higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

INDUSTRIAL ELECTRONICS N6

25 NOVEMBER 2014

This marking guideline consists of 7 pages.

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QUESTION 1: TRANSCIENTS AND TRANSDUCERS

1.1
1.1.1 True
1.1.2 True
1.1.3 False
1.1.4 True
1.1.5 False
1.1.6 True
1.1.7 True
1.1.8 False

(8 x 1) (8)

1.2 $I = V/R = 28/50X10^{3} = 0,56$ mA
25% of 0,56 = 25/100 x 0,56 = 14 mA
$I = I_m(1- e^{-t/\tau})$
$0,14x10^{-3} = 0,56x10^{-3}(1-e^{-t/12x10-6})$
$0,75 = e-t/12x10^{-6}$
$\log 0,75 = -t/12x10^{-6}\text{Log } e$
$-0,288 = -t/12x10^{-6}$
$t = 0,0287 \times 12x10^{-6}$
t = 3,456µsec (4)

1.3 It can be corrected by modifying the transducer circuitry in order to provide a feedback signal that will balance the bridge circuit to obtain an output proportional to the resistance change. (2)

1.4
- Measurement of small changes about a large initial value
- Measurement employing a device that has an absolute scale
- Introducing an offset where the minimum value is about zero. (3)

1.5 For appropriate excitation of the output signal. The nature of the conditioning depends on the characteristics of the transducer and the signal destination. Attenuation, amplification, linearasation, etc. (3)
[20]

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QUESTION 2: ULTRASONICS, X-RAYS AND RADIOACTIVITY

2.1 Reflection and refraction take place when the energy is transferred from one medium to another with a different density. Absorption and attenuation of the energy also takes place when propagated over a distance. (4)

2.2 The vibration of the soldering tip causes cavitations within the molten solder which breaks up the oxide film. Since the surface is now covered with solder, re-oxidation is prevented and the solder is able to flow onto the aluminum surface and set before the oxide film develops. (4)

2.3
- Science research: e.g development of quantum mechanics
- Engineering: e.g nondestructive inspection (NDT or NDI) and automatic inspection and testing
- Medicine: e.g radiographs (X-ray photographs), CAT scans, etc.
- Airports: e.g security (detecting luggage)

(1 application with example equals 1 mark) (4)

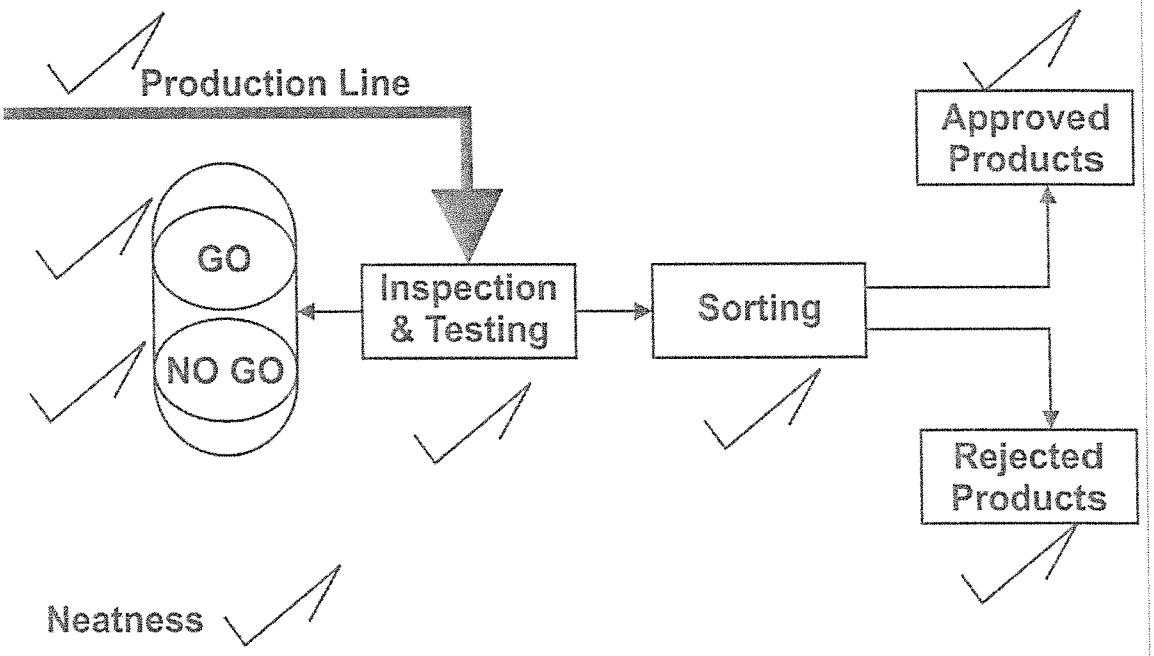
2.4
- Ionisation chamber
- Proportional counter
- Geiger-Müller counter

