RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. General Degree
Fourth Year Semester II Examination – September/ October 2013

MAT 4304 – OPERATIONAL RESEARCH II

Answer all questions .

Time: 3 hours

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1. Kentwood Electronic manufactures three components for stereo systems: CD players, tape decks, and stereo tuners. The wholesale price and manufacturing cost of each item are given below:

Wholesale Manufacturing

Component	Price ($)	Cost ($)
CD player	150	75
Tape Deck	85	35
Stereo Tuner	70	30

Each CD player produced requires 3 hours of assembly; each tape deck requires 2 hours of assembly; and each tuner requires 1 hour of assembly. The marketing department has indicated that it can sell no more than 150,000 CD players, 100,000 tape decks, and 90,000 stereo tuners. However, the demand is expected to be at least 50,000 units of each item, and Kentwood wants to meet this demand. If Kentwood has 400,000 hours of assembly time available, how many CD players, tape decks, and stereo tuners should it produce in order to maximize profits while meeting the minimum demand figures?

(i)   Formulate a linear programming model for this problem.
(ii) Create an Excel spreadsheet model for this problem and solve it using Solver.
(iii) What is the optimal solution?
(iv) What total profit level is realized if 100 extra hours of labor are available?
(v)   Assume a marginal labor cost of $11 per hour in determining the unit profits of each of the three products. How much should the management pay to acquire 100 additional labor hours?
(vi) Interpret the reduced cost value for tuners. Why are more tuners not being produced?

2. Union Express has 60 tons of cargo that needs to be shipped from Boston to Dallas. The shipping capacity on each of those routes Union Express planes fly each night is shown in the following table:

Nightly Flight Segments	Capacity (in tons)
Boston to Baltimore	30
Boston to Pittsburgh	25
Boston to Cincinnati	35
Baltimore to Atlanta	10
Baltimore to Cincinnati	5
Pittsburgh to Atlanta	15
Pittsburgh to Chicago	20
Cincinnati to Chicago	15
Cincinnati to Memphis	5
Atlanta to Memphis	25
Atlanta to Dallas	10
Chicago to Memphis	20
Chicago to Dallas	15
Memphis to Dallas	30
Memphis to Chicago	15

Will Union Express be able to move all 60 tons from Boston to Dallas in one night?

(i)   Draw a network flow model for this problem.
(ii)   Create an Excel spreadsheet model for the problem and solve it using Solver.
(iii)   What is the maximum flow for this network?
(iv)

3. A manufacturer is considering alternatives for building new plants in order to be located closer to three of its primary customers with whom it intends to develop long-term, sole-supplier relationships. The net cost of manufacturing and transporting each unit of the product to its customers will vary depending on where the plant is built and the production capacity of the plant.

	Net Cost per Unit to Supply Customer		
Plant	X	Y	Z
1	35	30	45
2	45	40	50
3	70	65	50
4	20	45	25
5	65	45	45

The annual demand for products from customers X, Y, and Z is expected to be 40,000, 25,000 and 35,000 respectively. The annual production capacity and construction costs for each plant are:

Plant	Production Capacity	Construction Cost (in $000s)
1	40,000	$1,325
2	30,000	$1,100
3	50,000	$1,500
4	20,000	$1,200
5	40,000	$1,400

The company wants to determine which plant to build in order to satisfy customer demand at a

minimum total cost.

(i)   Formulate an integer linear programming model for this problem.

(ii)   Create an Excel spreadsheet model for this problem and solve it using Solver.

(iii)   What is the optimal solution?

4. A national accounting firm has identified the following set of activities that must occur to carry out

and audit for one of their major clients.

Activity	Days Required	Predecessor Activities
A	12	---
B	16	---
C	13	A
D	14	A
E	9	A
F	12	C
G	6	B,E
H	4	C,D,E
I	24	C,D,G
J	12	F,H
K	22	F,H
L	8	I,J

(i)   Draw a network for this problem and use Critical Path Method to find the minimum project time and critical activities.

(ii)   Formulate a linear programming model to identify the earliest start time for each activity.

(iii)   Formulate a linear programming model to identify the latest start time for each activity.

Create a spreadsheet to summarize the earliest and latest start and finish times, the slack for each activity, and the critical