QUESTION 2 :

- The region of experimentation for two factors are temperature (100 ≤ T ≤ 300°F) and catalyst feed rate (10 ≤ C ≤ 30 lb/in). A first-order model in the usual ±1 coded variable has been fit to a molecular weight response, yielding the following model:
- y' = 2000 + 125x1 + 40x2
- Find the path of steepest ascent and complete the table

In [30]:

```
import numpy as np

# Define the coefficients of the model
c0 = 2000
c1 = 125
c2 = 40

# Define the ranges for the coded variables
xmin = -1
xmax = 1

# Define the ranges for the natural variables
Tmin = 100
Tmax = 300
Cmin = 10
Cmax = 30

# Define the step sizes for the natural variables
dT = (Tmax - Tmin) / 2
dC = (Cmax - Cmin) / 2

# Define the origin
x1_0 = x2_0 = 0

# We know that x1=(T-200)/100
Torigin=x1_0*dT+(Tmax - Tmin)
Corigin=x2_0*dC+(Cmax - Cmin)

# Define the delta values
# Considering dx=1 as initial condidition
dx1 =1
two_lambda=c1/dx1  # Calculating lambda
# Calculating dx2 from dx1
dx2=c2/two_lambda
# Calculating dT1
dT1=dx1*dT
# Calculating dC1
dC1=dx2*dC

# Calculate the values for the path of steepest ascent
x1_d = [x1_0, x1_0 + dx1, x1_0 + dx1,x1_0 + 5*dx1]
x2_d = [x2_0, x2_0 + dx2, x2_0 + dx2, x2_0 + 5*dx2]
T_d = [Torigin,dT1,Torigin+dT1,Torigin+5*dT1]
C_d = [Corigin,dC1,Corigin+dC1,Corigin+5*dC1]

print("\nPath of steepest ascent:\n")
print("\t\tCoded Variables  \tNatural Variables")
print("\t\t  x1\t x2\t\t   T\t\tC")
print(f'Origin            {x1_d[0]} \t {x2_d[0]}\t\t {T_d[0]}\t\t{C_d[0]}')
print(f'del               {x1_d[1]} \t {x2_d[1]}\t\t {T_d[1]}\t\t{C_d[1]}')
print(f'Origin + del      {x1_d[2]} \t {x2_d[2]}\t\t {T_d[2]}\t\t{C_d[2]}')
print(f'Origin + 5*del    {x1_d[3]} \t {x2_d[3]}\t\t {T_d[3]}\t\t{C_d[3]}')
```

Path of steepest ascent:

	Coded Variables		Natural Variables	
	x1	x2	T	C
Origin	0	0	200.0	20.0
del	1	0.32	100.0	3.2
Origin + del	1	0.32	300.0	23.2
Origin + 5*del	5	1.6	700.0	36.0