

**MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY**

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**University Examinations 2015/2016**

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

**SMS 3325: BUSINESS SYSTEMS MODELLING**

**DATE: November, 2015 TIME:** $2 $**HOURS**

**INSTRUCTIONS:** *Answer questions* ***one*** *and any other* ***two*** *questions*

**QUESTION ONE - (30 MARKS)**

1. Describe the first four steps in model-building process. (4 Marks)
2. Define linear programming. (3 Marks)
3. Using graphical method, show that the following LPP is unbounded. (4 Marks)

Max Z = $10x\_{1}+ 3x\_{2}$

S.t - $2x\_{1}$ + $3x\_{2}\leq 6$

$x\_{1}+2x\_{2}$ $\geq 4$

$$x\_{1} , x\_{2}\geq 0$$

1. Find the initial basic feasible solution of the following transportation problem using North west corner rule. To (6 Marks)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | $$M\_{1}$$ | $$M\_{2}$$ | $$M\_{3}$$ | $$M\_{4}$$ |  |
| $$F\_{1}$$ | 3 | 2 | 4 | 1 |  |
| $$F\_{2}$$ | 2 | 4 | 5 | 3 |  |
| $$ F\_{3}$$ | 3 | 5 | 2 | 6 |  |
| $$ F\_{4}$$ | 4 | 3 | 1 | 4 |  |
|   | 30 | 20 | 25 | 25 |  |

 20

 15

 25

 From 40 Supply
 Demand

1. A reputed manufacturer of electronics is producing certain component which is sold at a uniform price of $10 each. The variable cost of producing this component works out to$6 per unit and the fixed cost apportioned to this product and process for manufacturing this product is $30,000. how many units of the component must be produced and sold so that the company breaks even? (3 Marks)
2. A stockiest has to supply 400 units of a product every Monday to his customers. He gets the product at $50 per unit from the manufacturer. The cost of ordering and transportation from the manufacturer is $75 per order. The cost of carrying the inventory is 7.5% per year of the cost of the product.

Find the following;

1. The economic lot size (3 Marks)
2. The total optimal cost, including the cost of purchase, per week (2 Marks)
3. The total weekly profit if the item is sold for $55 per unit. (2 Marks)
4. The manager of a retail store observes that on average 16 customers are serviced by a cashier in a hour. Assuming that the service time has exponential distribution, what is the probability that the customer will be free in 3 minutes. (3 Marks)

**QUESTION TWO (20 MARKS)**

1. Solve the following LPP graphically and interpret the results.

 $Min Z = 20x\_{1}+10x\_{2}$

 S.t $x\_{1}+2x\_{2}\leq 40$

 $3x\_{1}+x\_{2}\geq 30$

 $4x\_{1}+3x\_{2}\geq 60$

 $x\_{1},x\_{2}\geq 0$ (4 Marks)

1. A company uses three machines in the manufacture of three products P,Q, and R. Each unit of P,Q and R has the machine hour requirements as shown in the table. The profit contribution of the three products is $36, $42 and $ 32 respectively. The available machine hours on the machines $M\_{1,}M\_{2}$ and $M\_{3}$ is 120,54 and 105 hours respectively.

|  |  |  |
| --- | --- | --- |
| Machine |  Products  | Available Hours |
| P | Q | R |
| $$M\_{1}$$ | 3 | 4 | 2 | 120 |
| $$M\_{2}$$ | 2 | 1 | 2 | 54 |
| $$M\_{3}$$ | 1 | 3 | 2 | 105 |
| Profit  | 36 | 42 | 32 |  |

1. Formulate the problem as n LP. (4 Marks)
2. Obtain the optimal solution to the problem by using the simplex method. (8 Marks)
3. Are all the products manufactured by the firm? If not , why? (2 Marks)
4. What is the percentage of capacity utilization on machine$M\_{3}$? (1 Mark)
5. What are the shadow prices of the machine hours? (1 Mark)

**QUESTION THREE (20 MARKS)**

1. The table below lists the various details of project activities.

|  |  |  |
| --- | --- | --- |
| Activity  | Predecessor | Duration in weeks |
| $$t\_{0}$$ | $$t\_{m}$$ | $$t\_{p}$$ |
| ABCDEFG | ---ABCD,E | 1121223 | 1421556 | 778114815 |

1. Draw the project network and identify all paths through it. (9 Marks)
2. Find the expected duration and variance for each activity. (5 Marks)
3. What is the expected duration of the project with 50% chance of completion?(2 Marks)
4. Show that the starting basic solution of the following LPP is degenerate.

 $Max Z = 3x+9y$

 S.t $x+4y\leq 8$

 $x+2y\leq 4$

 $x,y\geq 0$ (4 Marks)

**QUESTION FOUR (20 MARKS)**

1. Consider a scenario where four different jobs can be done on four different machines. The table below gives the cost (in dollars) of processing job I on machine j. How should the jobs be assigned to the various machines so that the total cost is minimized? (8 Marks)

|  |  |
| --- | --- |
| Job |  Machine  |
|  | $$M\_{1}$$ | $$M\_{2}$$ | $$M\_{3}$$ | $$M\_{4}$$ |
| $$J\_{1}$$ | 5 | 7 | 11 | 6 |
| $$J\_{2}$$ | 8 | 5 | 9 | 6 |
| $$J\_{3}$$ | 4 | 7 | 10 | 7 |
| $$J\_{4}$$ | 10 | 4 | 8 | 3 |

1. Workers come to the tool storeroom to receive the special tools required by them for accomplishing a particular project assigned to them. The average time between two arrivals is 60 seconds and the arrivals are assumed to follow the poisson distribution. The average service time of the tool room attendant is 40 seconds. Determine the following:
2. average queue length (4 Marks)
3. Average length of non-empty queues. (2 Marks)
4. Average number of workers in the system. including the worker being attended.

(2 Marks)

1. Mean waiting time of an arrival (2 Marks)
2. Average waiting time of an arrival in system. (2 Marks)

**QUESTION FIVE (20 MARKS)**

1. A manufacturing company has to select one of the two product A and B for manufacturing. Product A requires an investment of $ 40,000. Market research survey, which shows high, medium, and low demands with corresponding probabilities and sales earnings in thousands of dollars for the two products is given in the table below;

|  |  |  |
| --- | --- | --- |
| Market | $$Probability $$ | $$Sales $$ |
| A | B | A | B |
| High | 0.4 | 0.3 | 50 | 80 |
| Medium | 0.3 | 0.5 | 30 | 60 |
| Low | 0.3 | 0.2 | 10 | 5 |

 Construct an appropriate decision tree. What decision should the company take. (4 Marks)

1. (i) Describe the stages involved in simulation. (5 Marks)

(ii) What is Monte Carlo simulation? (1 Mark)

1. A concrete company has plants in three locations and is currently working on three major construction projects, each located at a different site. The shipping cost per truckload of concrete, daily plant capacities and daily project requirements are provided in the accompanying table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  ToFrom | Project A | Project B | Project C | Plant Capacities |
| Plant 1 | 10 | 4 | 11 | 70 |
| Plant 2 | 12 | 5 | 8 | 50 |
| Plant 3 | 9 | 7 | 6 | 30 |
| Project Requirements | 40 | 50 | 60 | 150 |

Find an initial feasible solution to the concrete transportation problem using VAM. (10 Marks)