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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

INDUSTRIAL ELECTRONICS N6

4 AUGUST 2014

This marking guideline consists of 8 pages.

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QUESTION 1

(1,1) (1,1,1) $F_n = \frac{1}{2\pi} \cdot \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$ ✓

If $\frac{1}{LC} = \frac{R^2}{4L^2}$ using a Critically damped Case

$R = \sqrt{\frac{4L}{C}} = \sqrt{\frac{4 \times 20 \times 10^{-3}}{15 \times 10^{-6}}}$ ✓

$R = \sqrt{\frac{0,8}{15 \times 10^{-6}}}$

$R = 53,3\,\Omega$ ✓ (3)

(1,1,2) $F_n = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$

$F_n = \frac{1}{2\pi}\sqrt{\frac{1}{20 \times 10^{-3} \times 15 \times 10^{-6}} - \frac{(53,3)^2}{4(20 \times 10^{-3})^2}}$ ✓

$\frac{1}{2\pi}\sqrt{33 \times 10^6 - 1332,5}$

$= \frac{1}{2\pi}\sqrt{32928667,5}$

$f_n = 289\,Hz$ ∧

$\int = \frac{\pi R}{\omega L}$ where $\omega = 2\pi f$ (3)

$= \frac{\pi (53,3)}{2\pi (289)(20 \times 10^{-3})}$ ✓

$\int = 4.61$ ∧

(1,1,3) $n = \frac{1 + 4,605}{\int} = \frac{1 + 4.605}{4.61}$ ✓

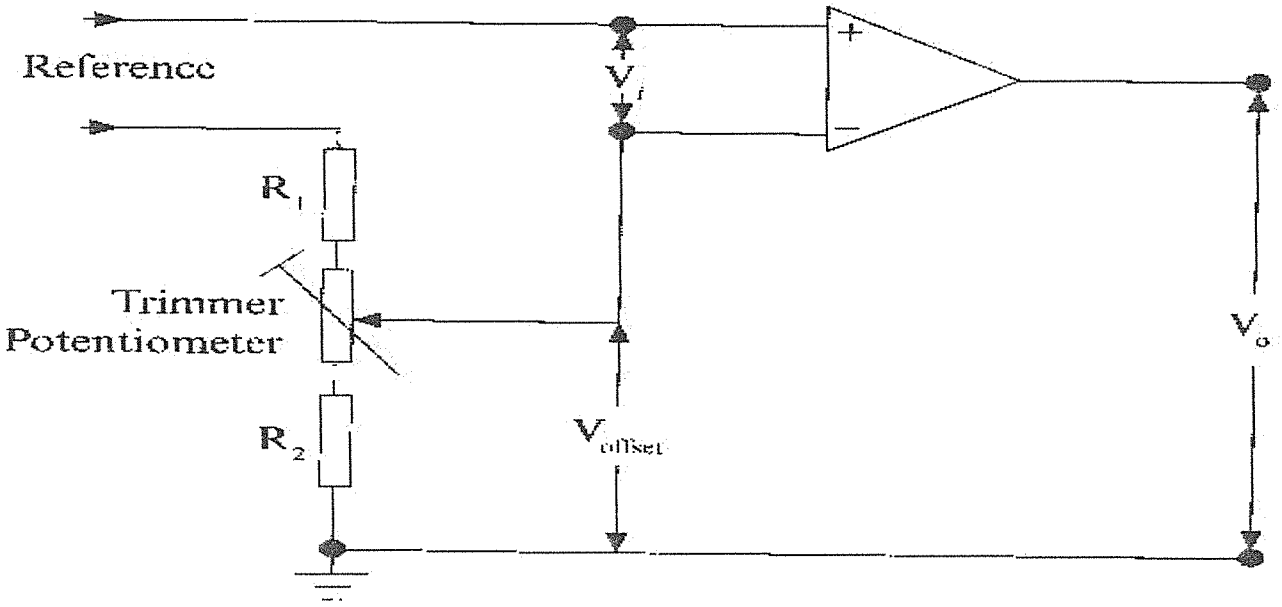
$n = 1,22$ Oscillations

$t = \frac{1}{F} \times n = \frac{1,22}{289} = 4,22 \times 10^{-3}\,s$ ✓ (2)

