

Optimization Homework Problem C-1.**REGION ELIMINATION Function****Fibonacci Search**

1 Variable Optimization

{ 10 point homework }

Find the **Minimum Y** for the function:

$$Y = 2X^3 - 3X^2 - 14X + 2$$

over the region: $1.0 \leq X \leq 3.0$ Use a Fibonacci search with $n = 7$

NOTE: show your work and plot the results!

Demonstrating the procedure is the objective.

Supplemental Project Optimization Problem C-2.**{ 25 point individual project }****ECONOMIC OPTIMUM BATCH TIME****Golden Section Search**

1 Variable Optimization

A batch process consists of a reactor and a separator which operate in sequence as illustrated in attached Figure. A cycle begins when a charge is placed in the reactor, after a period of T days, the partially reacted charge is transferred to the separator. The amount of product made depends upon T and is measured by X as shown in the graph of experimental data. The separation cost per batch also depends on X as shown in the graph of cost data. What is the optimum batch time, T , which **MAXIMIZES** gross profit, P , from the process when:

$$P = [1/T] * [2.00 \text{ \$/lb} * 1000 \text{ lb} * X - 100 \text{ \$/day} * T - C_s]$$

where T = Time, days X = Feed ratio, lb. product / lb. charge C_s = Separation costs, \$ / batch

Reactor holds 1000 Lbs.

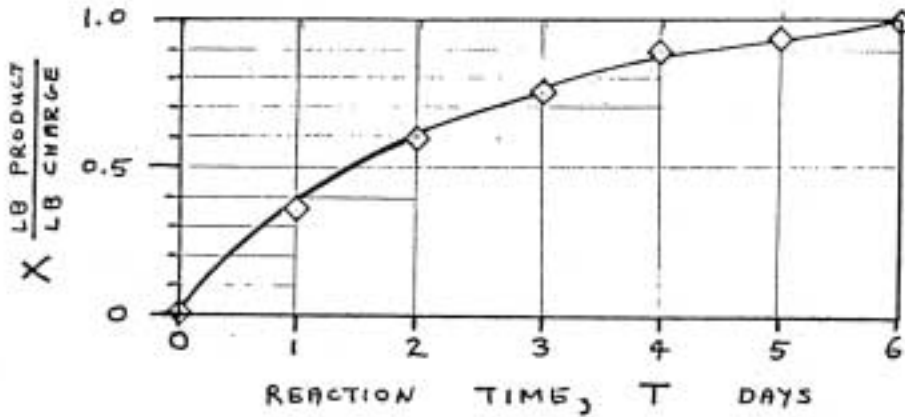
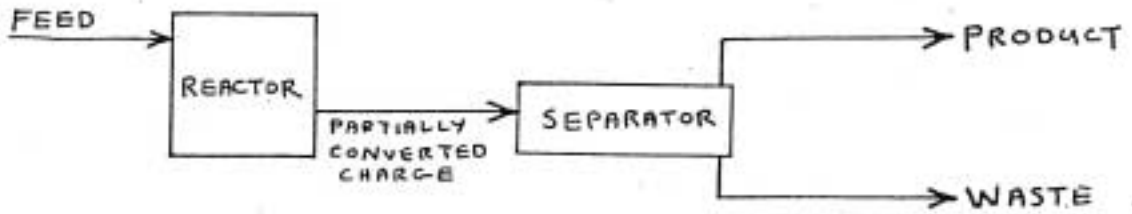
Value of product = \$ 2.00 / lb.

Cost of running the reactor = \$ 100 / day

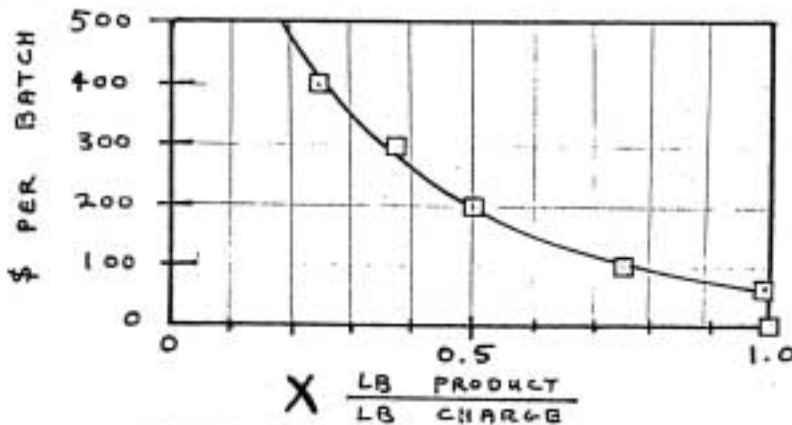
- Determine the result to within 5% of the original region using a Golden Section Search.
- Is the result reasonable? Recommend a practical operating scenario.
- How sensitive is the profit to ± 2 Hour changes in batch time?
- Is the response unimodal? Or multi-modal? Think carefully and show justification.
- Is the result a local or overall optima?

Submit a one page FORMAL MEMO report summarizing the results and recommendations. The memo should present your objectives, conclusions, and recommendations to the plant manager. Attach your 'calculational work' as an appendix to each memo. Communicating the results will be a significant part of the project grade.