(3)
[15]

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

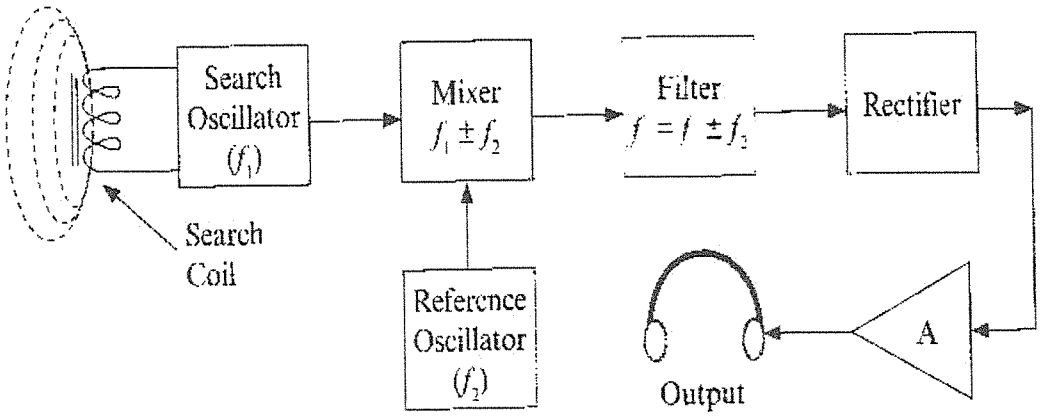
3.1



BLOCK DIAGRAM FOR A 2-WAY SYSTEM

(4 MRKS) (4)

3.2 Block diagram of a metal detector



- Search coil
- Search oscillator
- Mixer
- Filter
- Rectifier
- Amplifier
- Output
- Reference oscillator

(Each block item drawn and labelled carries 1 mark) (8)

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3.3 **Principle of operation of a metal detector**

Its operating principle employs **a search coil** in an oscillator circuit. When metallic objects are in **sensing range** of the coil there is an induction change in the oscillator circuit and consequently the frequency changes. This change, after all noise has been filtered out and the remaining signal amplified, can then be use to bring about any of the following results:
Sounding an alarm or beep tone on head set
Stopping the process
Identifying the location of the object
Rejecting the contaminated package or container

OR

When the search coil oscillator f_1, is initially tuned to the same frequency as the reference oscillator f_2, when no metal are in the vicinity of the search coil. Since these two frequencies are equal, the output from the mixer and filter circuit is zero ($f_0 = f_1 - f_2$).
As soon as the metal parts enter the detector range of the search coil, the frequency of the search coil oscillator changes and the output frequency f_o, is then the differences between the two frequencies f_1 and f_2. the output is fed to a rectifier and is amplified. Required action can then be initiated such as stopping the conveyor belt while sounding the alarm (4)

3.4 $t = \frac{2d}{v}$

$t = \frac{(0,75)}{6000}$

$= 250\ \mu sec$ √ √

$PRR = \frac{1}{t}$

$\frac{1}{250\ \mu sec}$

$= 4KHz$ √ √ (4)
[20]

QUESTION 4: SCR POWER SUPPLIES AND ELECTRONIC POWER CONTROL

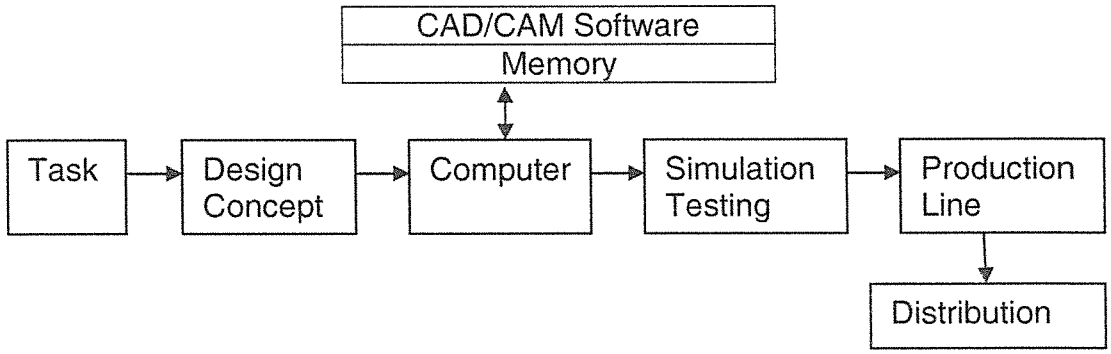
4.1 4.1.1 Regulator systems: They are **feedback control systems in which the set point is rarely adjusted**. The function is **to maintain the variable constant irrespective of large load changes.**
(Any of the points may be considered) **(2 marks)**
Example: Voltage regulator of a motor vehicle
Thermostat of industrial and domestic geyser systems
(1 mark for any example)

4.1.2 Followup systems: They are **feedback control system in which the set up is constantly changed.** (2 marks)
Examples: Reversible and non reversible AC or DC motor drive systems.

