***DO NOT WRITE ANYTHING ON QUESTION PAPER EXCEPT YOUR NAME, DEPARTMENT AND ENROLMENT No.***

Name of Student ---------------------------------------------------------- Enrolment No. ------------------

Department / School -----------------------------

**BENNETT UNIVERSITY, GREATER NOIDA**

**End Term Examination, Even Semester 2020-21**

COURSE CODE: MSOM188L SUBMISSION DUE DATE: 10th June, 6.00 PM COURSE NAME: Supply Chain Simulations and Heuristics MAX. MARKS: **35**

**Note: 1.** The question paper contains two sections -A and B. Section A is compulsory. Attempt any two out of four questions from section B. Figures on right hand side indicate marks.

**2.** Answer to all questions should be done in MS Excel and submit (upload) your answer sheet in single excel file through LMS only.

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**SECTION A (Compulsory)**

**Q.1** Texmart is a locally owned “big-box” retail store chain in Texas (USA), with stores primarily located in the Dallas-Fort Worth area. In order to compete with national big-box store chains, it is planning to undertake several “sustainability” (i.e., “green’) projects at its stores. These national chains have been heavily publicizing their sustainability efforts, including the reduction of greenhouse gas (GHG) emissions (in metric tons per year) and energy savings (in kilowatt hours), which have had a positive effect on their sales. They have also demonstrated that sustainability projects can have a positive impact on cost (specially energy) savings. The projects Texmart is considering including solar panels at its stores, installing wind turbines at its stores, replacing their trucks with more fuel-efficient hybrid trucks, and implementing waste reduction programs at its stores, including recycling and reducing the use of plastic bags. Texmart wants to use to evaluate the projects on the following criteria.

F1: Media and public response

F2: Cost of projects

F3: Amount of GHG emissions reduction

F4: Amount of energy savings

Standard preference scale used for decision making process is presented in Table below

|  |  |
| --- | --- |
| **Preference Level** | **Numeric Value** |
| Equally preferred | 1 |
| Equally to moderately preferred | 2 |
| Moderately preferred | 3 |
| Moderately to strongly preferred | 4 |
| Strongly preferred | 5 |
| Strongly to very strongly preferred | 6 |
| Very strongly preferred | 7 |
| Very strongly to extremely strongly preferred | 8 |
| Extremely preferred | 9 |

Following are the pairwise comparisons for the projects for above mentioned four criteria, and the pairwise comparisons for the criteria separately.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **F1 (Media/Public Response)** | | | |
| **Project** | Solar Power | Wind Power | Shipping/Vehicles | Waste/Recycling |
| Solar Power | 1 | 3 | 5 | 7 |
| Wind Power | 1/3 | 1 | 3 | 5 |
| Shipping/Vehicles | 1/5 | 1/3 | 1 | 3 |
| Waste/Recycling | 1/7 | 1/5 | 1/3 | 1 |
|  |  |  |  |  |
|  | **F2 (Cost of Projects)** | | | |
| **Project** | Solar Power | Wind Power | Shipping/Vehicles | Waste/Recycling |
| Solar Power | 1 | 1/3 | 1/5 | 1/7 |
| Wind Power | 3 | 1 | 1/2 | 1/5 |
| Shipping/Vehicles | 5 | 2 | 1 | 1/3 |
| Waste/Recycling | 7 | 5 | 3 | 1 |
|  |  |  |  |  |
|  | **F3 (GHG Reduction)** | | | |
| **Project** | Solar Power | Wind Power | Shipping/Vehicles | Waste/Recycling |
| Solar Power | 1 | 3 | 2 | 4 |
| Wind Power | 1/3 | 1 | 2 | 3 |
| Shipping/Vehicles | 1/2 | 1/2 | 1 | 3 |
| Waste/Recycling | 1/4 | 1/3 | 1/3 | 1 |
|  |  |  |  |  |
|  | **F4 (Energy Savings)** | | | |
| **Project** | Solar Power | Wind Power | Shipping/Vehicles | Waste/Recycling |
| Solar Power | 1 | 2 | 4 | 8 |
| Wind Power | 1/2 | 1 | 3 | 5 |
| Shipping/Vehicles | 1/4 | 1/3 | 1 | 3 |
| Waste/Recycling | 1/8 | 1/5 | 1/3 | 1 |
|  |  |  |  |  |
| **Criteria** | **F1** | **F2** | **F3** | **F4** |
| **F1** | 1 | 2 | 3 | 5 |
| **F2** | 1/2 | 1 | 2 | 3 |
| **F3** | 1/3 | 1/2 | 1 | 2 |
| **F4** | 1/5 | 1/3 | 1/2 | 1 |

Apply Analytical Hierarchy Process (Heuristic approach) in the spreadsheet, rank the projects and choose the best project for Texmart. **[15]**

**SECTION B**

(Attempt any two out of four questions)

