TECHNICAL UNIVERSITY OF MOMBASA

A Centre of Excellence

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS AND PHYSICS

MAY 2016 SERIES EXAMINATION

UNIT CODE:SMA 2472   UNIT TITLE:OPERATIONAL RESEARCH

MAIN EXAMINATION

TIME ALLOWED: 2HOURS

INSTRUCTIONTO CANDIDATES:

You should have the following for this examination

- Mathematical tables
- Scientific Calculator

This paper consists of **FIVE** questions

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are as shown

QUESTION ONE (30 MARKS COMPULSORY)

a. Define the following terms as used in network analysis
   i. Dummy activity   (1 mark)
   ii. Event   (1 mark)
   iii. Network   (1 mark)

b. Use simplex method to

$$\text{Maximize p} = 2x + 6y + 4z$$
$$\text{subject to} \quad 2x + 5y + 2z \leq 38$$
$$4x + 2y + 3z \leq 57$$
$$x + 3y + 5z \leq 57$$

$x, y, z \geq 0$ (8 marks)

c. Calculate the 3 and 6 monthly averages of the forecasting data below (5 marks)

MON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SALES	1200	1280	1310	1270	1190	1290	1410	1360	1430	1280	1410	1390

d. ABC ltd has aggregate demand of 1.2 million units. Each time they place an order, there is an ordering cost of ksh 1000, holding cost is ksh 100 per unit. Determine

    i. EOQ (2 marks)

    ii. Number of order to be based on EOQ (2 marks)

    iii. Total cost of stocks based on the EOQ (3 marks)

e. At a power distribution centre in a town there is only one resident Engineer to serve the customers arriving from the rural community. The government is convinced that the situation faced here is a single serve queuing situation with Poisson arrivals and Poisson service. After all, the calling units are the members of the community and the service mechanism is the resident Engineer attending to them. It is known that customers arrive randomly at a rate of 0.2 customers per hour. Each customer requires different amount of time for service. The Engineer reckons, however, that he serves his customers at an average rate of 0.2 customers per hour. Calculate

    i. The average number of customers in the queuing system (1 mark)

    ii. The number of customers actually waiting in the queue (2 marks)

    iii. The average amount of time a customer spends on a queuing system (1 mark)

    iv. The average amount of time a customer spends in the queue (2 marks)

    v. The probability of having exactly zero customers in the queue. (2 marks)

QUESTION TWO (20 MARKS)

a. An Engineer designs a machines power rating for bread production such that type I bread costs ksh 50 to produce and is sold at x shillings while Type II bread costs ksh 60 and is sold at Y shillings. If the company makes (250y-250x) pieces of Type I bread and (32000 + 250x - 500y) of Type II bread. Determine x and y so that profit is maximized. (6 marks)

b. KenGen has four sales people who have to visit four clients. The profit records from previous visits are tabled below and it is required to maximize profits by the best assignments (profits are in $). Work out the best assignment (6 marks)

CUSTOMERS	SALES PEOPLE			
		HENRY	GEORGE	STEVE	OSCAR
	1	6	12	20	12
	2	22	18	15	20

3	12	16	18	15
4	16	8	12	20

c. A firm produces two products X and Y with contributions of $8 and $10 per unit respectively. Solve by graphical method and L.P model associated with the data above. (8 marks)

	Labour hours	Material A	Material B
X	3	4	6
Y	5	2	8
Total available	500	350	800

QUESTION THREE (20 MARKS)

a. A filling station is being planned and it is required to know how many attendants will be needed to maximize earnings. From traffic studies is has been forecasted that the customers will arrive in accordance with the following table.

Customers	probability
0	0.72
1	0.24
2	0.03
3	0.01

From past experience it has been estimated that service times vary according to the following table.

