Indian Statistical Institute, Bangalore

M.S (Q.M.S) First Year

Second Semester - Operations Research II

Final Exam Duration: 3 hours Date : April 20, 2016

Max Marks: 60

Answer any five.

1. (a) Pursue University admission office is processing freshman applications for the upcoming academic year. The applications fall into three categories: In-state, Out-of state, and international. The male female ratios for in state and out of state applicants are 1 : 1and and 3 : 2 respectively. For international students, the corresponding ratio is 8 : 1. The ACT score is an important factor in accepting new students. The statistics gathered by the university indicate the average ACT scores for in-state, out-of state and international students are $27, 26$ and 23 respectively. The committe on admissions has established the following desirable goals for the new freshman class:

   i. The incoming class is at least 1200 high school graduates (freshmen)
   ii. The average ACT score for all incoming students is at least 25.
   iii. International students constitute at least 10% of the incoming class
   iv. the female-male ratio is at least 3 : 4
   v. Out-of state students constitute at least 20% of the incoming class

   Formulate the problem as a goal programming model.
   or

   (b) Minimize $n_1 + n_2 + \rho_3$, ρ_4 , n_5
   Subject to
   $X_1 + Y_1 + n_1 - \rho_1 = 20$
   $X_2 + Y_2 + n_2 - \rho_2 = 20$
   $4X_1 + 3X_2 + n_3 - \rho_3 = 90$
   $4Y_1 + 3Y_2 + n_4 - \rho_4 = 20$
   $7X_1 + 8X_2 + 6Y_1 + 7Y_2 + n_5 - \rho_5 = 20$
   $X_i, Y_j, n_j, \rho_j \geq 0.$
   Solve the above Goal Programming Problem using Simplex Method. [12 Marks]

2. A production Manager faces the problem of job allocation between two assembly lines. The production rate of assembly line 1 is 10 units per hour and the production rate of assembly line 2 is 12 units per hour. The normal working period for both lines is eight hours per day. The production Manager has set the following goals for the next day. Listed in order of importance: [12 Marks]

   (a) Avoid any under achievement of the production level, which is set at 200 units of product.

   (b) Avoid any overtime operation of line 2 beyond four hour.

   (c) Avoid any under utilization of regular working hours (assign differentiates weights according to the relative productivity of the two lines.)

   (d) Minimum over time in both assembly lines. Formulate the goal programming model and solve it.

3. Solve the following integer linear programming problem using the cutting plane algorithm.

$$\text{Maximize } Z = 3x_1 + x_2 + 3x_3$$

$$\text{Subject to Constraints}$$

$$-x_1 + 2x_2 + x_3 \leq 4$$

$$4x_2 - 3x_3 \leq 2$$

$$x_1 - 3x_2 + 2x_3 \leq 3$$

x_1, x_2 and x_3 all are non-negative integer.

[12 Marks]

4. A company manufacturers around 200 motor bikes. Depending on the condition, the daily production has been varying from 196 motor bikes to 204 motorbikes whose probability distribution is given below.

Productivity Per day	196	197	198	199	200	201	202	203
Probability	0.05	0.09	0.12	0.14	0.20	0.15	0.11	0.08

The finished motorbike are transported in a specifically designed truck that can accommodate and 200 motorbikes using the 15 given random numbers as under: 82,89,78,24,53,61,18,45,04,23,50,77,27,54,10;
simulate the process to find

(a) What will be the average number of motorbikes waiting in the factory?

(b) What will be the average number of empty spaces in the truck? [12 Marks]

5. All trucks traveling on Interstate 40 between Albuquerque and Amarillo are required to stop at a weigh station. Trucks arrive at the weigh station at a rate of 200 per 8-hour day, and the station can weigh, on the average, 220 trucks per day.

(a) Determine the average number of trucks waiting, the average time spent waiting and being weighed at the weigh station by each truck, and the average waiting time before being weighed for each truck.

(b) If the truck drivers find out they must remain at the weigh station longer than 15 minutes, on average, they will start taking a different route or traveling at night, thus depriving the state of taxes. The state of New Mexico estimates that it loses $10,000 in taxes per year for each extra minute trucks must remain at the weigh station. A new set of scales would have the same service capacity as the present set of scales, and it is assumed that arriving trucks would line up equally behind the two sets of scales. It would cost $50,000 per year to operate the new scales. Should the state install the new set of scales? [12 Marks]

6. Carol Latta is visiting hotels in Los Angeles to decide where to hold a convention for a national organization of college business school teachers she represents. There are three hotels from which to choose the Cheraton, the Milton, and the Harriott. The criteria she is to use to make her selection are ambiance, location (based on safety and walking distance to attractions and restaurants), and cost to the organization. Following are the pairwise comparisons she has developed that indicate her preference for each hotel for each criterion and her pairwise comparisons for the criteria:

Ambiance

Hotel	Cheraton	Milton	Harriott
Cheraton	1	1/2	1/5
Milton	2	1	1/3
Harriott	5	3	1

Location

Hotel	Cheraton	Milton	Harriott
Cheraton	1	5	3
Milton	1/5	1	1/4
Harriott	1/3	4	1

Cost

Hotel	Cheraton	Milton	Harriott
Cheraton	1	2	5
Milton	1/2	1	2
Harriott	1/5	1/2	1

Criterion Ambiance Location Cost

Hotel	Cheraton	Milton	Harriott
Ambiance	1	2	4
Location	1/2	1	3
Cost	1/4	1/3	1

Develop an overall ranking of the three hotels, using AHP, to help Carol Latta decide where to hold the meeting. [12 Marks]

7. (a) The Uptown Bar and Grill serves Rainwater draft beer to its customers. The daily demand for beer is normally distributed, with an average of 18 gallons and a standard deviation of 4 gallons. The lead time required to receive an order of beer from the local distributor is normally distributed, with a mean of 3 days and a standard deviation of 0.8 day. Determine the safety stock and reorder point if the restaurant wants to maintain a 90% service level. What would be the increase in the safety stock if a 95% service level were desired?

(b) The Laurel Creek Lawn Shop sells Fastgro Fertilizer. The annual demand for the fertilizer is 270,000 pounds. The cost to order the fertilizer from the Fastgro Company is $105 per order. The annual carrying cost is $0.25 per pound. The store operates with shortages, and the annual shortage cost is $0.70 per pound. Compute the optimal order size, minimum total annual inventory cost, and maximum shortage level. [12 Marks]

8. A charter pilot has additional capacity for 2000 pounds of cargo on a flight from Delhi to Bangalore. A transport company has four types of cargo in Delhi to be delivered to Bangalore. The number of units of each cargo type, the weight per unit, and the delivery fee per unit are shown. [12 Marks]

Table

Cargo Type	Units available	Weight per unit (in 100 kgs)	Delivery fee (in 1000s)
C1	2	8	22
C2	2	5	12
C3	4	3	7
C4	3	2	3

(a) Use dynamic programming to find how many units of each cargo type the pilot should contract to deliver.

(b) Suppose the pilot agrees to take another passenger and the additional cargo capacity is reduced to 1800 pounds. How does your recommendation change?