NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

ER OF MANUFACTURING ENGINEERING/SYSTEMS AND OPERATIONS MANAGEMENT

OPERATIONS RESEARCH

EIE 6130

Main Examination Paper Semester II

September/October 2024

This examination paper consists of 3 printed pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Dr Nicholas Tayisepi (Pr Eng)

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer any four (4) questions. Attempt a maximum of two (2) questions from each section.
2. Each question carries 25 marks.
3. Use of calculators is permissible.

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
5.	**25**
6.	**25**
TOTAL MARKS ATTAINABLE BY CANDIDATE	**100**

SECTION A

QUESTION ONE

Tamnhold Enterprises Bike shop is considering three options for their facility in the coming year. The Enterprise can expand its current shop, move to a larger facility or make no change. With a favourable market, the annual payoff would be $56000 if it expands, $70000 if it moves and $30000 if it does nothing. With an average market, its payoff will be $21000, $35000 and $10000 respectively. With an unfavourable market, its payoff will be $29000, $45000 and $500 respectively.

(a) Prepare the Payoff Table for this decision making situation of Tamnhold Enterprises Bike shop. **[6]**

(b) Which option should Tamnhold choose if it uses the Maximax criterion? **[5]**

(c) If the Maximin criterion is the decision making basis, which option Tamnhold choose **[5]**

(d) If the probability of a favourable market is 25%, the probability of an average market is 45% and the probability of an unfavourable market is 30%. Using EMV;

(i) What option should Tamnhold Enterprise choose? **[5]**

(ii) What is the optimal expected value? **[4]**

QUESTION TWO

Galaxy manufactures two toy doll models –Space Ray and Zapper. Resources are limited to 1000 pounds of special plastic. The available production time per week is 40 hours. Marketing requirement is such that total production cannot exceed 700 dozens, and the number of dozens of Space Rays cannot exceed the number of dozens of Zappers by more than 350. Technological input is such that Space Rays require 2 pounds of plastic and 3 minutes of labour per dozen. Zappers require 1 pound of plastic and 4 minutes of labour per dozen. The current production plan calls for: Producing as much as possible of the more profitable product, Space Ray ($8 profit per dozen), and Using the resources left over to produce Zappers ($5 profit per dozen), while remaining within the marketing guidelines. The current production plan consists of 450

dozen Space Rays per week, 100 dozen Zappers per week whilst profit amount is $4100 per week. The Galaxy Company Management is seeking a production schedule that will increase the company's profit.

(a) Develop a linear programming model in order to provide an insight to the company management in this production situation, and **[13]**

(b) Apply the simplex algorithm in developing an intelligent solution to this problem. **[12]**

QUESTION THREE

(A) Bulawayo Brick Manufacturing Company (BBMC) has orders for 80 tons of bricks at three suburban locations as follows: North-wood -- 25 tons, West-wood -- 45 tons, and Eastwood -- 10 tons. BBMC has two plants, each of which can produce 50 tons per week. How should end of week shipments be made to fill the above orders given the following delivery cost per ton:

