NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
SUPPLEMENTARY EXAMINATIONS – AUGUST 2010
CHEMICAL ENGINEERING PLANT DESIGN – SCH 4108
TIME: (3) THREE HOURS

INSTRUCTIONS TO CANDIDATES

1. **Answer ALL questions.**
2. **Each question carries 20 marks.**
3. **Total marks are 100.**

Question 1

(a) You are required to the determine the thickness of a cylinder that is subjected to an internal pressure using the equation contained in the ASME Code Section 8, Division 1.The cylinder has an inside diameter, D, of 1.27 metres and it is subjected to an internal pressure, P, of 689 kPa . Using an allowable stress, S, of 120 659 kPa and an allowable joint efficiency, E, of 0.85, find the required thickness of the cylinder in milimetres (mm). [12 Marks]

(b) Draw a Stress – Strain Curve for a material of your choice that you are going to use for construction of a pressure vessel. On your curve indicate the positions of the following points or sections of the curve:

(i) area of plastic deformation
(ii) point of yield strength
(iii) point of breaking strength [8 Marks]

Question 2

(a) Name **two** broad categories of pumps that are used for moving liquids in Industry? Further, state the contruction features of each design of pump and then explain briefly, preferably diagramatically, the mode of operation of each design. [7 Marks]

(i) What parameters would you require to be available in order for you to determine the Reynold's Number (Re) of a liquid flowing through a pipe? In addition, how does the Re value assist the Process Engineer to characterize a system? [7 Marks]

(ii) Name the various machines that are used for movement of air or gases, and which of these machines has the closest resemblance to pumps in general? [6 Marks]

Question 3

(a) Enumerate the basic features that must be found in every design of Chemical Reactor? [5 Marks]

(b) State a minimum of five (5) qualitative and quantitative considerations that must always precede either the design or selection of a Chemical Reactor? [5 Marks]

(c) Do a diagram of a Tank Flow Reactor and follow up with a full description of the equipment. In the description you are required to cover such aspects like the following:

- the type of chemical preparations that the reactor can be used for
- the mass and heat transfer performance aspects of the reactor design
- the composition and quality of products yielded by the reactor design

[5 Marks]

(d) Make a diagrammatic representation of a Tubular Flow Reactor and discuss its operational characteristics in a manner that is in contrast to that of the Tank Flow Reactor. [5 Marks]

Question 4

(a) What industrial name is given to an alloy of iron and carbon? [1 Mark]

(b) What kind of an alloy is stainless steel ? [1 Mark]

(c) Define the phenomenon of corrosion ; and then draw a diagram (which is fully labeled) to illustrate the electrochemical theory of corrosion. [8 Marks]

(d) Name and discuss some four (4) principal factors that influence the corrosion of carbon steel in water. [4 Marks]

(e) Name up to six (6) different kinds of corrosion and in **one** sentence for each instance, suggest how that particular kind of corrosion can be inhibited. [7 Marks]

Question 5

(a) An investor purchased a security worth \$600 today. The deal was that the investment was going to yield 10% interest compounded annually. How much will the investment be worth at the end of five years? [5 Marks]

(b) Mr Sibanda desires to have on hand a sum of \$ 1 950.00 in exactly 3 years from today. How much does he need to put aside today, at 10 % compound interest, in order for him to realize his target of \$ 1 950.00 at the end of 3 years?
Take note: Work to the nearest decimal point. [5 Marks]

(c) A medium-size pharmaceutical company required an initial total capital investment (CF_0) of \$120 000. The company's estimated cash flows (CF_S) in the succeeding

5 years were as follows: Year 1: $70 000 ; Year 2 : $ 40 000 ; Year 3: $ 30 000; Year 4: $ 10 000; Year 5 : $ 10 000.

The company's required rate of return on the investment was 11%. Calculate **either** the Net Present Value (NPV) **or** the Internal Rate of Return (IRR) for the Company? [10 Marks]

On the basis of what is revealed by your calculations, make a comment on the viability of this investment.

END OF QUESTION PAPER!!!