

**MANICALAND STATE UNIVERSITY OF  
APPLIED SCIENCES**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF CHEMICAL AND PROCESSING ENGINEERING**

**PLANT AND EQUIPMENT DESIGN**

**CODE: HCHE 321**

**SESSIONAL EXAMINATIONS**

**APRIL-MAY 2021**

**DURATION: 3 HOURS**

**EXAMINER: MR C.K. SIMENDE**

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**INSTRUCTIONS**

1. Answer **any 4** questions.
2. Each question carries 25 marks.
3. Total marks 100

## QUESTION 1

- a. Explain what you understand by the following terms:
- i. Cost estimation [2 marks]
  - ii. Fixed capital investment [3 marks]
  - iii. Working capital [1 mark]
  - iv. Total capital investment [1 mark]
  - v. Grass root plant [1 mark]
- b. Describe and explain the three methods used to obtain Fixed Capital Investment using any examples of your choice. [17 marks]

## QUESTION 2

- a. Describe and explain the three different methods for estimating purchased equipment cost. [11 marks]
- b. A new plant ordered a set of floating head heat exchangers (Area = 100 m<sup>2</sup>) cost \$92,000. What would cost be for a heat exchanger for similar service if area = 50 m<sup>2</sup> and  $n = 0.44$ ? Use the information to explain the meaning of the term Economy of Scale. [6 marks]
- c. The elementary liquid phase reaction  $2A \rightarrow B$  is carried out isothermally in a CSTR. Pure A enters at a volumetric flow rate of 25 dm<sup>3</sup>/s and at a concentration of 0.2 mol/dm<sup>3</sup>. What CSTR volume is necessary to achieve a 90% conversion when  $k = 10 \text{ dm}^3/(\text{mol}\cdot\text{s})$ ? [8 marks]

## QUESTION 3

- a. You have recent quotes for two fixed tube sheet heat exchangers as shown in Table 1.

Table 1 : Heat Exchanger Prices

Area (ft <sup>2</sup> )	Cost (\$)
500	9,450
2000	20,000

Using this data, estimate the cost of a 900-ft<sup>2</sup> fixed tube sheet heat exchanger.

[6 marks]

b. What are the five capital cost estimating techniques? Order them in terms of their accuracy.

[19 marks]

#### QUESTION 4

Describe and explain Guthrie's Modular Technique giving examples if any.

[25 marks]

#### QUESTION 5

a. Describe and explain the term Hazop Study as it is used in plant design.

[11 marks]

b. Figure 1 shows a chlorine vaporizer, which supplies chlorine at 2 bar to a chlorination reactor. The vaporizer is heated by condensing steam. Consider the steam supply line and associated control instrumentation. The designer's intention is that steam shall be supplied at a pressure and flow rate to match the required chlorine demand. Perform a Hazard and Operability analysis on the chlorination reactor using the guide words NO and MORE.

[11 marks]

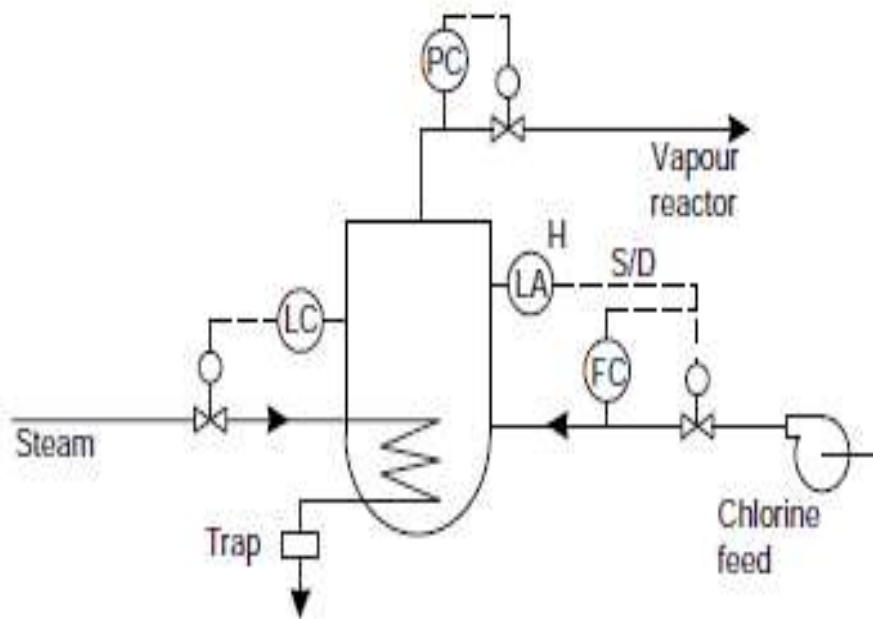


Figure 1. Chlorine vaporizer instrumentation

- c. Determine the capital cost for a major expansion to a fluid processing plant that has a total purchased equipment cost of \$6,800,000. [3 marks]

$$f_L = 3.10 \text{ for solids processing plant}$$

$$f_L = 3.63 \text{ for solid – fluid processing plant}$$

$$f_L = 4.74 \text{ for fluid processing plant}$$

**END OF PAPER**