V/D/TZ

Reg. No:

VIT®

Vellore Institute of Technology

Final Assessment Test – April 2026

Course: BMEE215L - Engineering Optimization

Class NBR(s): 1040 / 1045 / 3094 / 3097 / 3098 / 6598 Slot: A2+TA2+TAA2

Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction : The normal distribution table is allowed.

COs	CO Statements
CO1	Formulate and solve linear programming problems.
CO2	Understand and apply suitable approach for solving transportation and assignment problems.
CO3	Demonstrate the usage of network optimization algorithms for traditional applications.
CO4	Apply goal programming and dynamic programming approach for solving problems of appropriate applications.
CO5	Apply classification optimisation techniques and suitable algorithms for non-linear programming problems.
CO6	Justify and apply evolutionary algorithm for solving optimization problems.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. A diet for a sick person must contain at least 4,000 units of vitamins, 50 units of minerals, and 1,400 calories. Two foods A and B are available at a cost of Rs. 4 and Rs. 3 per unit, respectively. One unit of food A contains 200 units of vitamins, 1 unit of mineral, and 40 calories, and one unit of food B contains 100 units of vitamins, 2 units of minerals, and 40 calories. Formulate this problem as a Linear Programming (LP) model and solve it by the graphical method to find the combination of foods to be used to obtain the least cost. **CO1 BL4**

2. A construction company must supply gravel to three construction projects A, B, and C. The weekly demand (in truckloads) for the projects is given below. **CO2 BL5**

Project	Demand (Truckloads)
A	72
B	102
C	41

The company has three gravel pits located at X, Y, and Z. The supply available (in truckloads) at each pit is:

Pit	Supply (Truckloads)
X	76
Y	82
Z	77

The transportation cost (in Rs.) per truckload from each pit to each project is given below.

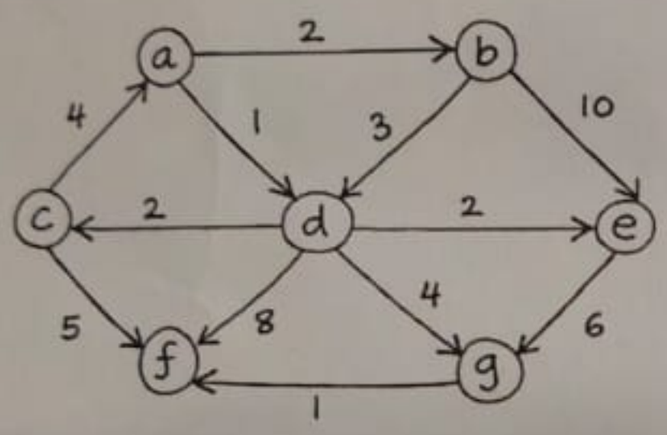
Pit / Project	A	B	C
X	4	8	8
Y	16	24	16
Z	8	16	24

Questions:

i. Formulate the above problem as a Transportation Model.
ii. Determine the optimal shipping schedule using a suitable transportation method.
iii. Find the minimum transportation cost.

5.

3. Using Dijkstra's Algorithm, determine the shortest path from node *c* to node *e* in the given directed weighted graph. Show the step-by-step iteration table and construct the final shortest path tree. **CO3 BL5**



4. *The activities of a project with their durations (in days) and immediate predecessor relationships are given below.* **CO3 BL5**

Activity	Duration	Immediate Predecessor
A	2	—
B	5	—
C	4	—
D	5	B
E	7	A
F	3	A
G	3	B
H	6	C, D
I	2	C
J	5	E
K	4	F, G, H
L	3	F, G, H
M	12	I
N	8	J, K

Questions:

I. Draw the network diagram for the project.
II. Determine the Earliest Start Time (EST) and Latest Start Time (LST) for each activity.
III. Identify the critical path of the project.

Find the minimum completion time of the project.

5. A consumer electronics company has divided its market into three regions: CO4 BL3

- North Region (Stage 1)
- Central Region (Stage 2)
- South Region (Stage 3)

The company has analysed past performance data and observed that annual revenue (in ₹ lakhs) depends on the number of sales executives assigned to each region.

- For the upcoming financial year, the company has 8 sales executives available. The objective is to allocate these executives among the three regions such that total expected revenue is maximized

Estimated Annual Revenue (₹ Lakhs)

No. of Sales Executives	North Region	Central Region	South Region
0	20	25	30
1	38	40	45
2	55	52	60
3	68	65	72
4	78	74	85
5	85	82	95
6	90	88	100
7	88	92	102
8	80	95	103

The firm has only 8 sales executives to assign across the three regions.

Determine:

- How many sales executives should be assigned to each region?
- What is the maximum total revenue achievable?

6. A manufacturing firm produces two products, namely Product X_1 and Product X_2. CO4 BL4

Each unit of:

- Product X_1 yields a profit of ₹8
- Product X_2 yields a profit of ₹6

The production of these products requires machine time as follows:

- Product X_1: 2 hours per unit
- Product X_2: 4 hours per unit

The firm has set the following goals in order of priority:

- P_1: Achieve a minimum profit of ₹240.
- P_2: Fully utilize the available machine time of 100 hours.
- P_3: Do not produce more than 40 units of Product X_2.

Formulate the above problem as a Goal Programming model and determine the optimal solution using Graphical Approach.

7. Using Lagrange multipliers, find the maximum value of CO5 BL3

$$f(x_1, x_2) = 4x_1 + 6x_2 - 2x_1^2 - 2x_1x_2 - 2x_2^2$$

subject to

$$x_1 + 2x_2 = 2$$

$$and\ x_1, x_2 \geq 0$$

8. Minimize $f(x1, x2) = X_1^2 + X_2^2$ CO5 BL4

Subject to constraint: $X_1 + X_2 - 4 = 0$

(a) Convert into an unconstrained problem using Quadratic Penalty Method.

(b) Write the penalized objective function.

(c) Find the minimum for penalty parameter r.

(d) Explain behavior as $r \to \infty$.

9.a) Using the Simplex method, minimize the following objective function. CO1 BL5

Maximize

$Z = 3x_1 + 5x_2 + 4x_3$

Subject to:

$2x_1 + 3x_2 \leq 8$

$2x_2 + 5x_3 \leq 10$

$3x_1 + 2x_2 + 4x_3 \leq 15$

$x_1, x_2, x_3 \geq 0$

$\frac{5}{3} + \frac{16}{15}$

$= \frac{25+16}{15} \frac{29}{3} - \frac{56}{5}$

OR

9.b) Using the Big-M method, CO1 BL5

Minimize $Z = 600x_1 + 500x_2$

Subject to the constraints:

(i) $2x_1 + x_2 \geq 80$

(ii) $x_1 + 2x_2 \geq 60$

and $x_1, x_2 \geq 0$

10.a) Solve the given problem using Genetic Algorithm (GA) Minimize $f(x) = x^2 - 10x + 25$, over the range [0, 10]. Assume initial population as 2, 5, 3, 7 and 1. Choose crossover between second and third decimal and avoid mutation. Do one iteration. CO6 BL4

OR

10.b) Maximize $f(x) = -x^2 + 2x$ where $0<x<2$. Consider initial population: 11010, 00111, 10110, 00101. Select cross over at 3rd digit. Solve this problem either with using the random numbers (Random Numbers: 40, 15, 70, 90) or using the expected count approach. CO6 BL4

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