$= 4,22\,mS$

1.2 1.2.1
- 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 above zero (3)

1.2.2



Neat sketch 2 marks
Correct labelling 2 marks (4)

1.3 Below table shows some common transducers, Copy the table as is & fill in the gaps indicated from (1.3.1) – (1.3.4).

	ELECTRICAL PARAMETER	**PRINCIPLE OF OPERATION**	**PRACTICAL APPLICATION**
1.3.1	Potentiometer	…varies the resistance…..	….Pressure…….. …Displacement (any one)
1.3.2	Photo-conductive cell	……..incident light……..	…Photosensitive devices…..
1.3.3	Thermocouple	……Generated EMF across dissimilar metals….	…….Temperature……..
1.3.4	Ionisation chamber	……..ionisation of gas…..	…Radiation particle counting….

(2 × 4) (8)
[23]

QUESTION 2

2.1 2.1.1 Magnetostriction refers only to conductive materials such as iron-cobalt and nickel alloys. The materials are unique in properties, they will undergo dimensional changes when subjected to oscillating or magnetic field. (3)

2.1.2 The function of a DC bias in an ultrasonic application is to allow the magnetostrictive core to expand along the nodal line so that the core can oscillate when AC signals from the ultrasonic generator are applied. (2)

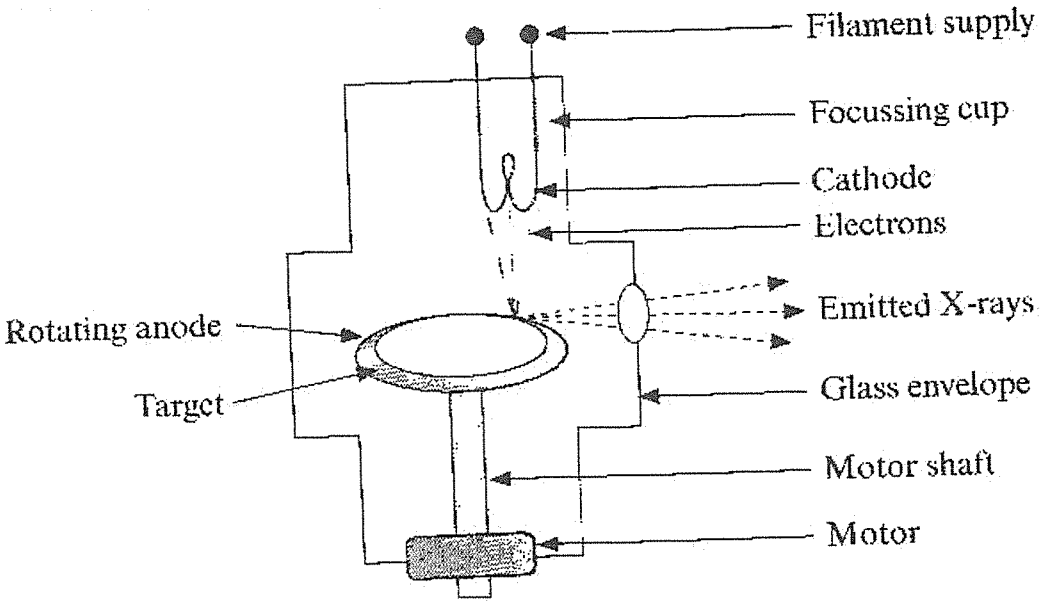
2.2
- Consider the shell life and demand of the project
- Consider the packaging and storage methods
- Consider the rejection cycles of the product, that is rejected in the main stream production line
- Consider the character of the final product , such as size, mass, structure, density, colour, texture etc
- Consider the availability and the economic factors of labour versus automation
- Perform as many processes as possible in a single stage

(Any 3 × 1) (3)

2.3 2.3.1 <u>Priniciple of Operation</u>

Electrons is emitted from the hot filament and as they combine with the atoms of the target, they dislodge electrons from their normal energy levels in the target materials, the excited electrons gains energy and move into higher energy levels. Producing mainly heat, only electrons releasing energy by falling from a higher energy level to the inner most energy (K shell) will produce X-ray energy. (3)