BATCH REACTION - SEPARATION



CONVERSION IN REACTOR



BATCH SEPARATION COST, Cs

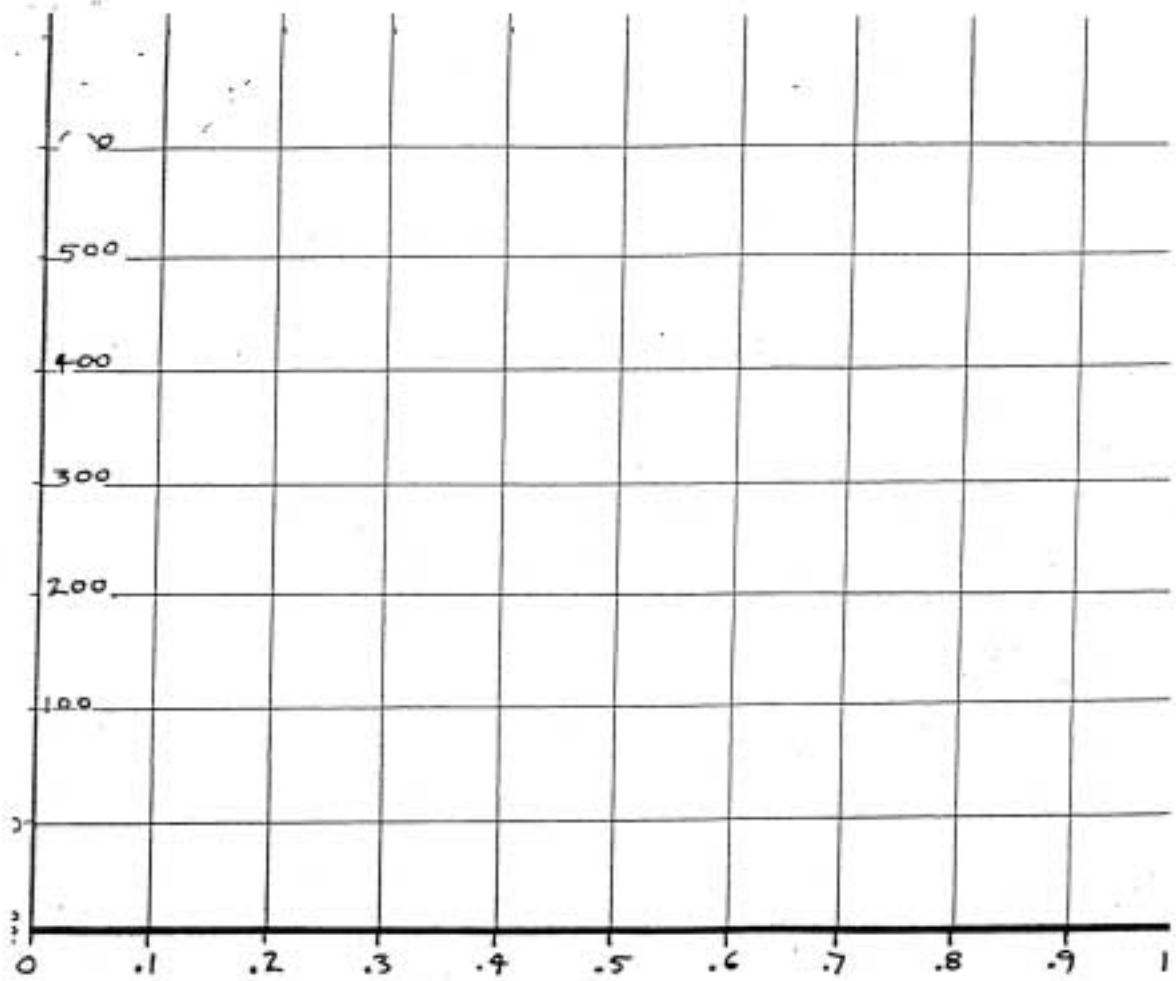
REACTOR HOLDS 1000 LBS
 COST OF RUNNING REACTOR = \$100/DAY
 VALUE OF PRODUCT = \$2.00/LB

reasonable correlations of the charts above as function of X lb. product/lb. charge

days $T = 3.973X - 6.695X^2 + 8.659X^3$

\$/batch $C_s = 710.7 - 1371X + 732.6X^2$

chart paper to show search region elimination:



Supplemental Project Optimization Problem C-3. { 25 point individual project }
ECONOMIC OPTIMUM REFLUX RATIO

Excel Macro Golden Section Search

1 Variable Optimization

The annual charge for investment and operation of a particular distillation column are as follows :

$$C_T = C_1 + C_2 + C_3$$

$$C_1 = 48.0 R^{0.3} S^{0.6} \quad \{ \text{column investment} \}$$

$$C_2 = 2800 R^{0.6} \quad \{ \text{condenser and reboiler investment} \}$$

$$C_3 = 3900 R \quad \{ \text{utilities and operating costs} \}$$

where C_T = Total annual cost, \$/year

R = Reflux Ratio

S = Number of Theoretical Stages

For this particular column, the Gilliland-type correlation relating number of theoretical stages to the reflux ratio is :

$$(R - R_M) * (S - S_M) = 390$$

where R_M = Minimum Reflux Ratio = 10.0

S_M = Minimum Number of Theoretical Stages = 100.0

Use the Golden Section Search procedure to determine the reflux ratio which will minimize the total annual cost to within $\pm \$10$.

NOTE : Plot the results to analyze sensitivity! **EXPLAIN** your assumptions in selecting the constraints on the region of search.

Answer the four questions about the results which must be addressed to interpret the conclusions after any optimization. Recommend a practical design range.

Submit a one page FORMAL MEMO report summarizing the results and recommendations. The memo should present your objectives, conclusions, and recommendations to the plant manager. Attach your 'calculational work' as an appendix to each memo. Communicating the results will be a significant part of the project grade.