Service time in minutes	1	2	3	4	5	6	7	8	9	10	11	12
probablity	0.16	0.13	0.12	0.1	0.09	0.08	0.07	0.06	0.05	0.05	0.05	0.04

If there are more than two customers waiting, in addition to those being serviced, new arrivals drive on and the sales is lost. A petrol pump attendant is paid $40 per 8 hour day, and the average contribution per customer is estimated to be $4. How many attendants are needed?
(6 marks)

b. A lorry costs $ 50000 and it is required to find the least cost point to replace it with a new vehicle. The following data have been estimated. Use the data to approximate the best replacement time (8 marks)

year	1	2	3	4	5	6	7	8
Resale value	36000	28000	22500	17500	13000	10000	8000	6000
Annual maintenance cost	2000	2600	3200	4600	7000	11000	13000	15000

c.

    i. A company uses 100 000 units per year which cost $ 3 each. Carrying costs are $250 per order. Find EOQ? (2 marks)

ii. Using (i) above what would be the EOQ if the company made items themselves on a machine with a potential capacity of 600000 units per year (2 marks)

iii. Calculate the various control levels given the following information.

Normal usage	560 per day
Minimum usage	240 per day
Maximum usage	710 per day
Lead time	15-20 days
EOQ	10000	(2 marks)

QUESTION FOUR (20 MARKS)

a. Find the optimum strategies and the value of the game from the following pay off matrix concerning two persons game

Player Y

Player x $\begin{pmatrix} 1 & 4 \\ 5 & 3 \end{pmatrix}$ (6 marks)

b. Find the critical path of the following network using the EST/LSTs hence find the floats of the network below.

Activity	preceeding activity	duration(days)
1	-	4
2	1	7
3	1	5
4	1	6
5	2	2
6	3	3
7	5	5
8	2,6	11
9	7,8	7
10	3	4
11	4	3
12	9,10,11	4

Also, if the δ of the activities on the critical path are 1, 2, 1.5, 3, 2.5 and 3 respectively. Based on these values calculate the probability of achieving a scheduled time of 40 days for the project duration. (9 marks)

c. A company wishes to optimize profit and realizes electrical appliances Type I yields Revenue R1 defined by $R_1 = A_1Q_1 - B_1Q_1^2$ while Type II yields revenue R_2 definued as $R_2 = A_2Q_2 - B_2Q_2^2$. The total cost of production is defined as.

$$C = A_3 + B_3(Q_1 + Q_2)$$

Determine Q_1 and Q_2 that maximize profit (5 marks)

QUESTION FIVE (20 MARKS)

a. TUM has a project to make a perimeter wall in one of its campuses with the following activity durations and resources requirements.

Activity	preceding activity	duration days)	resource requirements(units)
A	-	6	3
B	-	3	2
C	-	2	2
D	C	2	1
E	B	1	2
F	D	1	1

Assuming no restrictions show the network, critical path and resource requirements on a day by day basis assuming that starts are made on the EST of each activity.State the plan if there are only 6 units of resources? (7 marks)

b. A company with an ageing product range is investigating the launch of a new range. Their business analysts have mapped out several possible scenarios which are given below.
Scenario 1
Continue with old range producing projects declining at 10% p.a on a compounding basis. Last year's profits were $60000 from this range
Scenario 2
Introduce a new range without any prior market research. If sales are high, annual profit is put at $90000 with a probability which from past data is put at 0.7. if sales are low, annual profit is put at $30000 with a probabity of 0.3
Scenario 3
Introduce a new range with prior market research costing $ 30000. The market research will indicate whether future sales are likely to be 'good' or 'bad'. If the research indicates 'good', then the management will spend $ 35000 more on capitalequipment and this will increase annual profits to $100000 if sales are actually high. If however sales are actually low, annual profits will drop to $2500. Should market research indicate 'good' and should management not spend more on promotion then profit levels will be as for scenario 2 above.

If the research indicates bad then the management will scale down their expectations to give annual profits of $50000 when sales are actually low. However, if sales do turn out to be high, profits can only rise to $70000 because of capacity constraints. Past history of the market research company indicates the following results.

PREDICTED SALES LEVEL	ACTUAL SALES		
		High	Low
	Good	0.8	0.1
	Bad	0.2	0.9

When actual sales were high the market research company had predicted good sales levels 80% of the time and so on.

Use a time a horizon of 6 years to indicate to the management of the company which scenario they should adopt   (9 marks)

c. State FOUR circumstances that would force a company management to do replacement analysis in the establishment   (4 marks)

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