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Construction of a modern X-ray tube

Neat & correct sketch 1 mark
Any 3 correct labelling 1 mark each (4)

2.3.2 The purpose of an auto transformer in the PSU is for the unit to be adjusted for variations in the mains supply voltage before an exposure is made, since the amount of X-ray produced is directly proportional to the voltage applied to the anode. (3)

2.3.3 ➢ Less than 2% of all the energy generated in an X-ray tube correspond to actual X-rays emitted.

or

➢ Bulk of the energy produced by an X-ray tube is in the form of heat and the effectiveness of the tube is further more proportional to both the applied voltage and atomic number of the target material.

(Any one above) (2)
[20]

QUESTION 3

3.1 Non-destructive testing/Non-destructive investigation: These are quality control processes or methods carried out to identify any form of flaws or defects without harming the material or product being tested. (2)

3.2 Advantages of indirect viewing method

- A permanent record is made of the flaw in a particular object.
- A skilled operator can view a large batch of X-ray films in rapid succession after they have been exposed and developed by semi-skilled operator who doesn't have to interpret the developed films.
- There is less danger of exposure to X-radiation to the operator (3)

3.3 3.3.1 $d = 540mm=0,54m,\ t = 220m/s$
$V = 2d/t = 2\ (0,54)\ /220 \times 10^{-3}$
$= 4,91$ m/s (2)

3.3.2 $PRR\ (f) = 1/t = 1/(220 \times 10^{-3})$
$= 4,55Hz$ (2)

3.3.3 $d = vt/2 = (4,91 \times 0,01 \times 10^{-3}) / 2$
$= 0,000025$ m (2)

3.4 Factors to be considered when installing any safety device

- The safety device must be 'fail safe' OR if the safety device itself is faulty operation of the equipment should be made impossible.
- The operator should not be able to by-pass the safety device, if in his opinion he can work faster or better without the safety device being operational. (2)

3.5 3.5.1 Negative protection: It is represented by logic or function. The machine and its safety device are connected in parallel.

Example: Non-protection in Industrial DC motors

Positive Protection: It is expressed by logic AND function. The machine and its safety device are connected in serial mode.

Example : The over-current protection of a motor (2×3) (6)
[19]

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QUESTION 4

4.1 To trigger a thyristor possibly in the shortest time, it is desirable to have the gate current with fast rise time up to the maximum permitted value. You can achieve this with pulse techniques where the firing circuit generates fast rise pulse of sufficient length to allow the anode current enough time to reach its latching value.

The advantage of the pulse is that much less power is dissipated in the gate compared to a continuous current and the instant of firing can be accurately timed. (justification 1 mark) (4)

4.2 Advantages of using DC-motor speed control

- 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 × 1) (5)

4.3 4.3.1 Plugging: It involves reversing the armature conditions to the supply via resistor for the motor to rotate finally in the reverse direction. It is used in traction application and high speed drives.
(Application 1 mark) (Definition 2 marks)

4.3.2 Regenerative braking: This is applied to device where there is a need to preserve energy, The motor supply is removed which turns the motor into a generator and returns the energy to the DC source. It is used in a battery operated vehicle.
(Application 1 mark) (Definition 2 marks)
(2 × 3) (6)

