MUEO

MOI UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR, ACADEMIC AFFAIRS, RESEARCH & EXTENSION

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

END OF SEMESTER EXAMINATIONS

FOR THE DEGREE
IN BACHELOR OF BUSINESS AND ECONOMICS

EXAM CODE : - BBM 351

COURSE TITLE : - OPERATIONS RESEARCH

DATE: - 11TH AUGUST, 2021 TIME: - 9.00A.M-12NOON

INSTRUCTION TO CANDIDATES

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BBM 351: OPERATIONS RESEARCH

END OF SEMESTER EXAMINATION

INSTRUCTIONS:-

1. *Answer **Question ONE** and any other **THREE.***
2. *Time allowed: **3 hours.***

QUESTION ONE - COMPULSORY [25 MARKS]

(a) *"Operations research is an ongoing process."* Explain this statement with examples. **[4marks]**

(b) What areas of operations research have made a significant impact on the decision-making process? Explain. **[4 marks]**

(c) What is meant by the term critical activities, and why is it necessary to know about them? **[5 marks]**

(d) The *Comrades Company Ltd* manufactures purses, shaving bags, and backpacks. The construction includes leather and synthetics, leather being the scarce raw material. The production process requires two types of skilled labor: sewing and finishing. The following table gives the availability of the resources, their usage by the three products, and the profits per unit.

	Resource requirements per unit			
Resource	**Purse**	**Bag**	**Backpack**	**Daily availability**
Leather (ft^2)	2	1	3	42
Sewing (hr)	2	1	2	40
Finishing (hr)	1	0.5	1	45
Price (KSh.)	24	22	45	

Required:

(a) Formulate the problem as a linear program, and find the optimum solution. **[10 marks]**

(b) From the optimum solution, determine the status of each resource. **[2 marks]**

QUESTION TWO - COMPULSORY [20 MARKS]

(a) An established company has decided to add a new product to its line. It will buy the product from a manufacturing concern, package it, and sell it to a number of distributors that have been selected on a geographical basis. Market research has already indicated the volume expected and the size of sales force required. The steps shown in the following table are to be planned.

Activity	Description	Predecessors	Duration (days)
A	Organize sales office	-	6
B	Hire salesmen	A	4
C	Train salesmen	B	7
D	Select advertising agency	A	2
E	Plan advertising campaign	D	4
F	Conduct advertising campaign	E	10
G	Design package	-	2
H	Setup packaging facilities	G	10
I	Package initial stocks	J,H	6
J	Order stock from manufacturer	-	13
K	Select distributors	A	9
L	Sell to distributors	C,K	3
M	Ship stocks to distributors	I,L	5

Required:

(i) Represent the project by means of a network diagram. **[4 marks]**

(ii) Show the earliest and latest times of each activity. **[3 marks]**

(iii) Determine the critical path and the minimum completion time of the project. **[3 marks]**

(iv) For each non-critical activity, find the total and free float. **[5 marks]**

QUESTION THREE [15 MARKS]

(a) Explain the difference between pure strategy and mixed strategy as used in game theory. **[2 marks]**

(b) Game theory provides a systematic quantitative approach for analysing competitive situations in which the competitors make use of logical processes and techniques in order to determine an optimal strategy for winning: Comment. **[3 marks]**

(c) For what value of λ, the game with following pay-off matrix is strictly determinable? **[3 marks]**

		Player B Strategies		
		B_1	B_2	B_3
Player A Strategies	A_1	λ	6	2
	A_2	-1	λ	-7
	A_3	-2	4	λ

(d) Consider the two person zero sum game between players A and B given the following payoff table:

		Player B Strategies			
		B_1	B_2	B_3	B_4
Player A Strategies	A_1	3	2	4	0
	A_2	3	4	2	4
	A_3	4	2	4	0
	A_4	0	4	0	8

Required:

Determine the optimal strategies for the players. **[7 marks]**

QUESTION FOUR [15 MARKS]

(a) Briefly discuss the Monte Carlo method of solving a problem, illustrating it by outlining a procedure to solve a specified problem of your choice. **[4 marks]**

(b) A company trading in motor vehicle spare parts wishes to determine the levels of stock it should carry for the items in its range. The demand is not certain and there is a lead time for stock replenishment. For an item A, the following information is obtained:

Demand (units/day)	:	3	4	5	6	7
Probability	:	0.10	0.20	0.30	0.30	0.10
Carrying cost (per unit/day)	:	KSh. 2				
Ordering cost (per order)	:	KSh. 50				
Lead time for replenishment	:	3 days				

Stock on hand at the beginning of the simulation exercise was 20 units.

