MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

Chemical and Processing Engineering Department

PROFFESSIONAL ETHICS AND PRACTICE

CODE: HCHE 511

SESSIONAL EXAMINATIONS
MARCH-APRIL 2021

DURATION: 3 HOURS

EXAMINER: MR F.K. CHIKAVA

INSTRUCTIONS

1. *Answer **all** questions*
2. *Total marks 100*
3. *A list of formulae is provided on the last page*

QUESTION 1

a) Briefly explain why process control is necessary in industrial plants. **[5]**

b) List **5 (five)** advantages of automated control systems. **[5]**

c) An exothermic reaction occurs in a mixed flow reactor shown on Figure 1. A heat transfer oil circulates through the reactor jacket and transfers the heat to cooling water in an external exchanger. Show a control configuration which achieves the following objectives:

(i) A flow controller for the total oil circulation uses the oil valve exit the CW exchanger.

(ii) The reactor temperature control cascades to the oil flow controller.

(iii) The temperature of the oil supplied to the jacket is controlled by manipulating the CW valve to the exchanger.

(iv) The level in the reactor is controlled using the valve on the process stream leaving the reactor.

(v) The exchanger CW valve is kept more than 5% open by opening the oil bypass valve.

(vi) The CW valve is overridden open if the level in the reactor falls below 20%. **[15]**

NB: COMPLETE YOUR SOLUTION ON FIGURE 1 ON PAGE 3 AND SUBMIT WITH YOUR ANSWER SCRIPT.

REGISTRATION NUMBER:

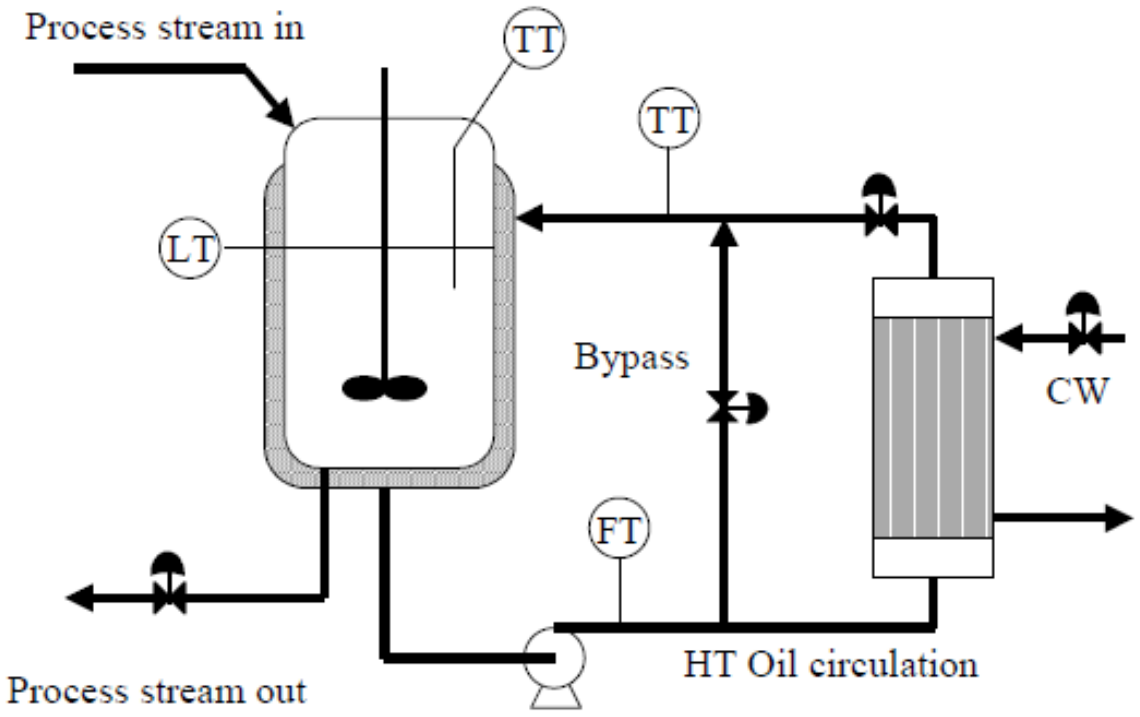

Figure 1

QUESTION 2

a) The capacity of a sugar refinery is to produce 50 000 tons of refined sugar per month. The selling price of refined sugar is R2 800 per ton. To produce one ton of refined sugar requires 1.3 tons of raw sugar. The purchase price to the refinery of raw sugar is R1 650 per ton. The production cost of refined sugar is R350 per ton. The fixed cost of the refinery is R10.3 million. Calculate:

