THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF INDUSTRIAL STUDIES (Industrial Management)
FINAL EXAMINATION 2007/2008

MEX 4241– OPERATIONAL DECISION MAKING

DATE : 05th of May 2008

TIME : 0930hours – 1230hours

DURATION : 03 Hours

INSTRUCTIONS:

- **Answer any five (05) questions.**
- **All questions carry equal marks.**
- **Normal distribution and P_O values for multiple – server model tables are attached to the question paper.**
- **Graph papers will be provided at request.**

Q1

i) A random variable X has the probability density function,

$$f(x) = \begin{cases} cx & 0 \le x < 1 \\ c & 1 \le x < 3 \\ 0 & \text{otherwise} \end{cases}$$

where c is a constant.

Find,

a) the value of c;

b) the mean of the distribution;

c) $P\{0.5 \le X < \le 2.5\}$

ii) The diameters of cylinders produced by a machine are normally distributed with mean 6.50cm and standard deviation σ.

a) If 5% of the cylinders produced by this machine have their diameters greater than 6.54cm, estimate the standard deviation σ.

b) If 500 cylinders are produced by this machine, how many of the cylinders may be expected to have diameters between 6.49 to 6.52cm.

Q2

i) The operations manager of a factory assembling transformers has placed two rush orders for winding coils with two different suppliers, A and B. if neither deliver order arrives in 4 days, the assembly process must be shutdown until at least one of the orders arrives. The probability that supplier A can deliver winding coil in 4 days is 0.55. The probability that supplier B can deliver winding coil in 4 days is 0.35. Find the following.

a) The probability that both suppliers deliver winding coils in 4 days. (since separate suppliers are involved, you can assume independence)

b) The probability that at least one supplier delivers winding coil in 4 days

c) The probability that the assembly process is shutdown in 4 days because of a shortage of winding coils.

ii) The poison random variable X has the probability density function

$$P(X=x) = \frac{e^{-\lambda}\lambda^{x}}{x!} \qquad x = 0, 1, 2, 3, \ldots..$$

Find the mean of the distribution of X.

Q3

i) What is linear programming? Discuss its limitations.

ii) A firm manufactures two products P1 & P2 on their three machines M1, M2 & M3. P1 requires processing on M1 & M2 and P2 on all machines. The manufacturing times, profit margins and machine capacities are as follows.

	M_1	M_2	M_3	Profit Margin
P_1	0.25	0.40	0.00	2.0
P_2	0.50	0.20	0.80	3.0
Capacity (Weekly)	40	40	40	

Assuming unlimited markets, what quantities of P_1 & P_2 should be made each week to maximize profit?

(Solve the problem using graphical method)

Q4

i) Maximize $Z = -5x_1 + 5x_2 + 13x_3$,

subject to,

$$-x_1 + x_2 + 3x_3 \leq 20$$

$$12x_1 + 4x_2 + 10x_3 \leq 90$$

$$x_1, x_2, x_3 \geq 0$$

ii) What will be the solution if a new variable x_4 is introduced with the objective function coefficient of 10 and coefficients of first and second constraints of 3 and 5 respectively?

iii) Supposed introduction of a new constraint $2x_1 + 3x_2 + 5x_3 \leq 50$. Would this cause the objective function to increase, decrease or stay the same? Give a reason for your answer.

Q5

An oil company has three refineries, namely A, B and C that produce oil, which is then, transported to four distribution centres, namely W, X, Y and Z. The total quantity produced by each refinery and the total requirement of each distribution centre and associated transportation cost per 1000 barrels are given in table Q5.

Refinery	Distribution centre and associated transportation cost in rupees				Supply (Barrels)
	W	X	Y	Z	
A	80	70	50	60	16,000
B	60	90	40	80	20,000
C	50	50	95	90	14,000
Demand (Barrels)	10,000	10,000	12,000	18,000	50,000

Table Q5

i) Suggest the transportation schedule that minimizes the total transportation cost.

ii) If the company wants that at least 5,000 barrels of oil be transported from refinery C to distribution centre W, will the optimum transportation schedule change? If so, what will be the new schedule?

Q6

i) The demand for an item is 12,000 units per year and the item is used continuously at constant rate. The price of the item is Rs.50 per unit. The ordering cost is estimated as Rs.1,000 per order. The inventory holding cost is Rs.8 per unit per month. Lead time is one week. Find,

   a) economic order quantity (EOQ)
   b) reorder level
   c) annual cost
   d) how often to order

ii) An item is used at a constant and continuous rate of 5,000 units per year. The ordering cost is Rs.200 per order and the inventory holding cost is estimated as 10% of the price per unit per year. The price of the item depends on the quantity purchased as given below in table Q6.

Order quantity (units)	≤ 499	500 – 2,499	2,500 – 4,999	$\geq 5,000$
Price per unit (Rs.)	5.00	4.90	4.80	4.75

Table Q6

If no buffer stock is kept and no shortages are allowed find,

a) the most economical reorder quantity

b) the annual cost

c) cycle length

Q7

i) Define the four basic waiting (Queue) structures and quote an example to explain the definition of each structure.

ii) A bank has two tellers machines, working on savings accounts. The first teller machines handles withdrawals only, while the second machine handles deposits only. It has been found that service time for the both deposits and withdrawals are exponentially distributed with a mean of 3 minutes per customer. Depositors arrive in a Poisson fashion throughout the day with a mean arrival rate of 16 per hour, while withdrawals arrive in a Poisson fashion throughout the day with a mean arrival rate of 14 per hour.

a) What would be the effect on the average waiting time for depositors and withdrawals if each teller machine could handle both withdrawals and deposits?

b) What would be the effect on the average waiting time by increasing the service time to 3.5 minutes?

Q8

A leading scientific equipment manufacturing company is engaged in producing different types of high-class equipment for use in science laboratories. The company has two different assembly lines to produce particular equipment. The processing time for each of the assembly line is regarded as a random variable and is described as shown in following table.

Processing Time (minutes)	***Assembly A_1***	***Assembly A_2***
20	0.20	0.10
21	0.40	0.15
22	0.20	0.40
23	0.15	0.25
24	0.05	0.10

Table Q8

Using the following random numbers, generate data on the process time for 15 units of the items and compute the expected process time to assemble the product.

41	92	05	44	66	07	00	00	14	62
20	07	95	05	79	95	64	26	06	48

Formulae for Question No. 7

	Single Server Model	**Multiple Server Model**
Average number of customers in the queuing system	$L = \frac{\lambda}{\mu - \lambda}$	$L = \frac{\lambda\mu(\lambda/\mu)^s}{(s-1)!(s\mu - \lambda)^2} P_o + \frac{\lambda}{\mu}$
Average number of customers in the queue	$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$	$L_q = L - \frac{\lambda}{\mu}$
Average time a customer spends in the queuing system	$W = \frac{1}{\mu - \lambda}$	$W = \frac{L}{\lambda}$
Average time a customer spends in the queue	$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$	$W_q = W - \frac{1}{\mu}$

λ = mean arrival rate;
μ = mean service rate;
s = number of servers