Required:

Carry out a simulation run over a period of 10 days with the objective of evaluating the inventory rule: Order 15 units when present inventory plus any outstanding order falls below 15 units. You may use random numbers in the sequence of: 0, 9, 1, 1, 5, 1, 8, 6, 3, 5, 7, 1, 2, 9, using the first number for day one. Your calculation should include the total cost of operating this inventory rule for 10 days.

[12 marks]

QUESTION FIVE [15 MARKS].

(a) Three electric power plants, P_1, P_2 and P_3 with capacities of 25, 40, and 30 million kWh supply electricity to three cities, C_1, C_2 and C_3 respectively. The maximum demands at the three cities are estimated at 30, 35, and 25 million kWh. The price per million kWh at the three cities is as given in the table below.

		Price/Million kWh		
		City		
		C_1	C_2	C_3
Plant	P_1	KSh. 600	KSh. 700	KSh. 400
	P_2	KSh. 320	KSh. 300	KSh. 350
	P_3	KSh. 500	KSh. 480	KSh. 450

During the month of August, there is a 20% increase in demand at each of the three cities, which can be met by purchasing electricity from another network at a premium rate of KSh.1000 per million kWh. The network is not linked to city 3, however. The utility company wishes to determine the most economical plan for the distribution and purchase of additional energy.

Required:

(a) Formulate the problem as a transportation model. **[3 marks]**

(b) Determine an optimal distribution plan for the utility company. **[3 marks]**

(c) Determine the cost of the additional power purchased by each of the three cities. **[2 marks]**

(d) A department of a company has five employees with five jobs to be performed. The time (in hours) that each man takes to perform each job is given in the effectiveness matrix.

		Employees				
Jobs		E_1	E_2	E_3	E_4	E_5
	J_1	10	5	13	15	16
	J_2	3	9	18	13	6
	J_3	10	7	2	2	2
	J_4	7	11	9	7	12
	J_5	7	9	10	4	12

Required:

How should the jobs be allocated, one per employee, so as to minimize the total man-hours? **[7 marks]**

QUESTION SIX [15 MARKS]

(a) In each of the following queuing situations, identify the customer, the server, nature of the calling source and nature of arriving customers.

	Situation	Customer	Server	Nature of calling source	Nature of arriving customers
(i)	Planes arriving at an airport				
(ii)	Taxi stand serving waiting				
	passengers				
(iii)	Parking lot operation				

[3 marks]

(b) Visitors' parking at Comrades College is limited to five spaces only. Cars making use of this space arrive according to a Poisson distribution at the rate of six cars per hour. Parking time is exponentially distributed with a mean of 30 minutes. Visitors who cannot find an empty space on arrival may temporarily wait inside the lot until a parked car leaves. That temporary space can hold only three cars. Other cars that cannot park or find a temporary waiting space must go elsewhere.

Required:

(i) The probability of n cars in the system. **[1 mark]**

(ii) The effective arrival rate for cars that actually use the lot. **[1 mark]**

(iii) The average number of cars in the lot. **[1 mark]**

(iv) The average utilization of the parking lot. **[2 marks]**

(c) A firm is considering the replacement of a machine, whose cost price is KSh. 12,200, and its scrap value is KSh. 200. From experience the running (maintenance and operating) costs are found to be as follows:

Year	1	2	3	4	5	6	7	
Running cost (KSh)	200	500	800	1,200	1,800	2,500	3,200	4,000

Required:

When should the machine be replaced? **[5 marks]**

(d) Give **four** situations that make the replacement of items necessary. **[2 marks].**

END

Formulae for use (Single Server Queues)

$$\mathbf{P\ (n \geq k) = \left(\frac{\lambda}{\mu}\right)^{k}}$$

$$\mathbf{U = Utilization\ ratio = \frac{\lambda}{\mu}}$$

$$P_o = \text{Prob}\begin{bmatrix}\text{system is}\\ \text{empty (idle)}\end{bmatrix} = 1 - \frac{\lambda}{\mu}$$

$$L_q = \begin{matrix}\text{average number}\\ \text{in the queue}\end{matrix} = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$L = \begin{matrix}\text{average number}\\ \text{in the system}\end{matrix} = \frac{\lambda}{\mu - \lambda}$$

$$W_q = \begin{matrix}\text{average time}\\ \text{in the queue}\end{matrix} = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$W = \begin{matrix}\text{average time}\\ \text{in the system}\end{matrix} = \frac{1}{\mu - \lambda}$$

Note:

λ is the arrival rate.
μ is the service rate.