**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**
**FACULTY OF APPLIED SCIENCES**

**BACHELOR OF APPLIED SCIENCES HONOURS DEGREE**

**END OF SECOND SEMESTER EXAMINATIONS - JUNE 2010**

**CHEMICAL ENGINEERING PLANT DESIGN - SCH 4108**

**TIME: THREE (3) HOURS**

**Instructions to Candidates:**

1. Answer five questions only.

2. Each question carries 20 marks.

3. Start the answer for each question on a fresh page.

4. The total score is 100 marks.

**Question 1**

1.1 The Board of Directors of Douglas Manufacturing Corporation was presented with an Income Statement and a Cash Flow Statement for the year ending 2006. The Income Statement showed a Net Income of $ 1.24 million; and the Cash Flow Statement showed a Cash Flow of $ 1.62 million. How do you explain the disparity between the two financial reports? **[ 3 marks]**

1.2 Make a diagrammatic illustration of the sources of Cash Inflows and Cash Outflows for Douglas Manufacturing Corporation in relation to the company's Operations, Investments and Financing arrangements. **[ 6 marks]**

1.3 An air compressor used by a company was purchased for a sum of US$ 280 000. The same machine was given a service life of 10 years, at the end of which it will have an estimated salvage value of

$ 40 000. Determine the annual depreciation charge for the machine? **[ 3 marks]**

1.4 The management of Douglas Manufacturing Corporation is considering two expansion projects, Project X and Project Y. The initial capital investment requirements of both projects are the same, namely $120 000. The estimated cash flows ( CFs) are as follows:

| Year | Project X | Project Y |
|---|---|---|
| 1 | $ 70 000 | $ 10 000 |
| 2 | 40 000 | 20 000 |
| 3 | 30 000 | 30 000 |
| 4 | 10 000 | 50 000 |
| 5 | 10 000 | 90 000 |

The company's required rate of return is 11%. Calculate the Net Present Values ( NPVs) of both projects. Which project should be chosen? Why?                    **[ 8 marks]**

**Question 2**

2.1 State two procedures that are normally used to select equipment for installation in a

Chemical Process Plant. Discuss briefly the merits of each procedure.          **[ 5 marks]**

2.2 There are five ( 5) categories of materials that are used for construction of equipment

and/or equipment parts in industry. Name the categories of materials concerned.

**[ 5 marks]**

2.3 Name five ( 5) important mechanical properties of metallic materials of construction that

ought to be taken into consideration during the selection of a material for use in the

fabrication of vessels for the Chemical Process Industry. For each "mechanical property",

stipulate the method of measurement.                              **[ 5 marks]**

2.4 Provide a definition of the phenomenon called Engineering Stress on materials. Explain

using both descriptive words and by means of a mathematical expression. For the

mathematical expression, you are required to indicate the SI units that are applicable.

**[ 5 marks]**

## Question 3

3.1 Name the two (2) most common shapes that obtain with vessels found in the Chemical

Process Industry. Name three (3) varieties of end caps, i.e. formed heads, which are fitted

on chemical process vessels. State the operating conditions that your three varieties of

heads are suited for. **[ 5 marks]**


3.2 The ASME Code VIII-1 provides a simplified equation for determining the required thickness

of a cylinder shell subjected to an internal pressure. Write the equation used in the

determination; in addition explain what each term in the equation stands for. Explain, very

briefly, the factors that influence the value of the term E in the equation. **[ 5 marks]**


3.3 What is the maximum allowable pressure that can be applied to a cylinder shell with an

outside diameter of 6ft, thickness 1.25 in., and an allowable stress of 17 500 psi?

Let E= 0.85. Do your calculation in SI units. Conversion Tables are provided. **[10 marks]**


## Question 4

4.1 Give five ( 5) prerequisites for designing a Chemical Reactor?**[ 5 marks]**

4.2 Draw labeled pictures of a Continuous Stirred Tank Reactor ( CSTR)  and  a Plug Flow

Reactor ( PFR). Compare the two reactor designs in terms of the following characteristics:

a) Mode of mixing of the reactants

b) Mode of heat transfer and temperature monitoring

c) Ease of automation

d) Phases of reactants that each reactor design can best handle

e) Capacity flexibility of the reactor design

f) Fixed capital and operating capital requirements for each reactor design

g) Give one example of a chemical preparation that is done in each one of the two reactor

designs.                                                                                    **[ 15 marks]**


## Question 5

5.1 Define the function of a pump as a piece of machinery.                    **[ 2 marks]**

5.2 Make a fully labeled sketch of a Reciprocating Pump.                      [**3 marks]**

5.3 What are the two sources of power for a Reciprocating Pump?              **[ 2 marks]**

5.4 Give three advantages of a Reciprocating Pump in comparison to a Centrifugal Pump and

vice versa?                                                                                  **[ 6 marks]**

5.5 Name three types of machinery that are used to accomplish movement of gases, and

subject to what conditions can you use the machines concerned.              **[ 3 marks]**

5.6 Produce a simple labeled diagram of a Centrifugal Compressor. Show and describe how the

gas enters and exits the machine and state what energy transformations take place.

**[ 4 marks]**

## Question 6

6.1 Corrosion is an electrochemical process. Describe the phenomenon briefly and in addition,

draw the electrochemical cell that illustrates the phenomenon. Show also the associated

chemical reaction equations.                                                            **[ 6 marks]**

6.2 Name two ( 2) pieces of equipment in the Chemical Process Industry that tend to be the

most affected by corrosion. What are the reasons for this? How can corrosion be prevented

or minimized in the equipment concerned?                                    **[ 6 marks]**


6.3 Describe the causes of the following kinds of corrosion; in addition indicate possible

prevention measures:

    a) Pitting corrosion

    b) Galvanic corrosion

    c) Microbiological corrosion

    d) Stress Corrosion Cracking (SCC)                                    **[ 8 marks]**


**END OF PAPER!!!!**