THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF MANAGEMENT STUDIES DEGREE PROGRAMME
LEVEL 6 - **2009/2010**
FINAL EXAMINATION : 2010
OPERATIONS RESEARCH – MCU 4202

Duration : Three (03) Hours

Date: 24th April 2010	Time: 9.30 am – 12.30 pm

This Question Paper consists of Six (06) pages and has Seven (07) questions.

Instructions :

- Answer **any five** questions.
  (*If more than five questions are answered only the first five questions attempted will be evaluated.*)
- All questions carry equal marks (20 marks each). Maximum marks : 100
- Use of a non-programmable calculator is allowed.
- Graph papers will be provided.

(1) (a) An oil company has two manufacturing units "A" and "B" which produce three different grades of oil namely super fine, medium and low grade. The company has to supply 12, 8, and 24 barrels of super fine, medium and low grade oils respectively per week. It costs the company Rs.10,000 and Rs. 8,000 per day to run units "A" and "B" respectively. On each day unit "A" produces 6, 2 and 4 barrels and unit "B" produces 2,2 and 12 barrels of superfine, medium and low grade oil respectively. The Manager has to decide how many days per week should each unit be operated in order to minimize cost.

(i) Formulate the above as a linear programming model.
(ii) Solve the problem using graphical method.

(b) The following table is the final incomplete simplex table of a maximization problem.

C_j / C_b	BASIC	SOLUTION	120	150		
			x_1	x_2	s_1	s_2
	x_1	60			$\frac{2}{3}$	$-\frac{1}{2}$
	x_2	30			$-\frac{1}{3}$	$\frac{1}{2}$
	z_j					
	$c_j - z_j$					

(i) Copy down the table and complete it filling the blank cells.
(ii) Write down the objective function of the problem.
(iii) Is the solution feasible? Give reasons.
(iv) Is the solution optimal? Give reasons.
(v) Has this problem got multiple optimal solutions? Give reasons.
(vi) Write down the optimal solution.
(vii) Write down the shadow prices of the resources s_1 and s_2 and explain its meaning.

(2) (a) Briefly discuss the limitations of the assignment theory.

(b) Four new machines M_1, M_2, M_3 and M_4 are to be installed in the machine shop of a newly built factory. Four locations L_1, L_2, L_3 and L_4 are reserved in the machine shop for the installation of the machines. The cost of installation of machines depends on the machine and the location where it is installed as shown in the table below.

Cost of Installation (Rs.000)

MACHINE	LOCATION			
	L_1	L_2	L_3	L_4
M_1	9	11	18	12
M_2	12	9	14	10
M_3	7	11	14	11
M_4	12	8	12	7

Use assignment theory to find how the machines should be installed so that the total cost of installation is a minimum.

(3) (a) Briefly explain what is meant by a balanced transportation problem.

(b) Sanjeewa company has three factories A, B and C that turns out gas cookers. The weekly capacities of the factories A,B and C are 5000, 6000 and 2500 respectively. These cookers are transported to four distribution centers P,Q,R and S whose weekly demands are 6000, 4000, 2000 and 1500. The cost of transporting one unit from a given factory to a given distribution center is explained in the table below.

Cost of Installation (Rs.000)

FACTORY	DISTRIBUTION CENTRE			
	P	Q	R	S
A	3	2	7	6
B	7	5	2	3
C	2	5	4	5

Sanjeewa company wishes to develop the transportation plan that would minimize total cost of transport.

(i) Find an initial feasible solution
(ii) Solve the transportation problem.

(4)

(a) A project consists of eight activities, A, B, C, …, and H. Their precedence and durations are stated in the table below.

ACTIVITY	PRECEDANCE	DURATION
A	PROJECT START	7
B	PROJECT START	5
C	PROJECT START	6
D	A	2
E	A	5
F	B, E	3
G	C	4
H	D, F, G	10

(i) Construct the network diagramme.
(ii) Find the float(s) of each activity.
(iii) Name the critical path:
(iv) Find EST, EFT, LST, LFT of activity "G".

(b) A project consists of six activities A, B,.., and F, whose precedence and pessimistic and optimistic durations are given in the table below.

