INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

Department of Chemical Engineering

CL 306 – Process Engineering and Economics

Assignment-03

Instructions:

a. **Deadline for submission is 31/03/2021(6.00 pm)**
b. **Submit as single pdf with the name CL-306_A3_Roll number**

Question 1. Solve the given function using MATLAB functions.

$$\underset{X}{\text{minimize}}\ 100\left(x_2 - x_1^2\right)^2 + (1 - x_1)^2$$

$$s.t.\ x_1 + 2x_2 \leq 4$$

$$2x_1 + x_2 = 1$$

$$0 \leq x_1 \leq 0.4$$

$$0 \leq x_2 \leq 0.4$$

Question 2. Suppose that a gas-processing plant receives a fixed amount of raw gas each week. The raw gas is processed into two grades of heating gas, regular and premium quality. These grades of gas are in high demand (that is, they are guaranteed to sell) and yield different profits to the company. However, their production involves both time and on-site storage constraints. For example, only one of the grades can be produced at a time, and the facility is open for only 80 hr/week. Further, there is limited on-site storage for each of the products. All these factors are listed below (note that a metric ton, or *tonne*, is equal to 1000 kg):

	Product		
Resource	**Regular**	**Premium**	**Resource Availability**
Raw gas	7 m^3/tonne	11 m^3/tonne	77 m^3/week
Production time	10 hr/tonne	8 hr/tonne	80 hr/week
Storage	9 tonnes	6 tonnes	
Profit	150/tonne	175/tonne	

Develop a linear programming formulation to maximize the profits for this operation and find the maximum profit using MATLAB.

Question 3. Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ with the starting point (0, 0).

Question 4. Use the MATLAB *fminbnd* function to find the maximum of

$$f(x) = 2\sin x - \frac{x^2}{2}$$

within the interval $x_l = 0$ and $x_u = 4$.

Question 5. Figure 1 and 2 shows two alternative flowsheets for energy integration for Hydrodealkylation process of toluene to produce benzene. The figures indicated inside the equipment boxes of the flow-sheet are annualised capital costs (in $\times 10^3$ \$/year) and the number written outside the equipment box indicate the annual cost of the utility, i.e., cooling water (indicated as c/w) or steam (indicated as STM) or fuel or power, associated with the equipment (in $\times 10^3$ \$/year). Table 1 gives the film transfer coefficients of various streams in the different heat exchangers in different flow-sheets.

Prepare Lumped Cost Diagrams for the two flow-sheets shown in figure 1 and 2 with the following components: a) Feed and recycle heating

b) Reactor

c) Product cooling,

d) Stabilizer column,

e) Benzene column,

f) Recycle compressor.

Table 1. Film transfer coefficients of various streams in different flow-sheets (corresponding figure number is indicated)

Heat Exchangers	**Stream 1 coefficient, h (kW/m^2K)**	**Stream 2 coefficient, h (kW/m^2K)**
FEHE-1 (Fig-1 and Fig-2)	0.69 (Reactor Feed)	0.69 (Reactor effluent)
FEHE-2 (Fig-1 and Fig-2)	1.57 (Reactor Feed)	0.69 (Reactor effluent)
Reboiler of stabilizer column (Fig-2)	1.57 (Stabilizer column bottom stream)	0.69 (Reactor effluent)
Reboiler of benzene column (Fig-1 and Fig-2)	1.57 (benzene column bottom stream)	0.69 (Reactor effluent)

NOTE: Show the calculations for each components.