(i) The number of tons of sugar that must be sold for the refinery to break-even. **[9]**

(ii) The profit made by the refinery if it sells 90% of its production capacity. **[8]**

b) The refinery needs to replace an evaporator in 4 years and 7 months. It is estimated that this evaporator will cost R6.8 million then. How much money

must be set aside each month, earning interest at 13.8% per annum, compounded monthly, so that the refinery can purchase the evaporator when it needs to be replaced? **[8]**

QUESTION 3

Set up a discounted cash flow (DCF) table over 5 years for a venture selling butterfly valves using the data given below. All escalations come into effect from year 2. Use Table 1 to determine the net present value (NPV) using a discount rate of 8.5%. Briefly comment on the significance of the value obtained for the NPV.

Table 1

Parameter	**Value**
Capital investment (year 0)	R92 225 600
Annual sales volume	48 000
Selling price (escalating by 6% p.a.) per valve	R1 050
Fixed costs p.a. (escalating by 4% p.a.)	R8 400 000
Production costs (escalating by 4% p.a.) per valve	R320
Tax rate (applicable on all positive income, and no tax allowance)	25%

[25]

QUESTION 4

a) Briefly describe **five (5)** factors to be considered when choosing a suitable site for a new project. **[10]**

b) Consider the reactor shown on Figure 2. The reaction is exothermic, so a cooling system is provided to remove the excess energy of the reaction. In the event that the cooling function is lost, the temperature of the reactor would increase. This would lead to an increase in reaction rate, leading to an additional energy release. The result would be a runaway reaction with pressures exceeding the bursting pressure level of the reactor vessel. The temperature within the reactor is measured and is used to control the cooling water flow rate by a valve.

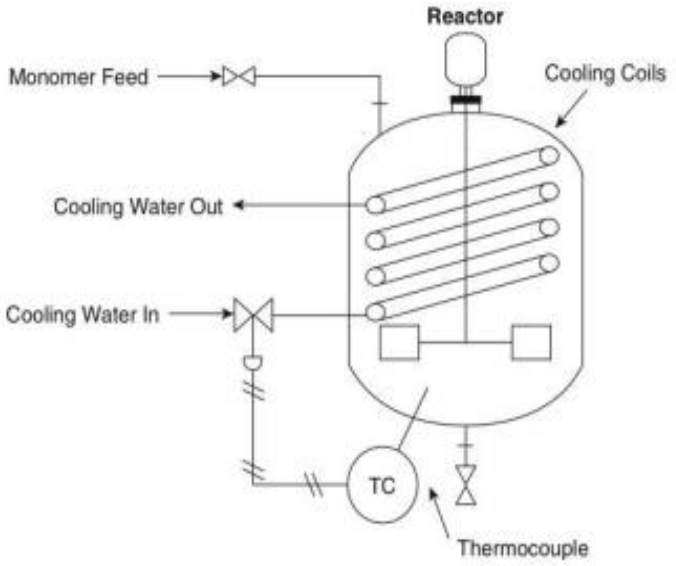

Figure 2

Perform a HAZOP study on this unit to improve the safety of the process. Use as a study node the following:

- monomer feed
- the cooling coils
- stirrer **[15]**

FORMULAE:

$$FV = PV(1+i)^n$$

$$FV = A\left[\frac{(1+i)^n - 1}{i}\right]$$

$$NPV = \sum_{t=0}^{n} \frac{C_t}{(1+k)^t}$$

END OF EXAM