

**THE OPEN UNIVERSITY OF SRI LANKA**  
**BACHELOR OF MANAGEMENT STUDIES DEGREE PROGRAMME**  
**LEVEL 06**



**FINAL EXAMINATION 2007**  
**OPERATIONAL RESEARCH MCU 4202**

**DURATION: THREE (03) HOURS**

**DATE: 7.7.2007**

**TIME: 9.30 a.m. - 12.30 p.m.**

**ANSWER ANY FIVE QUESTIONS**

**RANDOM NUMBER TABLES ARE ANNEXED.**

**USE OF NON-PROGRAMMABLE CALCULATORS ARE ALLOWED.**

1. a) A tile manufacturer produces two types of tiles, roofing tiles and terracotta floor tiles. The demand for roofing tiles is infinite whereas the demand for floor tiles is limited to 10,000 units a month. The tiles make contributions of Rs. 8/= and 18/= respectively.

The process of manufacturing tiles requires clay (raw material), machining and finally the products through kiln.

Manufacturer faces limitations such as 20,000 kg of clay, 200hrs. of machine time and 150 hrs. at kiln in a month.

A batch of tiles (i.e. 10,000 roofing tiles or 2000 terra cotta floor tiles) require;

	Clay (Kgs.)	Machine Time (Hrs.)	Kiln time (Hrs.)
Roofing	2000	25	20
Floor tiles	1500	20	15

Owner wishes to maximize his profits.

You are required to develop this problem as a linear programming model.

- b) An incomplete optimal simplex table of a maximization linear programming problem is shown below,

$C_j$	BASIS	SOLUTION	5	4			
$C_b$			X	Y	S1	S2	S3
	y	70			1		-1
	S2	70			-3		-4
	X	50			0		1
	$Z_j$						
	$C_j - Z_j$						

- Copy the above table and complete the blank cages.
- Write down the objective function of the linear programming problem.
- Is the solution feasible? Give Reasons.
- Give reasons as to why it is stated as an optimal solution.
- Write down the solution(s) as per the above.
- Are there multiple optimal solution(s)? Give reasons.
- What resources are not utilized in full, at this stage? How many units?
- Identify the range of the coefficient of the objective function variables, "X" and "Y", that will not change the optimal result given in the table.

2. a) Lanka tiles Ltd use clay as their main resource .They have three production plants,  $P_1$ ,  $P_2$  and  $P_3$ , whose daily requirement of clay is 80, 150 and 170 metric tons respectively. Clay is supplied by three suppliers,  $S_1$ ,  $S_2$  and  $S_3$ , whose daily capacities are 125 , 200 and 75 metric tons respectively. This information along with the cost of transport between suppliers and plants are explained in the tables bellow.

TABLE (1)

	$P_1$	$P_2$	$P_3$	CAPACITY
$S_1$				125
$S_2$				200
$S_3$				75
DEMAND	80	150	170	

TABLE (2)

Cost of transport of one unit

	$P_1$	$P_2$	$P_3$
$S_1$	8	5	1
$S_2$	7	3	6
$S_3$	2	4	7

- Find an initial feasible solution to the problem using north – west corner rule or least cost method.
- Find the optimal transporting plan of clay that would minimize total transportation cost.

b) Four operators  $M_1, M_2, M_3$  and  $M_4$  are to be assigned to four machines  $J_1, J_2, J_3$  and  $J_4$ . The daily output would depend on the operator and to which machine he is assigned, as explained in the table bellow.

DAILY OUTPUT ('000 UNITS)

Operator	Machine			
	$J_1$	$J_2$	$J_3$	$J_4$
$M_1$	7	9	6	8
$M_2$	17	22	25	15
$M_3$	12	5	8	9
$M_4$	15	14	21	17

The objective is to maximize total output.

- i.) How should the four operators be assigned to the machines so as to maximize total output.
- ii.) How should the operators be assigned to machines so as to maximize total output if a condition is made that  $M_2$  is not given machine  $J_3$ .

3. "Mitsu" corporation is planning to launch a project consisting of six activities A, B, C, D, E and F whose precedences, durations and costs are explained in the table bellow

Activity	precedence	Duration (days)	Duration after crashing (days)	Cost of crashing Rs.(thousands) Per day
A	Project start	4	3	4
B	Project start	2	2	-
C	After "A"	9	7	6
D	After "A"	3	2	3
E	After "B" & "D"	2	2	-
F	After "C" & "E"	7	6	2

- i.) Construct the network diagramme.
- ii.) Time analyze and find the float of each activity
- iii.) Name the critical path.
- iv.) In respect of each activity calculate EST, EFT, LFT and LST.
- v.) What is the total project duration.
- vi.) The management hopes to reduce the project duration by three days by spending more money. Identify the activities to expedite so that cost of crashing the project is minimized?

- 4 a) Explain briefly the term "SIZE OF WAITING ROOM" in a queuing system.
- b) At a service station there is only one servicing plant that takes on the average 20 minutes to service one vehicle (this service time is negative exponential). Vehicles arrive in a Poisson fashion at the rate of two per hour. The service station works 10 hours a day.
- i.) What is the probability that there are five vehicles at the service station.
  - ii.) How long does the service station stay idle per day.
  - iii.) On the average how many vehicles are there at the service station.
  - iv.) On the average how long must a customer wait until his vehicle is serviced?
  - v.) The service station has three parking plots inside the station and when it is full, vehicles are parked on the high way (Main road). However the traffic police is unhappy about this arrangement and has requested that the probability of more than two vehicles parked on the high way be kept below 5%. How many additional parking plots should they have inside the station to accommodate the request made by the police?
5. a) When is simulation considered to be more appropriate over mathematical models?
- b) A garment factory that works five days in the week from Monday to Friday has a warehouse to store its raw materials. At this warehouse replacement is done every Monday at 8am where 100 units are added to the stock. Issues are carried out once a day, at 9 a.m. A sample of data on quantity issued each day is described in table (1) below. The management wishes to decide on the quantity replenished each time.
- i.) Carry out a hand simulation on issues and replacements for a period of four weeks. In carrying out the simulation complete the table (2) shown below.
  - ii.) Based on the results of the simulation what is your advice to the management?
  - iii.) Briefly explain how you could improve your simulation.

TABLE (1)

serial number	quantity issued	serial number	quantity issued
1	14	11	10
2	22	12	27
3	06	13	15
4	12	14	12
5	15	15	17
6	17	16	19
7	18	17	14
8	14	18	12
9	15	19	25
10	17	20	14

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TABLE (2)

Day	Time	Replenishment	Issues		Balance stock
			random number	quantity issued	

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6. Write short note on ,

- b) Economic order quantity (EOQ)
- c) Re-order level (ROL)
- d) Critical path
- e) Sensitivity analysis
- f) North-west corner rule

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Mathematical formula

- i. Server idle time =  $H(1-\Theta)$
- ii.  $P(N) = \Theta^n (1-\Theta)$
- iii.  $L_s = \Theta / (1-\Theta)$
- iv.  $L_s = \lambda W_s$

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**TABLE**  
**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	2142	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	2557
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	9856	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	2022	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	6342	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	7175	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