ACTIVITY	PRECEDANCE	DURATION		
		PECIMISTIC	MOST LIKELY	OPTIMISTIC
A	P,S	2	5	8
B	P,S	3	4	5
C	A	5	7	9
D	A	4	4	4
E	B,D	7	9	11
F	C,E	6	7	8

You are required to;

(i) Calculate the mean and standard deviation of the duration of each activity.

(ii) Construct the network diagramme for the above project.

(iii) Calculate the float of each activity.

(iv) Name the critical path.

(5) (a) What are the advantages and disadvantages of simulation over mathematical model building?

(b) A mobile telephone company offers two policies for incoming calls as follows.

Policy (1) First 30 seconds free and there after Rs. 5/- for each period of 30 seconds.

Policy (2) First 60 seconds free and there after Rs. 12/- for each period of 30 seconds.

In both policies calls received from the same mobile company telephones are considered free. A person interested in only incoming calls wishes to decide on the more economical policy. He has gathered information on the duration of telephone calls he has received in the past as indicated in the table below.

DURATION OF TELEPHONE CALLS IN SECONDS

SERIAL NUMBER	DURATION	SERIAL NUMBER	DURATION	SERIAL NUMBER	DURATION
1	18	6	36	11	62
2	42	7	24	12	45
3	53	8	38	13	32
4	75	9	12	14	85
5	49	10	53	15	78

He has also observed that around 30% of the telephone calls received are from the same mobile telephone company. Carry out a hand simulation to decide on the policy that is more economical for this purpose. Simulate 15 incoming calls and provide the information requested in the table below.

Serial Number of simulated call	Decision on type of call		Decision on duration		Cost of call	
	Random Number Selected	Type of call	Random number selected	Duration of call	Policy (1)	Policy (2)

(c) Briefly describe how your simulation could be improved.

(6) A health center has one operating theatre that works three shifts covering a period of 24 hours a day. The three shifts are served by three surgeons, one surgeon for each shift. The mean time taken to perform one operation is 3 hours and has a negative exponential distribution. Patients arrive in a Poisson fashion at the rate of 7 per day. These patients are kept in a ward that is equipped with ten beds until they are called by the surgeon. The patients are put on a waiting list if ever the ward is full, the patients are served in the order they arrive.

(i) Evaluate the surgeon idle time per day.
(ii) On the average how many patients are there in the queuing system?
(iii) On the average how long must a patient wait until his treatment is complete?
(iv) What is the probability that the ward will be empty?
(v) On the average how long must a patient wait until he is taken for the operation?
(vi) What is the probability that a patient who just arrives will be put on the waiting list?
(vii) On the average how many patients will there be in the waiting list?

(7) Write Short notes on the following;

a) Simulation
b) Economic Order Quantity (EOQ)
c) Re-Order Level (ROL)
d) Buffer Stock
e) Critical path

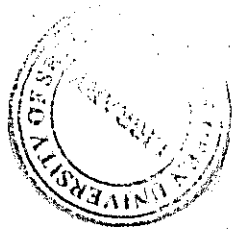

TABLE (12)

