The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	POSTGRADUATE DIPLOMA IN TECHNOLOGY IN INDUSTRIAL ENGINEERING
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX 7211 – OPERATIONS RESEARCH**
Academic Year	:	2013/14
Date	:	04th September 2014
Time	:	0930 hours -1230 hours
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. Answer any 5 questions only.
4. Graph paper will be provided.

Q(1) (a) How many times should a coin be tossed to be 95% sure of getting at least one "head"?

(b) In a factory, machines A, B and C manufacture respectively 25%, 35% and 40% of the total output. Out of their respective outputs "A" has 5% defective "B" has 4% defective and "C" has 2% defective. An item drawn at random out of the total production was found to be defective. What are the probabilities that it was manufactured by machine A, B or C?

(c) A binary digit (BIT) has to be passed through two pieces of repeater equipment each of which has a probability "P" of changing the digit. On the average 60% of the binary digits sent are of value "1". On a certain occasion a "1" was received. What is the probability that it was originally "1"?

Q(2) The following table describes the daily output and the number of years of service of eight operators.

OPERATORS NUMBER	NUMBER OF YEARS OF SERVICE	DAILY OUTPUT '000
1	7	1.0
2	12	2.0
3	25	4.0
4	5	0.6
5	10	1.8
6	30	4.2
7	20	3.6
8	15	3.0

(a) Calculate the coefficient of correlation between years of service and daily output.
(b) Develop the regression equation of the form y = a + bx where "y" is the output and "x" is years of service.
(c) Estimate the daily output of an operator with 18 years of service.
(d) Calculate sum of squares error given by "SSE".
(e) Calculate error of regression model given by "Syx".
(f) Calculate the coefficient of determination.
(g) Calculate the standard error of the "b" coefficient given by "S_b".
(h) Evaluate the 95% Confidence interval for the "b" coefficient.

Q(3) ABC – Electrical is engaged in selling washing machines. They observe that the annual demand for washing machines is 2500. The cost of placing one order is Rs. 9,000/= and the cost of holding one machine in stock for a period of one year is Rs. 125/= .

(a) If stock outs are not allowed.
  (i). Calculate the Economic Order Quantity (EOQ)
  (ii). Calculate Re-order Level (ROL) if the lead time is one month.
  (iii). Calculate Re-order Level (ROL) if the lead time is four month.
  (iv). If a discount of 5% is offered to all orders more than 400, would it change the EOQ, explain with reasons.
  (v). Find the Economic Order Quantity (EOQ), if the available floor space to store washing machines is 4,500 sq.ft. and the capital available to purchase machines is Rs. 875,000/=. It is noted that a washing machine costs Rs. 7,000/= and occupies a floor space of 9 sq.ft.

(b) If stock outs are allowed and the cost of running one item out of stock for one year is Rs. 75/= find,
  (i). Economic order quantity (EOQ)
  (ii). Maximum level of stock.

Q(4) A businessman owns two factories one at Gampaha and the other at Kalutara that produce Lemon, Chocolate and Vanilla Ice cream. Their daily production is explained in the table below. The daily cost of running Gampaha and Kaluthara factories is Rs. 1,200/= and Rs. 1,000/= respectively. It is estimated that the minimum demand during the month of April for Lemon, Chocolate and Vanilla Ice cream is 50,000, 60,000 and 42,000 respectively. The businessman wishes to minimize the cost of running both factories in the month of April while satisfying the minimum demand and wishes to know how many days each factory should run.

(a) formulate the above as a linear programming problem.
(b) Solve the problem using graphical method.

TYPE OF ICE CREAM	DAILY PRODUCTION	
	GAMPAHA	KALUTHARA
Lemon	2,000	2,500
Chocolate	4,000	2,000
Vanilla	1,000	7,000

Q(5) S_1 , S_2 and S_3 are three suppliers of a certain building material whose weekly capacities are 30, 40 and 30 tons respectively. W_1 , W_2 , W_3 and W_4 are four work sites that use these material and their weekly demands are 20, 20, 25 and 35 tons respectively.

