higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T830**(E)**(J24)T

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

(8080216)

24 July 2018 (X-Paper)
09:00–12:00

This question paper consists of 5 pages and 1 formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS 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.

SECTION A: ANALYSERS

QUESTION 1

1.1 Make a neat sketch of a Geiger-Mueller tube. (5)

1.2 Describe the construction and operation of a Geiger-Mueller tube. (5)

1.3 Draw a basic circuit for an AC arc and describe its working principle. (5)

1.4 Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–H) next to the question number (1.4.1–1.4.6) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.4.1	Source of IR energy	A	magnetic wind-type analyser
1.4.2	Radiation with a wavelength shorter than that of radio waves and longer than that of light waves	B	X-rays
		C	intensities of radiation
		D	wavelengths of the radiation
1.4.3	Measure the percentage of oxygen in the gas mixture	E	ultraviolet radiation
1.4.4	Very high-frequency electromagnetic waves with a very short wavelength of between 10^{-12} and 10^{-8} m	F	glow wire
		G	infrared radiation
		H	gas chromatography
1.4.5	Used to determine the concentration of the elements within the sample		
1.4.6	Used to identify the elements comprising the mixture		

(6 × 1) (6)

1.5 What is actually determined by an IR analyser? (3)

1.6 Make a neat, labelled sketch of an IR reflectance analyser. (6)

[30]

TOTAL SECTION A: 30

SECTION B: AUTOMATIC CONTROLLERS AND VALVES

QUESTION 2

2.1 Explain the difference between *split range control* and *override control*. (4)

2.2 Make a neat sketch of the valve characteristic curves (% flow against % valve opening) of the following valves on the same set of axis:

A quick opening valve, an equal-percentage valve and a linear valve (5)

2.3 Make a neat sketch and explain the derivation of the two parameters needed in the ultimate method of adjusting a PID controller. (6)

2.4 Define the following terms:

2.4.1 Measurement lag

2.4.2 Process lag

(2 × 2) (4)

2.5 With the derivative and integral action at its lowest value, we adjust the proportional band of a controller to decrease while the smallest set point variations are made, until the process just starts cycling. The Pbu is now 52% and the cycle period Pu is measured as 0,5 minutes.

By using the ultimate sensitive method, determine the adjustments of a PID action controller. (6)

[25]

TOTAL SECTION B: 25

SECTION C: DISTILLATION COLUMN AND STEAM BOILERS

QUESTION 3

3.1 Explain the basic distillation process of a mixture of two components. (5)

3.2 On what type of boiler can single-element level control be used? (2)

3.3 Explain why integral action should not be used in a single-element level control. (2)

3.4 A control valve must be installed in a line to control the flow of fuel to a furnace.

What type of valve would you use and why? (2)

3.5 A distillation column consists of the following components: A feed pump, preheater, reboiler, condenser, reflux accumulator and reflux pump.

Make a neat, labelled sketch, showing the following:

- Feed rate flow control (1)
- Temperature cascaded onto the steam flow control to the reboiler (5)
- Bottom product level control (2)
- Top product draw off controlled by the reflux accumulator level (3)

3.6 Explain why pressure control is important in distillation columns. (8)

[30]

TOTAL SECTION C: 30

SECTION D: INTRINSIC SAFETY

QUESTION 4

4.1 Name and briefly explain the THREE basic requirements that must be met, as a rule, for an explosion to take place in atmospheric air. (3 × 2) (6)

4.2 Define the term the *flash point* of a flammable liquid. (2)

4.3 Name FOUR types of protection that can be used in a hazardous location. (4)

4.4 Define a *hazardous location.* (3)

[15]

TOTAL SECTION D: 15
GRAND TOTAL: 100

FORMULA SHEET

1. $$Point\ of\ inflection = \frac{reaction\ range}{2}$$

2. $$\%\ change\ in\ variable = \frac{point\ of\ inflection}{process\ range} \times 100$$

3. $$R = \frac{\%\ change\ in\ variable}{time\ in\ minutes}$$

4. $$Proportional\ band = \frac{100\ RL}{\Delta P}$$

5. $$Proportional\ band = \frac{110\ RL}{\Delta P}$$

6. $$Integral\ rate\ (r/m) = \frac{0{,}3}{L}$$

7. $$Proportional\ band = \frac{83\ RL}{\Delta P}$$

8. $$Integral\ rate\ (r/m) = \frac{0{,}5}{L}$$

9. $$C_v = 1{,}16Q\sqrt{\frac{G_f}{\Delta P}}$$

10. $$C_v = \frac{1{,}16\ W}{\sqrt{G_f \Delta P}}$$

11. $$C_v = \frac{Q}{295}\sqrt{\frac{G.T}{\Delta P(P_1 + P_2)}}$$

12. $$C_v = \frac{47{,}2\ W}{\sqrt{\Delta P(P_1 + P_2)}}$$

13. $$C_v = \frac{72{,}4\ W}{\sqrt{\Delta P(P_1 + P_2)}}$$

14. $$PB = \frac{change\ in\ process\ variable}{100}\%$$