Name: Enrolment No:	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: System Analysis and Process Optimization **Semester: II**
Program: M. Tech. Chemical Engineering Spl. PD **Time: 03 hrs.**
Course Code: CHPD7027 **Max. Marks: 100**
Instructions: Attempt All questions

S. No.	SECTION A (5Qx4M=20Marks)	Marks	CO
Q1	Illustrate with the figure the 'Saddle point' in optimizing a function.	4	CO1
Q2	Classify discrete and continuous variables.	4	CO1
Q3	Explain the drawback of using the classical method for optimization.	4	CO3
Q4	Discuss the difference between design, behavior, and side constraints.	4	CO3
Q5	Recite the difference between deterministic and stochastic optimization techniques.	4	CO2
	SECTION B (4Qx10M= 40 Marks)		
Q6	The Gulf South Pipeline company, while transporting natural gas utilizes a certain part of the natural gas flowing in the pipeline as an energy source for running the compressor. Researchers found that around 3-4% of the total gas transported through the pipeline was consumed in turbine-run compressors. This energy consumption was quite large as a huge amount of the gas is being transported through pipelines. Researchers formulated the problem and found that the fuel consumed in compressors is dependent on the inlet and outlet pressure of the compressors and is obtained from the following relation: $m_f = P_1 - P_2 + 2P_1^2 + 2P_1P_2 + P_2^2$ Here: m_f = Natural Gas consumed in the compressor; P_1 = Pressure at the inlet of the compressor; P_2 = Pressure at outlet of the compressor Using **Cauchy's Steepest Descent** method and taking starting point as:	10	CO3

	$X = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$, calculate the optimum value of the pressures P_1 and P_2 at which the fuel consumed in the compressor gets **minimized.** Solve up to **FOUR NUMBER of iterations.**		
Q7	A research scholar working at "UNIVERSITY OF PETROLEUM AND ENERGY STUDIES" for a pipeline project wishes to minimize the cost of pipeline networks. On investigation, he found that there are two major components that contribute to the cost of pipeline networks. These are **i.** Investment Cost of pipeline Network **(I)** **ii.** Operating Cost of pipeline network **(O).** The researcher found that the total cost of pipeline networks is obtained from the following relation: $$TC = 6I^2 - I - 2O - 6IO + 2O^2$$ T.C. = Total Cost of Pipeline Networks; I = Investment Cost of Pipeline Networks; O = Operating cost of pipeline networks With an initial starting point $X = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$, probe length as $\theta = 0.01$, and using the **UNIVARIATE** method, minimize the cost of the pipeline network. Solve up to **TWO NUMBER** OF ITERATIONS.	**10**	**CO3**
Q8	A pipeline operator wishes to minimize the formation of gas hydrates in the pipeline. The operator found that the gas hydrates can be minimized by optimizing temperature and pressure in pipeline networks. Further, it was found that the gas hydrate formation was a correlated with temperature and pressure according to the following correlation: $$f(\mathrm{P, T}) = 6\,\mathrm{P}^2 - 6PT + 2P^2 - P - 2T$$ Perform **TWO ITERATIONS** of the **FLETCHER REEVES** that help the pipeline operator to **minimize** the formation of gas hydrates.	**10**	**CO4**

	Take starting point as: $X = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$.		
Q9	Use the **Exterior penalty method** to minimize the following function: $\min f = 9x_1^2 + 4x_2^2 + 3x_1 + 3x_2$ Subjected to: $g(x_1) = 5 - 2x_1 \le 0$; $g(x_2) = 2x_2 - 3 \le 0$	**10**	**CO4**
SECTION C (2Qx20M= 40 Marks)			
Q10	Use **Pivoting method** to solve the following set of equations: $2x_1 + 3x_2 - 2x_3 - 7x_4 = 1$; $x_1 + x_2 + x_3 + 3x_4 = 6$; $x_1 - x_2 + x_3 + 5x_4 = 4$	**20**	**CO2**
Q11	A pipeline network problem involves minimizing the cost of laying the pipeline by finding the optimum route of the pipeline. The cost of the pipeline depends on four decision variables, R_1, R_2, R_3, and R_4, and is obtained from the following co-relation $C = R_1 + 2R_2 + 3R_3 + 4R_4 - 30$ The bounds on various decision variables are as follows: $1 < R_1 < 25$; $3 < R_2 < 30$; $4 < R_3 < 28$; $5 < R_4 < 30$ Using **Genetic Algorithms,** *minimize* the cost of the Gas Pipeline Network. Show, manually the step wise procedure involved up-to one generation only. Assume the number of chromosomes as **six,** crossover rate as **25%** and Mutation rate as **10%.**	**20**	**CO5**