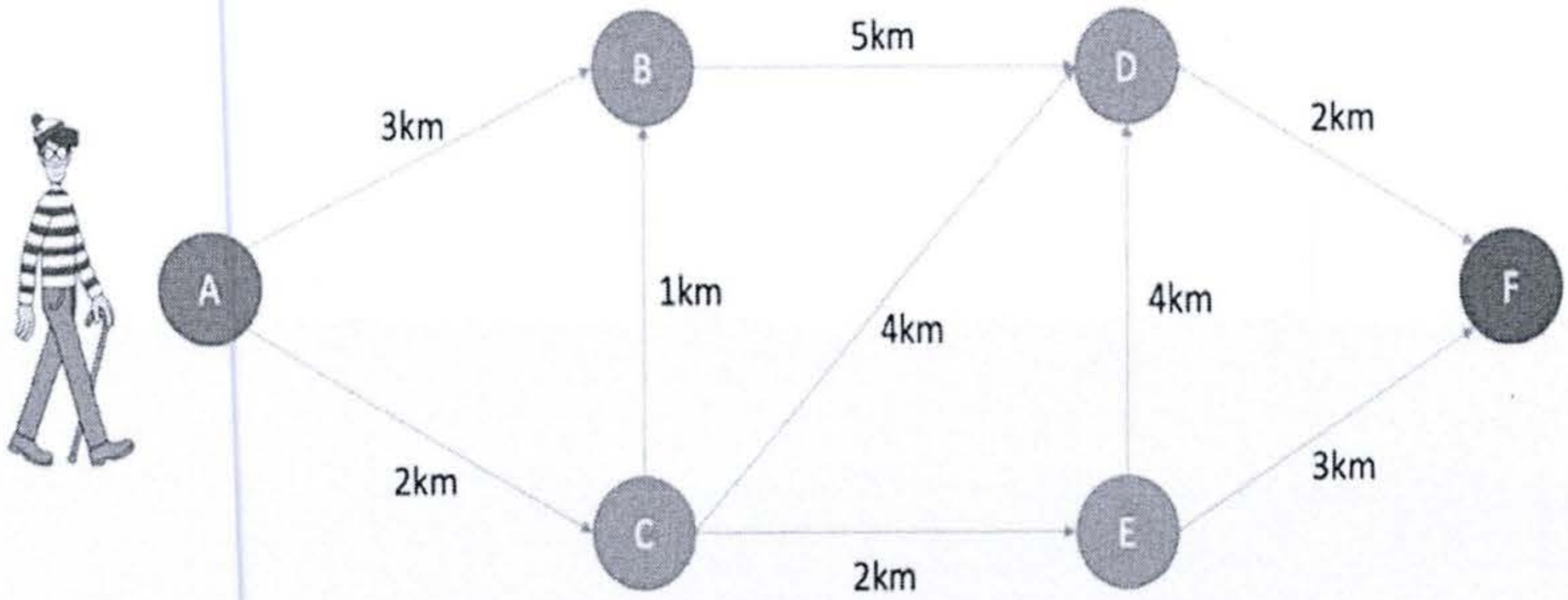
	North-wood	West-wood	Eastwood
Plant 1	24	30	40
Plant 2	30	40	42

(i) Indicate the initial transportation tableau for the BBMC business. **[5]**

(ii) Determine the initial basic solution using the Minimum-Cost Method. **[5]**

(iii) Find the optimum solution using the MODI method. **[5]**

(B) Determine shortest road travel distance route from the source city A to the destination city F using the backward recursion technique in dynamic programming, for the network shown in Figure QU3 (B). **[10]**



(C)

Figure QU 3(B)

SECTION B

QUESTION FOUR

(a) A Manufacturing Company has options to engage in six manufacturing projects during the next two-year period. There is, however, only approximately $500,000 available for manufacturing costs. The expected costs and expected net profits for the individual projects are listed in the Table QU4.

Table QU4. The expected costs and expected net profits

Manufacturing Project	Expected Net Profit (000)	Expected Cost (000)
A	180	125
B	120	90
C	100	60
D	140	125
E	105	50
F	200	150

Corporate policy places several additional restrictions on the project selection decision.

1. Exactly one of projects A, B and C must be selected
2. Exactly one of projects B, C, D, E and F must be selected
3. At most, one of the two projects E and F can be selected
4. At most, two of projects A, B, C, D and E must be selected

Model the problem as an Integer programming Model [20]

(b) Indicate the main steps which you would go through in order to solve this model using a stated computer package. [5]

QUESTION FIVE

QU5 (a) Discuss the importance of Goal programming as an important branch of operations research. [10]

QU5 (b) A factory produces two kinds of machined components on machines model type A and B. Table QU5 (b) shows the variety of production conditions:

Table QU5 (b). Machine constraints

Process	Model		Maximum weekly processing capacity
	A	B	
Ⅰ. (Hours/ units)	4	6	150
Ⅱ. (Hours / units)	3	2	70
Profits ($ / units)	300	450	

If the expectations of the factory business objectives and the priority is as follows:

P_1: Weekly total profits not less than $10,000.

