

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR
BACHELOR OF SCIENCE IN APPLIED STATISTICS WITH COMPUTING &
BACHELOR OF SCIENCE

MAT 315/STA 214: OPERATIONS RESEARCH I

INSTRUCTIONS TO CANDIDATES:

Answer question one in section one and any other two questions in section two.

SECTION ONE [Compulsory]

QUESTION ONE [Compulsory, 30 Marks]

- a) Define briefly the following terms in the context of operations research. [3 Marks]
- i. Model
 - ii. Constraints
 - iii. Objective function
- b) Give two advantages of operation research. [2 Marks]
- c) State any two properties of linear programming solution. [2 marks]
- d) Discuss briefly the phases of operation research. [5 Marks]
- e) Give two disadvantages of operation research. [2 Marks]
- f) Discuss the formulation steps in linear programming. [4 Marks]
- g) Identify and describe briefly four basic assumptions in Linear Programming [8 Marks]
- h) Express the following LP in standard form and obtain the initial feasible solution. [2 Marks]

$$\text{Min: } Z=3x_1 + 2x_2$$

$$\text{s/t: } 3x_1 + 4x_2 \leq 7$$

$$2x_1 + 5x_2 \geq 15$$

$$x_1 + x_2 = 6$$

$$\text{with } x_1, x_2 \geq 0$$

- i) Give is the general LP representation for a balanced transportation problem. [2 Marks]

SECTION TWO [Answer any two questions]

QUESTION TWO [20 Marks]

- a) Distinguish between slack and surplus variable and give an interpretation of each term. [4 Marks]
- b) Outline the procedure for solving a non- standard linear programming minimization problem. [5 Marks]
- c) A furniture manufacturing firm is contracted to make on weekly basis two products P and Q. Unit profit for Product P and Q is \$6 and \$8 respectively. Two resources are used by the firm produce the two products wood (board feet) and labor (hours). It takes 30 board feet and 5 hours to make product P, and 20 board feet and 10 hours to make product Q. There are 300 board feet of wood available and 110 hours of labor available.

Formulate a LP model that can be used to decide how to allocate the limited resources to maximize profits using simplex algorithm. [11 Marks]

QUESTION THREE [20 Marks]

- a) What steps are followed in solving transportation problems? [6 Marks]
- b) State three applications of transportation problems. [3 Marks]
- c) A transport company ships truckloads of grains from three silos (1, 2 and 3) to four mills (A, B, C and D). The supply and demand both in truckloads together with unit transportation costs in USD are as shown below.

Silos	Mills				Supply
	A	B	C	D	
1	10	2	20	11	15
2	12	7	9	20	20
3	5	14	16	18	25
Demand	10	30	15	5	

Determine the feasible solution and hence obtain optimal solution using;

- i) Northwest – corner method (NWCM). [5 Marks]
- ii) Vogel’s approximation method (VAM). [6 Marks]

QUESTION FOUR [20 Marks]

- a) State duality theorem. [3 Marks]
- b) Give steps followed in solving minimization problems with duals. [4 Marks]
- c) Let X_1, X_2 and X_3 be number of products A, B and C respectively. Express the following problem in dual form. [4 Marks]

$$\begin{aligned} \text{Max: } Z &= 60x_1 + 30x_2 + 20x_3 \\ \text{s/t: } & 8x_1 + 6x_2 + x_3 \leq 48 \\ & 4x_1 + 2x_2 + 1.5x_3 \leq 20 \\ & 2x_1 + 1.5x_2 + 0.5x_3 \leq 8 \\ & \text{with } x_1, x_2, x_3 \geq 0 \end{aligned}$$

- d) A paint manufacturer needs at least 6 units per day of component P and at least 3 units of component Q and the manufacturer can choose between two different types paints, interior and exterior paints. Each barrel of interior paint costs \$ 3 and provides 1 unit of component P and 2 units of Q, while each barrel of exterior paint costs \$ 2 and provides 3 units of component P and 1 unit of Q. Part of the final tableau is as shown below.

$$\left[\begin{array}{cccc|c} x_1 & x_2 & x_3 & x_4 & \\ \hline 1 & 0 & 0.6 & -0.2 & 1.4 \\ 0 & 1 & -0.2 & 0.4 & 0.2 \\ \hline 0 & 0 & 0.6 & 1.8 & \end{array} \right]$$

- i) Calculate the minimum cost. [6 Marks]
- ii) Use the shadow values to estimate the daily cost. [3 Marks]

QUESTION FIVE [20 Marks]

- a) Give the mathematical formulation and constraints of an assignment problem [4 Marks]
- b) State two properties of Hungarian Method of assignment problem [2 Marks]
- c) Describe an assignment problem giving relevant examples [4 Marks]
- d) A company employs service engineers based at various locations throughout the country to service and repair their equipment installed in customers' premises. Five requests for service have been received and the company finds that five engineers are available. The distance each of the engineers is from the various customers is given in the following table. Determine the optimum assignment schedule. [10 Marks]

		Customers				
		I	II	III	IV	V
Engineers	A	160	130	175	190	200
	B	135	120	130	160	175
	C	140	110	155	170	185
	D	50	50	80	80	110
	E	55	35	70	80	105