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

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^2) cost \$92,000.What would cost be for a heat exchanger for similar service if area = 50 m^2 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^3/s and at a concentration of 0.2 mol/dm^3. What CSTR volume is necessary to achieve a 90% conversion when k = 10 $dm^3/(mol*s)$? [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^2)	**Cost ($)**
500	9,450
2000	20,000

Using this data, estimate the cost of a 900-ft^2 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 with the aid of an example 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]

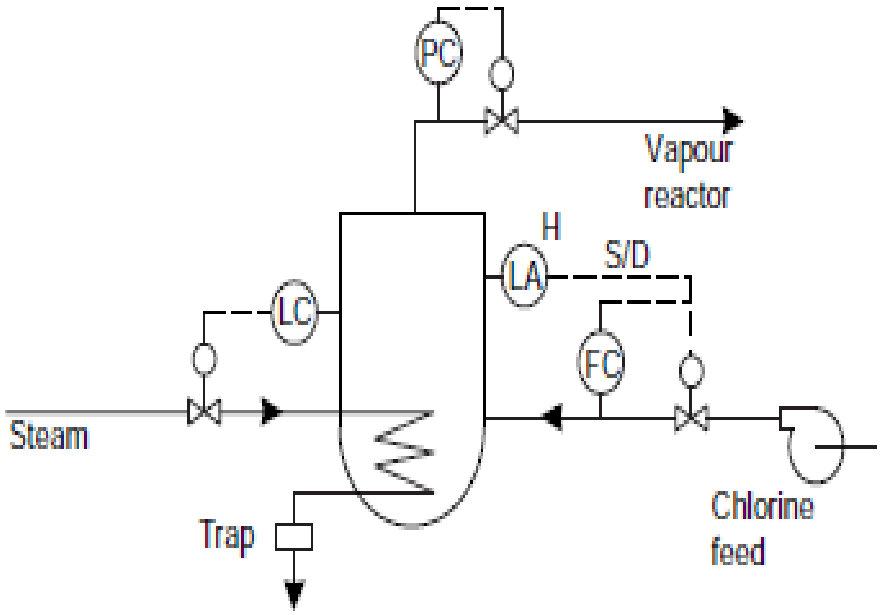

Figure 1. Chlorine vaporizer instrumentation

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]

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

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

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

END OF PAPER