P_2: Due to contractual requirements, A-type machine per week has to produce at least 10. B-type machine has to produce at least 15 per week.

P_3: It is hoped that the process I weekly production time is just 150 hours, and that process II weekly production time is just 70 hrs.

Develop a goal programming model for this problem. [15]

QUESTION SIX

(a) Determine the minimum spanning tree for the telecommunication supply services network shown in Figure QU6 (a). [12]

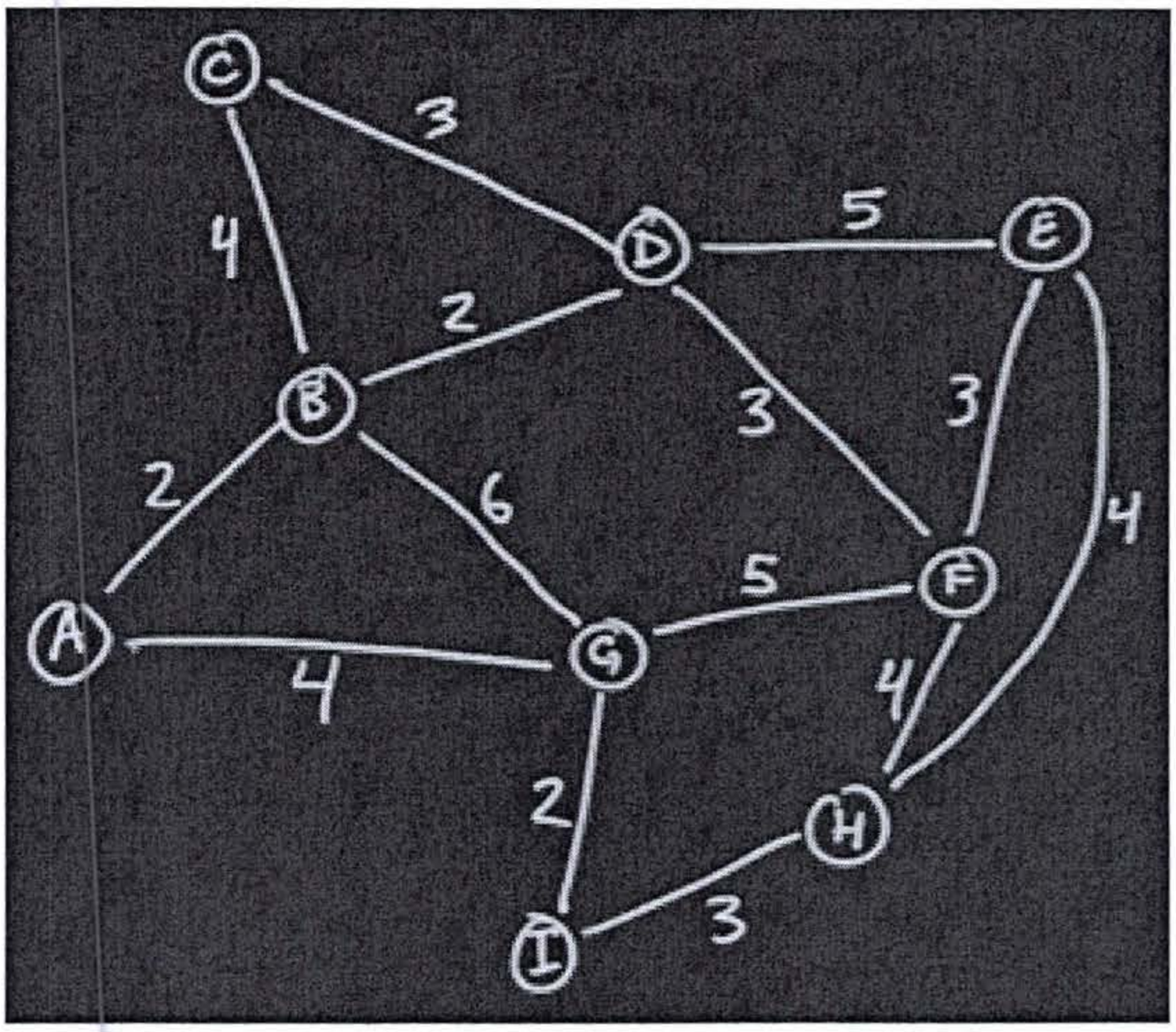


Figure QU6 (a) Telecommunication network

QU6 (b) Determine the maximum vehicle flow from the source to the sink, in the highway network shown in Figure QU6 (b), given that the flow capacity from Node i to Node j is the number of vehicles along the branch (i, j) nearest to Node i. [13]

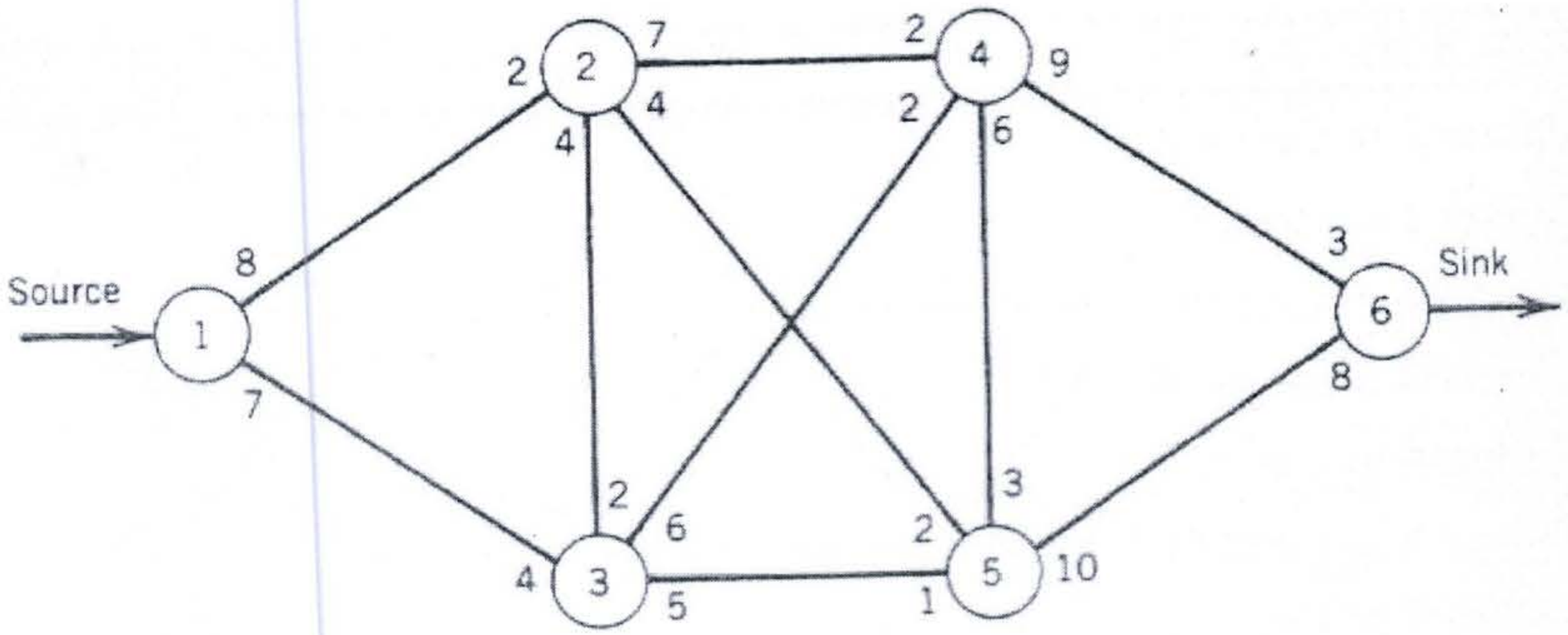


Figure QU6 (b) Highway network

End of Examination