NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

B-ENG HONS INDUSTRIAL AND MANUFACTURING ENGINEERING

OPERATIONS RESEARCH

TIE 5208

SECOND SEMESTER EXAMINATION PAPER

March 2025

This examination paper consists of 4 pages

Time Allowed:	**3 hours**
Total Marks:	**100**
Special Requirements:	**Nil**
Examiner's Name:	**Eng B. Sarema**

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer any four (4) questions
2. Each question carries 25 marks
3. There are six (6) questions
4. Use of calculators is permissible

QUESTION 1

(a) Give a brief account of various Operations Research Algorithms and indicate their practical application to Production, Inventory and Distribution Systems. [5]

(b) An engineering firm is considering tendering a consultancy contract to one of the state-owned enterprises. The cost of preparing the bid is USD 10,000, and the company stands a 60 % chance of getting shortlisted. Once shortlisted, the firm must supply further detailed information entailing costs estimated at USD 5,000. After this stage, the bid will either be accepted or rejected. The firm estimates that the labour and material costs associated with the contract amounts to USD 125,000. The firm is considering three bid prices, the values and associated chances of success of which are shown in Table Q1.

Table Q1: Bid prices and respective probability of success

Bid Price (USD)	Probability of Success
165, 000	0.90
175, 000	0.70
195, 000	0.35

You are required to help the firm with decision making by:

(i) Presenting a decision tree to the firm directors of the company showing alternative courses of action. [15]

(ii) Advising the firm on the appropriate course of action and its Expected Monetary Value. [5]

QUESTION 2

An Engineering company produces four types of rollers for conveyor belts: steel rollers, impact rollers, guide rollers, and coated rollers. The manufacturing process flows through four sections: drilling, milling, turning, and assembly. Table Q2 shows the variable time per unit of various products, the unit contributions of the four products, and the hours of availability in the four departments.

Table Q2: Rollers production information

	Drilling	**Milling**	**Turning**	**Assembly**	**Unit contribution (USD)**
Available time (hrs)	70	80	90	100	
Product					
Steel roller	3	0	3	4	**9**
Impact roller	7	2	4	6	**18**
Guide roller	4	4	0	5	**14**
Coated roller	0	6	5	3	**11**

a) Formulate a Linear Programme for scheduling production that maximizes the contribution. [5]

b) Determine the production schedule using the Simplex method. [20]

QUESTION 3

Four factories, A, B, C and D produce sugar and the capacity of each factory is given below: Factory A produces 10 tons of sugar and B produces 8 tons of sugar, C produces 5 tons of sugar and that of D is 6 tons of sugar. The sugar has demand in three markets X, Y and Z. The demand of market X is 7 tons, that of market Y is 12 tons and the demand of market Z is 4 tons. Table Q3 gives the transportation cost of 1 ton of sugar from each factory to the destinations. Find the optimal solution for least cost transportation cost [25]

Table Q3: Transportation Costs Matrix

Factories	**Transport Cost in USD per ton**			**Availability in tons**
	X	**Y**	**Z**	
A	400	300	200	**10**
B	500	600	100	**8**
C	600	400	300	**5**
D	300	500	400	**6**
Requirements in tons	**7**	**12**	**4**	

QUESTION 4

(a) Distinguish between an assignment algorithm and a transportation algorithm [8]

(b) Explain the difference between Modelling and Simulation in Operations Research. [7]

(c) Work Study results have indicated the completion time in hours for different tasks by different artisans as shown in Table Q4. You are required to assist the Planned Maintenance Officer to make a task allocation to minimize the total completion time for the jobs. [10]

Table Q4: Work Study results for Artisans task completion time in hours

Artisan	Task 1	Task 2	Task 3	Task 4
Joshua	10	7	6	11
Japhet	6	4	7	9
Deng	8	6	5	6
Jacob	9	5	3	12

QUESTION 5

(a) Using an example of your choice, explain how Big Data can be used as an Operations Research tool. [10]

(b) Explain how models can assist a manager in decision making. [5]

(c) Discuss the pros and cons of using models in decision making. [10]

QUESTION 6

(a) Give a brief description of the application of network models in solving operations research problems. [6]

(b) Distinguish between the Prim's Algorithm and the Kruskal's Algorithm in solving network models. [4]

(c) Using both, the Prim's Algorithm and the Kruskal's Algorithm, determine the minimum spanning distance of connecting the network model shown in Figure Q6. [15]

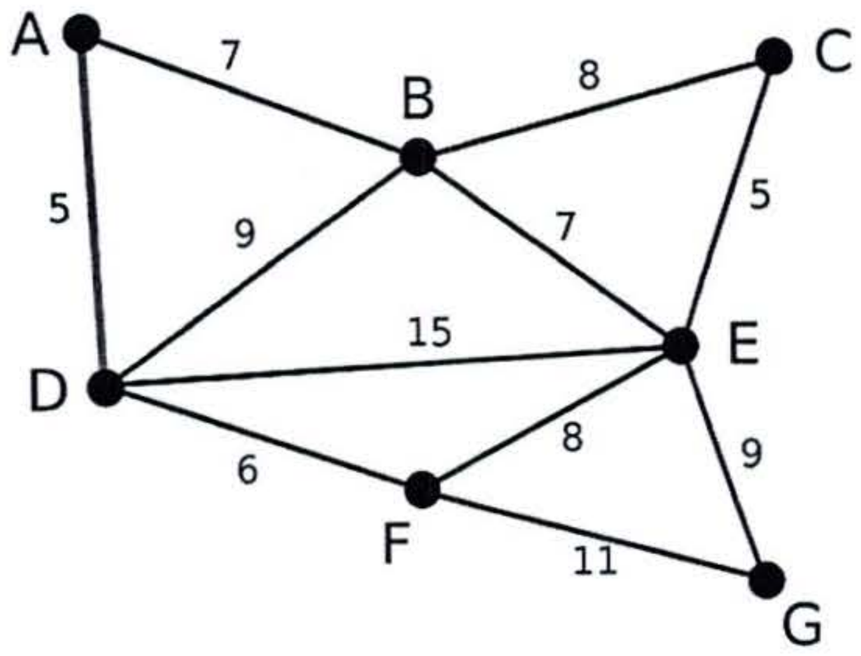

Figure Q6: Network model.

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