The cost of transporting one ton from a given supplier to a given work site is shown in the table below.

COST OF TRANSPORT (Rs. '000)

SUPPLIER	WORK SITE			
	W_1	W_2	W_3	W_4
S_1	7	10	14	8
S_2	7	11	12	16
S_3	5	6	15	9

(a) Find an initial feasible solution using North-West corner rule method or least cost method.
(b) Determine the minimum cost schedule and supply (solve the transportation problem).
(c) Suppose it is now necessary to purchase material from suppliers and then transport and the purchasing unit price of suppliers S_1 , S_2 , and S_3 are 2, 1 and 3 (measured in Rs. '000), respectively. Show that your present optimal solution still remains optimal even though you need to purchase and transport the material.

Q(6) An educational Institute has four teachers T_1 , T_2 , T_3 and T_4 who could teach any of the four subjects S_1 , S_2 , S_3 , and S_4 . However their capabilities in a given subject differ. The estimated percentage of failures when a given subject is assigned to a given teacher is explained in the table below.

ESTIMATED PERCENTAGE OF FAILURE

TEACHER	SUBJECTS			
	S_1	S_2	S_3	S_4
T_1	17	14	12	18
T_2	9	5	7	6
T_3	21	27	15	12
T_4	14	11	8	10

(a) Find how the teachers should be assigned to the given subjects so that the total percentage of failures is minimized.
(b) Find how the teachers should be assigned if it is told that subject S_4 should not be given to teacher T_2.

Q(7) At a laboratory blood samples are received in a Poisson fashion at the rate of 8 per hour. There is only one technologist who on the average takes 6 minutes to test one blood sample. The laboratory works 10 hours a day.
(a) How many hours does the technologist idle per day?
(b) What is the probability that there are three blood samples at the laboratory?
(c) On the average how many blood samples are there in the laboratory?
(d) How long will a blood sample have to be kept at the laboratory?

(e) On the average how many blood samples are there waiting to be tested in the laboratory?
(f) How long must a blood sample be kept until it is taken for testing?
(g) Blood samples as they are received are put in a freezer that has a capacity to hold 8 blood samples. If the freezer is full, the sample is kept out side.

(i). What is the probability that a blood sample just received is kept outside the freezer?
(ii). What is the average number of blood samples that are kept outside the freezer?

Q(8) Write the notes on the followings with suitable illustrations.
(a) Economic Order Quantity (EOQ)
(b) Re-order Level (ROL)
(c) Simulation
(d) Degeneracy in transportation

Mathematical formulae

Regression Analysis

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{n}\right]\left[\sum y^2 - \frac{(\sum y)^2}{n}\right]}}$$

$$b = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2} \qquad a = \frac{\sum y}{n} - b\frac{\sum x}{n}$$

$$SSE = \sum y^2 - a\sum y - b\sum xy$$

$$SST = \sum y^2 - \frac{(\sum y)^2}{n}$$

$$R^2 = \left|1 - \frac{SSE}{SST}\right|$$

$$S_{yx} = \sqrt{\frac{SSE}{n-2}}$$

$$SSX = \sum x^2 - \frac{(\sum x)^2}{n}$$

$$S_b = \frac{Syx}{\sqrt{ssx}}$$

Inventory control

$$EOQ = \sqrt{\frac{2DA}{C}}$$

$$EOQ = \sqrt{\frac{2DA}{C}\left(\frac{c+s}{s}\right)}$$ - with stock outs

$$\text{Maximum level of stock} = \frac{SXEOQ}{(C+S)}$$

Queuing Theory

$$P(n) = \theta^n(1-\theta)$$

Server idle time = H(1-θ)

$$L_s = \frac{\theta}{1-\theta}$$

$$L_Q = \frac{\theta^2}{1-\theta}$$

$$L_s = \lambda w_s$$

$$L_a = \lambda w_Q$$

$$1 + \theta + \theta^2 + \quad + \theta^n + \ldots. = \frac{1}{1-\theta}$$

$$1 + 2\theta + 3\theta^2 + \quad + \ldots\ldots = \frac{1}{(1-\theta)^2}$$