higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

INDUSTRIAL ELECTRONICS N6

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This marking guideline consists of 6 pages.

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QUESTION 1

1.1
1.1.1 Disturbance
1.1.2 Elements
1.2.3 Transitional period
1.1.4 Currents
1.1.5 Voltages
1.1.6 Former values
1.1.7 New values
1.1.8 Transient

(1/2 mark each) (4)

1.2 Time constant of an RC circuit is the **time taken** for the circuit to **reach steady-state conditions after a disturbance** assuming a constant rate **of change in the charging or discharging current.** $\tau = L/R$ seconds. (4)

1.3 It is achieved by converting and conditioned current signal into an equivalent volt drop across a suitable then fed through a buffer amplifier to isolate the output from the input so as to prevent shunting the dropping resistor and producing an error. (6)

1.4 $\tau = L/R = 2/4 = 0,5$ seconds
$I = V/R = 20/4 = 5$ amps

1.4.1 $\tau = i_m (1-e^{-t/\tau}) = 5(1-e^{-1}) = 3,161$amps

1.4.2 $V_R = E_m(1-e^{-t/\tau}) = 20(1-e^{-2/0.5}) = 19,634$ volts

1.4.3 $\omega = 0,5\ Li^2 = 0,5 \times 2 \times 5^2 = 25$ J

1.4.4 $I = i_m(1- e^{-t/\tau})$
$di/dt = i_m\ e^{-t/\tau} / \tau$
$di/dt = I_m/\tau = 5/0,5 = 10$A/second (8)

1.5
- 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)

[25]

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QUESTION 2

2.1 The phenomenon cavitation takes place when ultrasonic energy is generated in a liquid. The alternating regions of **high and low pressures generates vapour** voids which **form as the pressure drops and collapse as the pressure rises**. When these voids **collapse they inturn generate high energy shock-waves** which can disperse surface dirt on parts which are immersed in the liquid (cleaning fluid). (2)

2.2 2.2.1 True

2.2.2 True

2.2.3 False - The surface tension should be **low to ensure cavitation**.

2.2.4 False - The abrasive particles in the liquid, when agitated in the direction of the vibration, gradually sink cavities into the workpieces, corresponding to the shape of the tool.

2.2.5 False - The tip of the ultrasonic soldering iron is heated. (5 × 2) (10)

2.3 $c = \lambda \times f$
$f = c/\lambda$
$= 3\times10^{8}/1\times10^{-9}$
$= 3 \times 10^{17}$ Hz (2)

2.4
- Wear approved protective clothing
- Use level exposure indicator
- Premises must be clearly marked with applicable warning signs
- Proper shielding of work stations
- Decontamination of all personnel and equipment after exposure
- Maintain correct storage, transport and waste disposal procedures.

(Any 4 × 1) (4)

2.5 An auto-transformer is included in the power supply unit so that the unit can be **adjusted for variations** in the mains supply voltage **before an exposure is made**. (2)

[20]

QUESTION 3

3.1
- perform as many processes as possible in a single stage
- consider the availability and the economic factors of labour versus automation etc.
- consider the shelf life and demand of the product
- consider the packaging and storage methods
- consider the rejection cycles of the product that is if it is rejected in the main stream production line, what are the alternatives?
- consider the character of the final product, such as size, mass , structure, density, colour, texture, etc. (6)

3.2 3.2.1 $t = (2 \times d)/v = (2 \times 0,5)/(6 \times 10^3) = 166,667$ µ seconds
PRRF (f) = $1/t = 1/(166,667 \times 10^{-6}) = 6$ kHz

3.2.2 $d = (v \times t)/2 = (6\,000 \times 50 \times 10^{-6})/2 = 0,15$ m (4)

3.3 **Positive Protection** is applied to any electronic system whereby operation of the system can only be justified if all safety conditions are simultaneously fulfilled. e.g. the over current protection of a motor or in a microwave oven the magnetron heater is in standby mode (assuming power is connected) so that heat is produced when the ON/OFF switch is activated.

Negative Protection is represented by Logic OR function. This implies that the machine and its safety device are connected in parallel. E.g. No-voltage protection as is applied to industrial DC motors. (5)
[15]

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QUESTION 4

4.1 The UNCONTROLLED RECTIFIER circuits contain only diodes giving a DC load voltage fixed in magnitude relative to the AC supply voltage magnitude.

In the FULLY-CONTROLLED RECTIFIER circuits all the rectifying elements are thyristors. In these circuits, by suitable control of the phase angle at which the thyristors are triggered, it is possible to control the mean (DC) value of, and the reverse of the DC load voltage.

The HALF-CONTROLLED RECTIFIER circuits contain a mixture of thyristor. In these circuits, by suitable control of the phase angle at which the thyristors are triggered, it is possible to control the mean (DC) value of, and thereverse of the DC load voltage.

The HALF-CONTROLLED RECTIFIERS circuits contain a mixture of thyristors and diodes which prevent a reversal of the load voltage, but do allow adjustment of the direct (mean) voltage level. (6)

4.2
- A wide range of speed control is possible
- Can operate under constant or variable torque conditions
- Rapid acceleration, declaration and reversing
- Open or closed loop operation
- Operate under regenerative conditions
- Range from fractional Kw to 7 500 kW (Any 5 x 1) (5)

4.3 **Plugging**: this is the braking technique of reversing the armature connections to the supply via a resistor for the motor to finally ratates in the reverse directions.

Renerative braking: this is applied to devices where there is a need to preserve energy as is the case with battery operated vehicles with this type of braking the motor supply is removed which turns the motor into a generator and returns the energy to the DC source.

Dynamic braking: this is applied to those areas where rapid slowdown is required and regenerative braking is not possible. When the stop button is activated, a contactor places a fixed resistor across the armature of the motor while at the same time disconnecting the armature supply mechanically or electronically. (9)

4.4 $Z_{th} = T_{rise}/P_{loss}$
$T_{rise} = Z_{th} \times P_{loss} = 0{,}03 \times 2000 = 60\ °C$
Junction Temperature = T_a(ambient temp) + T_{rise} = 40 + 60 = 100 °C
Since the junction temperature of a typical SCR devices are usually limited to around 125 °C, the calculate junction temperature of 100 °C is a safe and realistic value. (5)
[25]

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QUESTION 5

5.1 5.1.1 Counter: an internal type of logic which produces an output after a pre-programmed number of occurrences have taken place.

5.1.2 Any element used in a ladder logic diagram that has an influence on the operation of the program.

5.1.3 Diagnostic: Display functions which are available to the facilitate in trouble shooting with programs and field devices.

5.1.4 To intentionally modify the user program on a PLC.

5.1.5 Timer: An internal function which produces an output after a pre-set interval of time.

5.2 5.2.1 True - the CPU may have entered an endless loop due to hardware failure.

5.2.2 True - it makes decisions based upon the logic that has been programmed.

5.2.3 True - being low power they do not require battery back up to hold data.

5.2.4 True - they lose their data when power is removed.

5.2.5 False - some programmer units have their own power sources.

(5 × 2) (10)
[15]

TOTAL: 100

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