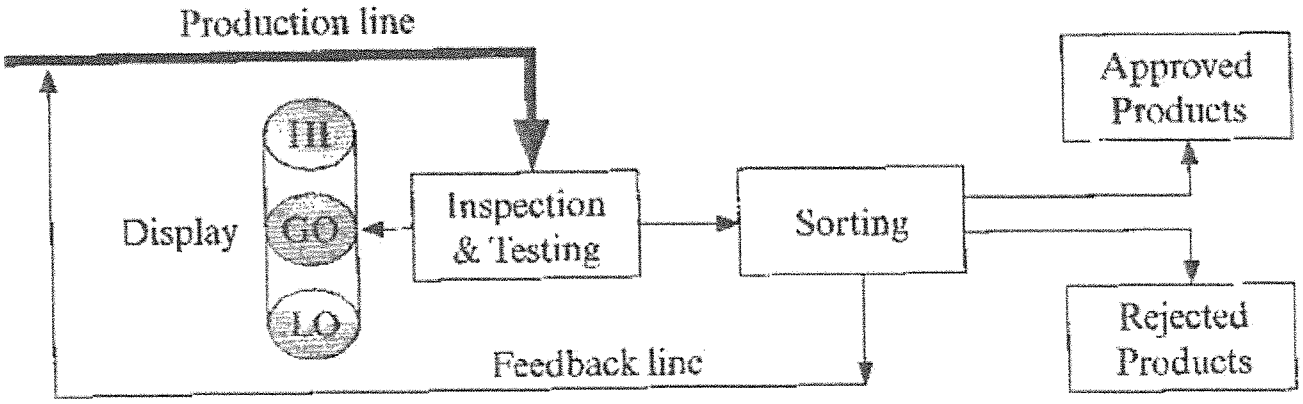
4.4 4.4.1 $V_{mean} = 3/\pi\ V_{line}.\sqrt{2}\cos\alpha V$
$= 3/\pi\ .\ 311.\ \sqrt{2}.\ \text{Cos}\ 45° - 2 \times 1{,}5V$
$= 293{,}983\ V$ (2)

4.4.2 $PIV = V_{max} = \sqrt{2}\ V_{RMS}$
$V_{line}.\ \sqrt{2} = V_{max}$
$V_{max} = 311.\ \sqrt{2}$
$V_{max} = 439{,}82\ V$
$V_{max} = PIV = 439{,}82\ V$ (3)
[20]

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QUESTION 5

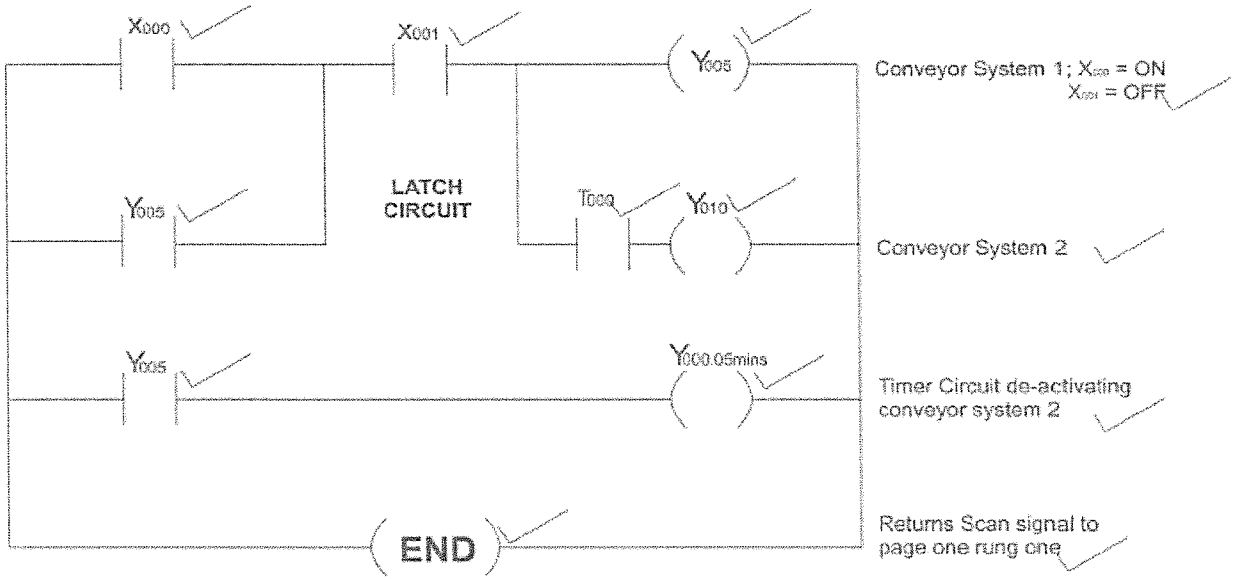
5.1



Block diagram of a three-way system (4mrks)

(4)

5.2



Labelled diagram symbol 1 mrk (14mrks)
Description of each rung ladder 1 mrk
Neatness 1 mrk

(14)
[18]

TOTAL: 100

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