CHBE 552 PROBLEM SET 3 Assigned: January 29, 2024 Total marks: 8

Q1 (2 marks). Minimize the following objective function

$$F(x_1, x_2) = x_1^2 + x_2^2 - 0.3cos(3\pi x_1) - 0.4cos(4\pi x_2) + 0.7. \qquad \text{where } x_1, x_2 \in [-1,1]$$

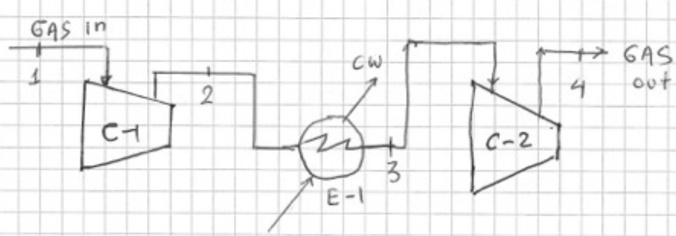
by applying the method of *simulated annealing* (direct search).

Q2 & Q3 (3 marks). Use the method of Luus and Jaakola to reproduce the results in example 3 and 4 of *Luus, R., and T.H.I. Jaakola*, "Optimization by Direct Search and Systematic Reduction of the Search Region", *AIChE J*, 19, 760, 1973.

Q4 & Q5 (2 marks). Minimize the following objective functions using the *Nelder Mead method*

1) $F(\mathbf{x}) = 100[x_2 - x_1^2]^2 + (1 - x_1)^2$. Starting point (-1.2,1)
2) $F(\mathbf{x}) = (x_1 + 10x_2)^2 + 5(x_3 - x_4)^2 + (x_2 - 2x_3)^4 + 10(x_1 - x_4)^4$. Starting point (3, -1,0,1)

Q6 (1 mark). A two-stage compression system shown below is used to compress V (m^3/min) of a gas at temperature T_1 (K) and pressure P_1 (bar) to a pressure P_4 (P_{out} from the second stage).



THEORETICAL WORK REQUIRED TO COMPRESS A GAS FROM P_{in} TO P_{out} PER MOL OF GAS IS GIVEN BY

$$W = \frac{RT_{in}}{\gamma}\left[\left(\frac{P_{out}}{P_{in}}\right)^{\gamma} - 1\right]$$

ASSUMING ADIABATIC COMPRESSION

T_{in} = Gas Temperature at the inlet

$\gamma = (C_p - C_v)/C_p$

P_{in}, P_{out} = Gas Pressure at inlet and outlet of Compressor

R = gas Constant

The gas exiting stage 1 is cooled using a heat exchanger (E-1) so that the temperature at 3 is the intial temperature T_1. Assume negligible pressure drop across the heat exchanger so that the pressure of the gas at point 3 is same as that at point 2 i.e. equal to P_2. Determine pressure P_2 that optimizes the theoretical required work required by the two compressors : $W_{tot} = W_{C-1} + W_{C-2}$.