(3 x 2) (6)

4.2
- A wide range of speed control is possible
- Can operate under constant or variable torque conditions
- Rapid acceleration, deceleration and reversing
- Open- or closed- loop operation
- Operate under regenerative conditions
- Range from fractional KW to 7500 KW (Any 5 x 1) (5)

4.3
- Products can be modified on the production line
- Machinery and plant can operate without skilled labour



(6)

4.4 $\text{Tan } \alpha = R\omega C$
$= 10 \times 10^3 \times 377 \times 0{,}22 \times 10^{-6} \times 10^3$
$\alpha = 39{,}67^0$ (2)

4.5 $V_{mean} = \frac{3}{\pi}\sqrt{2}\ V_{line} \cos \alpha - SCR_{voltdrop}$
$= \frac{3}{\pi}\sqrt{2}\ (311)\cos 60° - 2(1.5)$
$= 207\ V$

$PIV = \sqrt{2}\ V_{line}$
$= \sqrt{2}\ (311)$
$= 439{,}8V$ (4)
[23]

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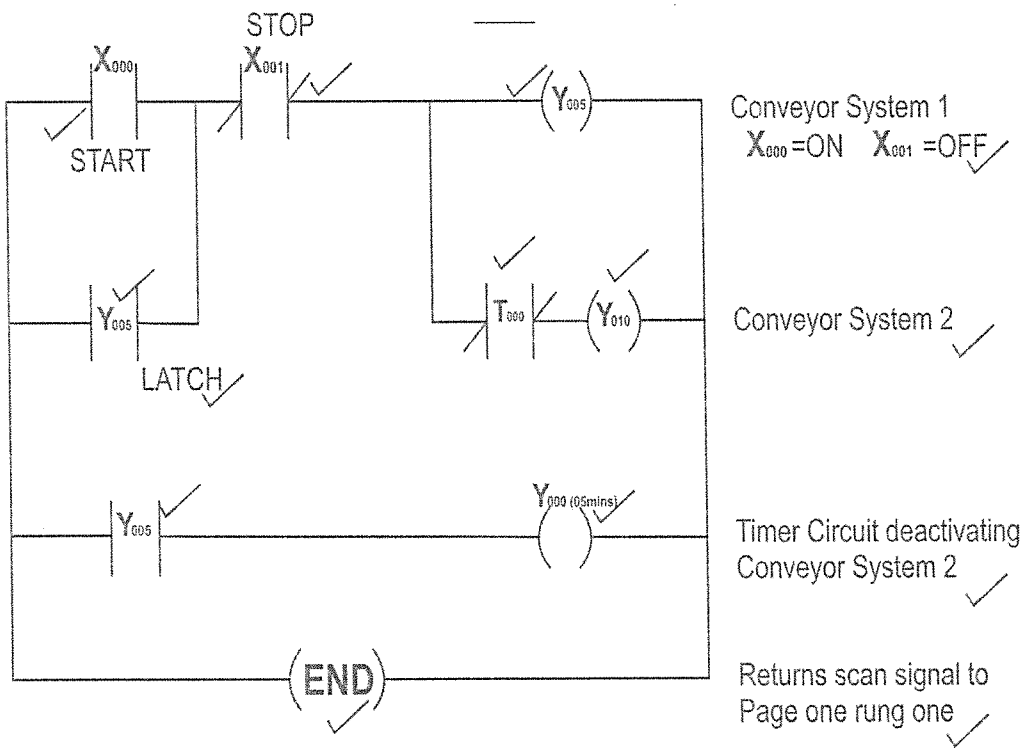
QUESTION 5: AUTOMATIC INSPECTION AND PROGRAMMABLE LOGIC CONTROLLERS (PLC's)

5.1 5.1.1 Watch-dog timer

5.1.2 The purpose of a watch-dog timer is to ensure that internal circuit and memory faults do not cause the CPU to enter an endless loop because of hardware failure

(2 x 1) (2)

5.2



(14)

5.3 5.3.1 True – it makes decisions based upon the logic that has been programmed.

5.3.2 False – the CPU may have entered an endless loop due to hardware failure.

5.3.3 True – being low power, they do not need battery backup to hold data.

(3 x 2) (6)
[22]

TOTAL: 100

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