

**BINDURA UNIVERSITY OF SCIENCE EDUCATION**

**FACULTY OF COMMERCE**

**DEPARTMENT OF BANKING AND FINANCE**

**OPERATIONS RESEARCH (BS 416)**

**DURATION: 3 HOURS**

**JUN 2023**

**INSTRUCTIONS TO CANDIDATES**

1. Answer any **FOUR** questions.
  2. All questions carry equal marks.
  3. Start each question on a fresh page.
  4. Use of a scientific calculator allowed.
  5. No cell phones in the examination room
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**QUESTION ONE**

The Planter Box Company makes medium and large units. Medium boxes each require 9 square meters of wood, while large ones require 15. All boxes require 0.5 hours of labour, regardless of size. Wood is limited to 450 square meters, and only 20.3 hours of labour are available. Due to space limitations, no more than 20 large boxes can be made each day. Also, customers can absorb at most 30 medium boxes. Subject to these constraints, any number of medium boxes can be made. Medium boxes yield a profit of \$6 and large ones a profit of \$2.

**Required:**

- a) Use the Simplex method to determine the optimal production level. **[25 marks]**

**QUESTION TWO**

- a) For what values of  $u$  and  $v$  are the following matrices equal?

$$\begin{pmatrix} (1+u) & v & 3 \\ v & 2u & 5 \\ 6 & 2u & -1 \end{pmatrix} = \begin{pmatrix} 4 & -2 & u \\ v & -3v & (u-v) \\ 6 & v+8 & -1 \end{pmatrix} \quad (5)$$

b) An ( $n \times n$ ) Matrix  $P$  is said to orthogonal if  $P'P = I_{(n \times n)}$  ;

When is matrix  $P = \begin{pmatrix} \beta & 0 & \beta \\ \beta & 0 & -\beta \\ 0 & 1 & 0 \end{pmatrix}$  orthogonal? (10)

c) Show that the ( $2 \times 2$ ) matrix  $\begin{pmatrix} p & -q \\ q & p \end{pmatrix}$  is orthogonal iff ( $p^2 + q^2 = 1$ ) (10)

[25 marks]

### QUESTION THREE

You have created a simulation model for a project with the results shown in table 1.

Table 1

Duration	Observed Occurrences	Probability
36	23	0.01
37	123	0.06
38	777	0.39
39	660	0.33
40	225	0.11
41	148	0.07
45	44	0.03
<b>Total</b>	<b>2000</b>	<b>1.00</b>

- d) Standard Critical Path Method (CPM) analysis indicates that the project should take 38 weeks. Is this likely to happen? What is the probability (chance) that it may take longer? (4)
- e) The customer has included penalties for lateness in their contract. These are equivalent to \$2000 per week the project is late. If the customer is offered a delivery date in 38 weeks' time, what penalty is the company likely to face? (6)
- f) The simulation model has used 2000 repetitions. Is this sufficient for you to be confident of your interpretation of the results or any management decisions that may be based on the results? Explain. (15)

[25 marks]

#### QUESTION FOUR

As the Operations Manager of company XYZ, you have five senior scientists to lead the company's five projects. You know that scientists can only work well if they are challenged and motivated by a project. To ensure that they are assigned to projects they find motivating, you have established a bidding system for the projects. You have given each scientist 1000 bid points so that they bid for each project, giving higher bids to projects they prefer most to lead.

The following table gives the bids from the five scientists for the projects.

Table 2

Project	Dr Kvaal	Dr Zuner	Dr Tsai	Dr Mickey	Dr Phil
1	0	100	100	267	100
2	200	400	100	153	33
3	800	200	100	99	33
4	0	200	100	451	34
5	0	100	600	30	800

**Required:**

Determine the appropriate assignment of these scientists.

[25 marks]

#### QUESTION FIVE

ABC Enterprises is a wholesaler supplying 100 hovers a week to various shops. Each hover is ordered at a cost of \$1000. An order placed with the manufacturer incurs \$5000 handling charge and \$20 000 per lot freight charge. The incremental cost is \$50 to store a hover in inventory. ABC Ltd finances inventory by paying its holding company a 52% interest per year for borrowed funds

**Required:**

- Compute the inventory annual cost of ABC Ltd current inventory policy of ordering 1300 hovers quarterly to meet the demand. (6)
- How many hovers should be ordered and how often should the orders be placed? (10)
- Comment on the resultant cost saving if ABC adopts an optimum inventory policy. (6)
- If the supplier takes one week to fill an order placed, what is the re-order point in doing this business? (3)

[25 marks]

### QUESTION SIX

A Company supplies goods to three customers, who each require 30 units. The company has two warehouses. Warehouse 1 has 40 units available and warehouse 2 has 30 units available. The costs of shipping 1 unit from warehouse to the customer are given in the table 3 below:

Table 3 Shipping costs

FROM	To		
	Customer 1	Customer 2	Customer 3
Warehouse 1	\$15	\$35	\$25
Warehouse 2	\$10	\$50	\$40

There is a penalty for each unmet customer unit demand; for customer 1 it is \$90, for customer 2 it is \$80 and for customer 3 it is \$110.

**Required:**

Formulate and solve the transportation problem that minimizes the sum of shortage and shipping costs.

[25 marks]

END OF EXAMINATION