RANDOM NUMBERS

2017	4228	2317	5966	3861	0210	8610	5155	9252	4455
7449	0449	0304	1033	5370	1154	4863	9460	9449	5738
9470	4931	3867	2342	2965	4088	7871	3718	4864	0657
2215	7815	6984	3252	3254	1512	5402	0137	3837	1293
9329	1218	2730	3055	9187	5057	5851	4936	1253	9640
4504	7797	3614	9945	5295	6985	0383	5187	8556	2237
4491	9949	8939	9460	4849	0677	6472	5926	0851	3557
1623	9102	1996	4759	8965	2784	3092	6337	2624	2366
0450	6504	6565	8242	7051	5504	6147	8883	9934	8237
3270	1772	0361	6626	2471	2277	8833	1778	0892	7349
0364	5907	4295	8139	0641	2081	9234	5190	3908	2142
6249	0090	6786	9348	3183	1907	6768	4903	2747	5203
6100	9586	9836	1403	4888	5107	3340	0686	3376	6857
8903	9049	2874	2104	0996	6045	2203	5280	0179	3381
0172	3385	5240	6007	0671	8927	1429	5524	8579	3196
2756	4979	3434	3222	6053	9117	3326	4470	9314	9970
4905	7448	1055	3525	7478	2023	3566	6634	2635	9123
4974	3725	9726	3394	4223	0128	5958	9269	0366	7382
2026	2243	8808	1985	0812	4765	6563	5607	9785	5679
4887	7796	4339	7693	0879	2218	5455	9375	9726	9077
0872	8746	7573	0011	2707	0520	3085	2221	0467	1913
9597	9862	1727	3142	6471	4622	3275	1932	2099	9485
3799	5731	7040	4655	4612	2432	3674	6920	7210	9593
0579	5837	8533	7518	8871	2344	5428	0048	9623	6645
5585	8542	0079	9122	2901	4139	5140	3665	2611	7832
6728	9625	6836	2472	0385	4924	0569	6486	0819	9121
8586	9478	3259	5182	8643	7384	4560	8957	0687	0815
4010	6009	0588	7844	6313	3825	3711	1847	7562	5221
9455	8948	9080	7780	2689	8744	2374	6620	2019	2652
1163	7777	2320	3362	6219	2903	9415	5637	1409	4716
6400	2604	5455	3857	9462	6840	2604	2425	0361	0120
5094	1323	7841	6058	1060	8846	3021	4598	7096	3689
6698	3796	4413	4505	3459	7585	4897	2719	1785	4851
6691	4283	6077	9091	6090	7962	5766	7228	0870	9603
3358	1218	0207	1940	2129	3945	9042	5884	8543	9567
5249	4016	7240	7305	5090	0204	9824	0530	2725	2088
7498	9399	7830	7947	9692	4558	4037	8976	8441	7468
5026	5430	0188	6957	5445	6988	2321	0569	9344	0532
4946	6189	3379	9684	2834	1935	2873	3959	5634	9707
1965	1344	7839	7388	6203	3600	2596	8676	6790	2168
6417	4767	8759	8140	7261	1400	2828	5586	2338	1615
1843	9737	6897	5656	5795	0188	1189	4807	4260	1192
6558	6087	5109	9661	1553	6681	6688	4475	3701	2888
7990	3100	9114	8565	3175	4315	4593	6478	3453	8802
0723	0015	5905	1609	9442	2040	6376	6567	3411	9410
9008	1424	0151	9546	3032	3319	0014	1928	4051	9269
5382	6202	2182	3413	4103	1285	6530	0097	5630	1548
9817	2615	0450	7625	2033	5484	3931	2333	5964	9627
0891	1244	8240	3062	4550	6454	6517	8925	5944	9995
3721	4677	8487	6739	8554	9737	3341	1174	9050	2962

Variables

λ Rate of arrival of units

μ Rate of service completion

$\theta = \lambda / \mu$

H = Number of working hours per day.

$P_{(n)}$ = Probability of "n" units in the queuing system

L_s = Average number of units in queuing system

L_q = Average number of units in queue

W_s = Average time spent by unit in queuing system

W_q = Average time spent by unit in queue.

Formulae

$$P(n) = \theta P(n-1) \quad \text{——————} \quad (1)$$

$$P(n) = \theta^n P(0) \quad \text{——————} \quad (2)$$

$$P(n) = \theta^n (1-\theta) \quad \text{——————} \quad (3)$$

(Probability that queuing system empty) $= (1-\theta)$ —————— (4)

(Probability that the server is idle) $= (1-\theta)$ —————— (5)

(Number of hours server idle per day) $= H(1-\theta)$ —————— (6)

$$L_s = \theta / (1-\theta) \quad \text{——————} \quad (7)$$

$$L_q = \theta^2 / (1-\theta) \quad \text{——————} \quad (8)$$

$$L_s = \lambda W_s \quad \text{——————} \quad (9)$$

$$L_q = \lambda W_q \quad \text{——————} \quad (10)$$

FORMULA LIST

(i) Server IDLE TIMF = H(1-θ)

(ii) $L_s = \frac{\theta}{1-\theta}$

(iii) $L_s = \lambda W_s$ and $L_q = \lambda W_Q$

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

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