BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc | **SEMESTER : VIII**
BRANCH: QEDS | **SESSION : SP/2025**

SUBJECT: ED413 ADVANCED OPTIMIZATION

TIME: 3 Hours | **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Find the optimality conditions for the following convex quadratic program	[5]	1	

$$\min_{x\in\mathbb{R}^n} \frac{1}{2}x^T P x + q^T x + r$$
$$\text{Subject to } Ax = b$$
$$\text{where, } P \in S_n^+, A \in \mathbb{R}^{m\times n}, b \in \mathbb{R}^m,\ q \in \mathbb{R}^n,\ r \in \mathbb{R}.$$

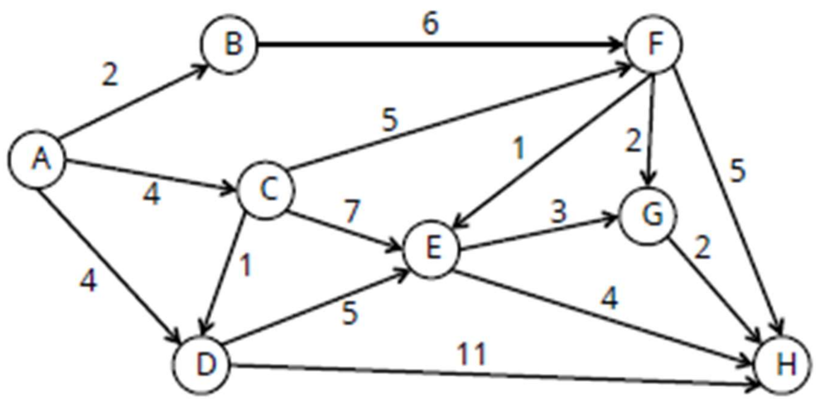
Q.1(b) Find the KKT conditions of the problem given in 1(a). [5] 1

Q.2(a) Derive the cost function and dynamic constraints of a Dynamic Portfolio investment. [5] 2

Q.2(b) Find the optimal replacement policy for an equipment replacement problem (using Dynamic Programming) with the following data: [5] 2

Year (t)	1	2	3	4	5	6
Cost c(t)	3300	4800	7600	9200	12500	15200
Life span of equipment L=6, Task span T=10,						

Q.3(a) Find the shortest path (using Dynamic programming) from node A to node H, where path length is indicated by the edge numbers: [5] 3



Q.3(b) Solve the following LQR problem using Dynamic Programming: [5] 3

$$\min_u x_N^T Q_f x_N + \sum_{k}^{N-1} x_k^T Q x_k + u_k^T R u_k$$
$$\text{Subject to}$$
$$x_{k+1} = Ax_k + Bu_k,\ k = 0,1,2,\dots,N-1.$$

PTO

Q.4(a) Formulate the Knapsack problem writhe following data: [5] 4

Index (i)	Per unit cost value (c_i)	Per unit volume (v_i)
0	0	1
1	2	2
2	1	3
Total volume unit is 9		

Q.4(b) Solve the above formulated Knapsack problem in the question 4(a). [5] 4

Q.5(a) Suppose $f(x) = \sin(\pi x)$. Define rank and fitness of the individuals in the population $P = \{-0.1, 0.1, 0.3, 0.7\}$ with function values $\{-0.309, 0.309, 0.809, 0.809\}$. [5] 5

Q.5(b) Explain simplex iterations in the Nelder Mead algorithm and apply to minimize the function $f(x) = x_1^2 - 4x_1 + x_2^2 - x_2 - x_1x_2$ with starting vertices $V_1 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, V_2 = \begin{pmatrix} 1.2 \\ 0.0 \end{pmatrix}, V_3 = \begin{pmatrix} 0.0 \\ 0.8 \end{pmatrix}$. [5] 5

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