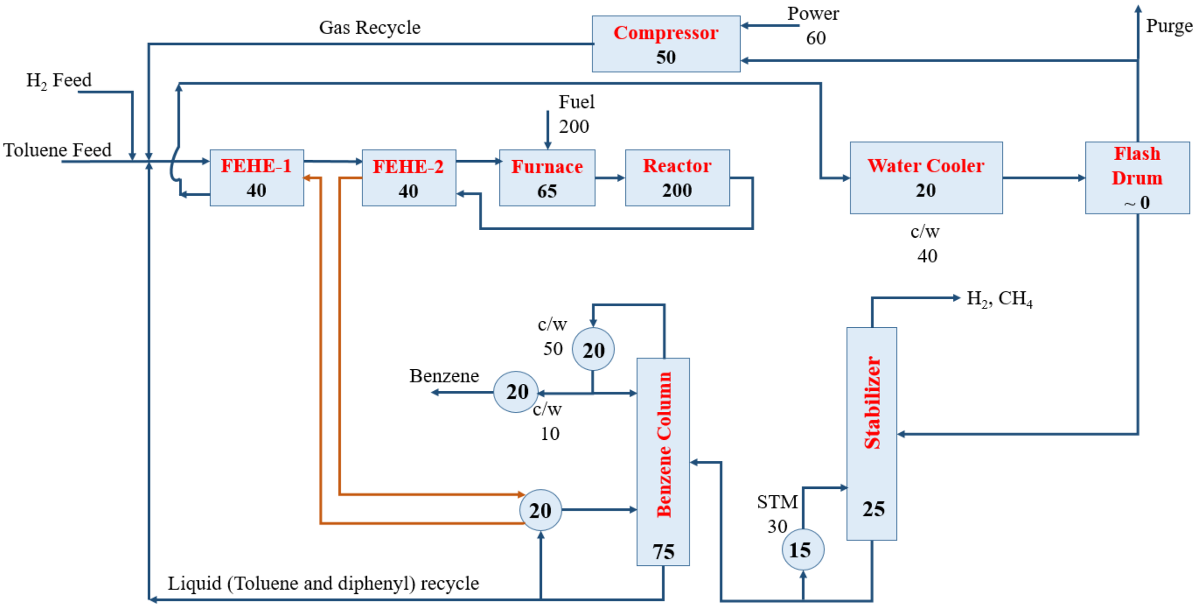

Figure 1. HDA process alternative-1

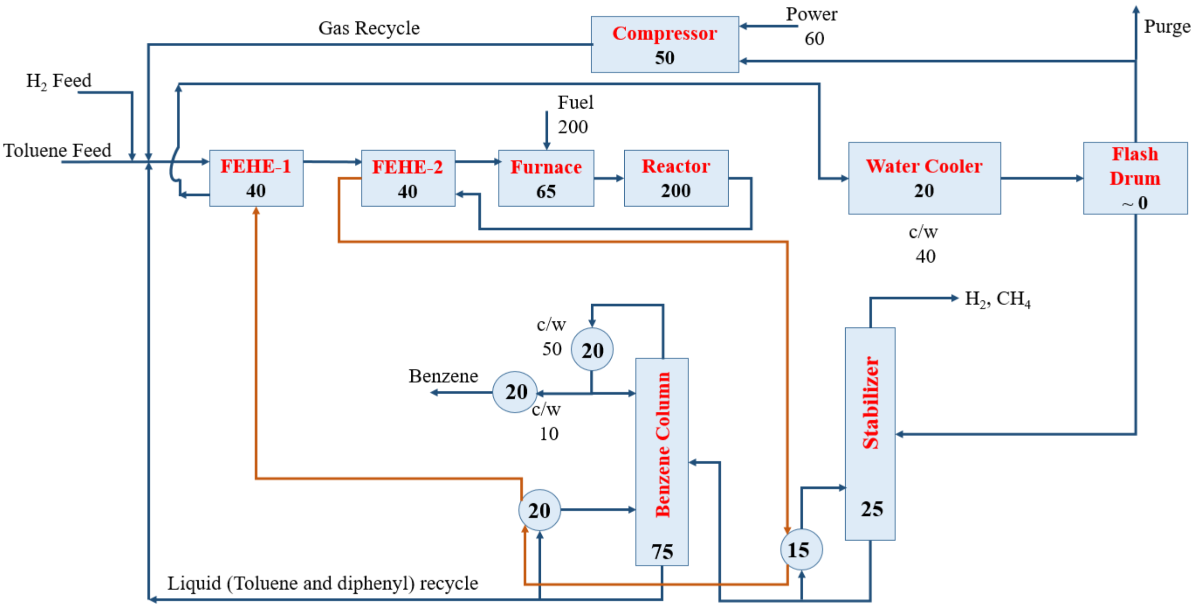

Figure 2. HDA process alternative-2

Question 6. For the given problem using MATLAB, find the slit length that maximizes the volume of the box.

From a 8 cm by 15 cm piece of a paper, an origami box is to be made by cutting four slits as shown and folding up the sides.