higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T830**(E)**(M27)T

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

(8080216)

27 March 2018 (X-Paper)
09:00–12:00

This question paper consists of 4 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, labelled sketch of the Cuttler-Hammer-type recording gas calorimeter. (5)

1.2 Discuss the operating principle of the calorimeter named in QUESTION 1.1. (8)

1.3 Draw a complete block diagram of gas chromatography. (5)

1.4 Make a neat, labelled sketch of a catalytic combustion-type O_2-analyser. (6)

1.5 Briefly discuss the operating principle of the analyser named in QUESTION 1.4. (6)

[30]

TOTAL SECTION A: 30

SECTION B: AUTOMATIC CONTROLLERS AND VALVES

QUESTION 2

2.1 Describe the systematic experimental method of adjusting the controller settings of a *proportional plus integral controller*. (8)

2.2 Illustrate, with the aid of sketches, the effect of increasing the integral rate, in question 2.1. (5)

2.3 Define the following terms as applied in control systems:

2.3.1 Potential value (2)

2.3.2 Inherent regulation (3)

2.3.3 Valve coefficient (2)

2.4 Calculate the C_v of a control valve suitable for controlling a process gas if the following information is given:

- Specific gravity of gas is 0,86
- Barometric pressure is 1,0135 bars
- Temperature of the gas is 86 °C
- Upstream pressure is 10,85 bars
- Downstream pressure is 2,3 bars
- Required flow rate is 386,5 m^3/h (5)

[25]

TOTAL SECTION B: 25

SECTION C: DISTILLATION COLUMN AND STEAM BOILERS

QUESTION 3

3.1 Discuss the construction and operation of the following devices, as used in the feeding of unmeasured fuel into a burner:

3.1.1 Stoker (4)

3.1.2 Cyclone burner (3)

3.2 Draw a two-element feed-water control system. (5)

3.3 Explain how the water level in a boiler drum is controlled by the system named in QUESTION 3.2. (5)

3.4 Name FIVE factors which will influence the operation of a reflux condenser. (5)

3.5 Explain the function of each of the following basic interlocks on a boiler:

3.5.1 Purge interlock

3.5.2 Low-water interlock

3.5.3 High-flame interlock

3.5.4 Low-airflow interlock

(4 × 2) (8)
[30]

TOTAL SECTION C: 30

SECTION D: INTRINSIC SAFETY

QUESTION 4

4.1 State THREE important questions to be asked when evaluating a system for intrinsic safety. (3)

4.2 Name THREE types of purging installation systems. (3)

4.3 Discuss what is meant by non-incentive equipment and wiring. (6)

4.4 Make a neat, labelled sketch of a type X purging system. (3)
[15]

TOTAL SECTION D: 15
GRAND TOTAL: 100

INDUSTRIAL INSTRUMENTS N6

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

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