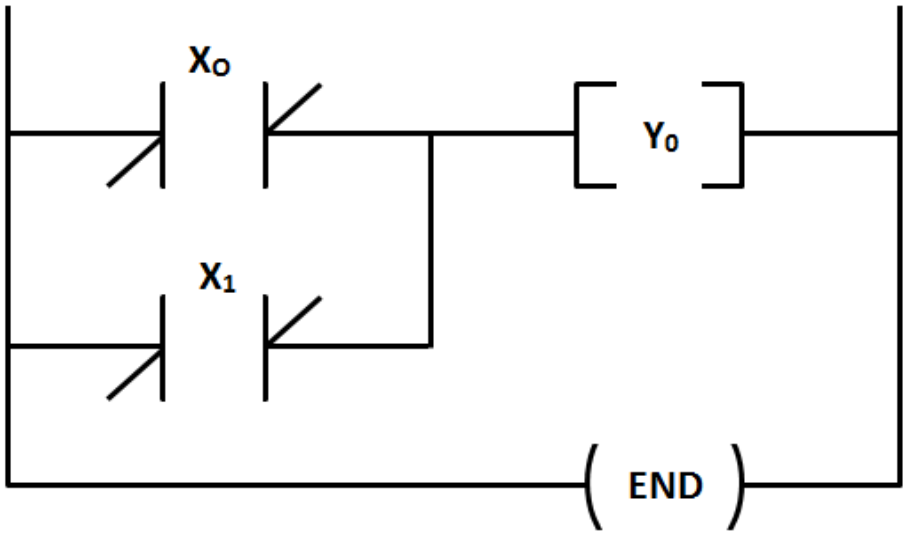
7.1.2 Element – a symbol used in a PLC program, such as a contact or a coil.

7.1.3 Rung – one line of ladder diagram containing relevant programming information.

7.1.4 Timer – an internal function which produces an output after a pre-set interval of time.

(4 × 1) (4)

7.3



(4)
[15]

TOTAL: 100

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