**Q.2** The time between arrivals of oil tankers at a loading dock at Kochi Port, Kerala is given by the following probability distribution

|  |  |
| --- | --- |
| **Inter-arrival Time (days)** | **Probability** |
| 1 | 0.05 |
| 2 | 0.10 |
| 3 | 0.20 |
| 4 | 0.30 |
| 5 | 0.20 |
| 6 | 0.10 |
| 7 | 0.05 |

The time required to fill a tanker with oil and prepare it for sea is given by the following probability distribution

|  |  |
| --- | --- |
| **Time to Fill and Prepare (days)** | **Probability** |
| 3 | 0.10 |
| 4 | 0.20 |
| 5 | 0.40 |
| 6 | 0.30 |

**(a)** Simulate the movement of tankers to and from the single loading dock for 20 arrivals. **[5]**

**(b)** Compute the average waiting time to load and average number of tankers waiting to be loaded. **[5]**

**Q.3** An electronic hardware store manager wishes to keep mobile charger of a leading brand in stock. The demand of the charger is not certain and there is a lead time of 2 days for stock replenishment. The probabilities of demand are given below

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Demand (Units/day)** | 0 | 1 | 2 | 3 | 4 |
| **Probability** | 0.05 | 0.10 | 0.30 | 0.45 | 0.10 |

Each time an order is placed, the store incurs an ordering cost of Rs 50 per order. The store also incurs a carrying cost of Rs 5 per day. The inventory carrying cost is calculated on the basis of stock at the end of each day. The manager of the hardware store wishes to compare two options for his inventory decision

Decision I: Order 5 chargers when the present inventory plus any outstanding order falls below 8 chargers

Decision II: Order 8 chargers when the present inventory plus any outstanding order falls below 8 chargers

Currently (beginning of 1st day) the store has a stock of 8 chargers plus 6 chargers ordered two days ago and are expected to arrive the next day. Carry out simulation run for 10 days to recommend an appropriate option. **[10]**

**Q.4 (a)** Wheat is harvested in a particular village and transported to grain elevators located three different cities -S1, S2 and S3 where grains are stored. The grain elevators supply to three flour mills located in cities A, B and C. The grain is shipped to the mills in mini truck, each truck capable of holding 1 ton of wheat. Each grain elevator is able to supply the following number of tons of wheat to the mills on a monthly basis

|  |  |
| --- | --- |
| **Grain Elevator** | **Supply** |
| **S1** | 150 |
| **S2** | 175 |
| **S3** | 275 |
| **Total** | 600 tons |

Each mill demands the following quantity (tons) of wheat per month

|  |  |
| --- | --- |
| **Mill** | **Demand** |
| **A** | 200 |
| **B** | 100 |
| **C** | 300 |

The cost of transporting 1 ton of wheat (in Rs) from each grain elevator (source) to each mill (destination) differs, according to the distance and road traffic system. The cost matrix is shown in the following table

|  |  |  |  |
| --- | --- | --- | --- |
|  | **A** | **B** | **C** |
| **S1** | 6 | 8 | 10 |
| **S2** | 7 | 11 | 11 |
| **S3** | 4 | 5 | 12 |

Find the quantities that should be supplied from each grain elevator (source) to each mill (destination) such that overall transportation cost is minimum. **[5]**

**(b)** Refer to the question 4(a), amount of wheat harvested at farms F1 and F2 is 300 tons each before being shipped to the three grain elevators located in S1, S2 and S3, which are now transhipment points. The wheat is then shipped to the mills in A, B and C. However, the shipping costs (in Rs) from the farms to the grain elevators are as follows

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Grain elevator** | | |
| **Farm** | **S1** | **S2** | **S3** |
| **F1** | 16 | 10 | 12 |
| **F2** | 15 | 14 | 17 |

Find the optimal quantities that should be shipped to each mill (destination) such that overall transportation cost is minimum. The shipping costs from the grain elevators to the mills and demands at each mill remain same as mentioned in question 4(a). **[5]**

**Q.5** A consumer goods company has to serve four dealers A, B, C and D from a depot located at point O. The data of average demand for each dealer and distance between depot and dealer (km) are presented in the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Dealer** | **A** | **B** | **C** | **D** |
| **Distance from depot (O)** | 8 | 15 | 8 | 7 |
| **Average demand (Ton)** | 2 | 1 | 3 | 2 |

Distance matrix for depot and dealer’s location (in kilometres) is presented below

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **O** | **A** | **B** | **C** | **B** |
| **O** | 0 |  |  |  |  |
| **A** | 8 | 0 |  |  |  |
| **B** | 15 | 12 | 0 |  |  |
| **C** | 8 | 9 | 6 | 0 |  |
| **D** | 7 | 13 | 8 | 6 | 0 |

The capacity of vehicle to transport the goods is 15 tons. Using Clarke-Wright algorithm or heuristics (saving matrix) design a vehicle route for this company that will minimize the total distance travelled to serve each dealer. **[10]**

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