RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES, MIHINTALE

B.Sc. (General Degree) in Applied Sciences
Third Year Semester II Examination – October/November 2014

Network Optimization – MAT 3302

Answer **five** questions only. Time allowed: **2 ½ hours**

01. a. A charity shop wishes to find one person per day to manage the shop from Monday to Friday among five people, Mr. Amal, Mr. Bandara, Ms. Kamani, Mr. Lalith ad Mrs. Sumalli. Each of them had to fill a form and thefollowing information is obtained from it.

Mr. Amal is available on Thursday and Friday
Mr. Bandara is available on Tuesday and Wednesday
Ms. Kamani is available on Tuesday and Thursday
Mr. Lalith is available on Monday, Tuesday and Wednesday
Mrs. Sumalli is available on Tuesday and Friday

Graphically model the information given above. *25*

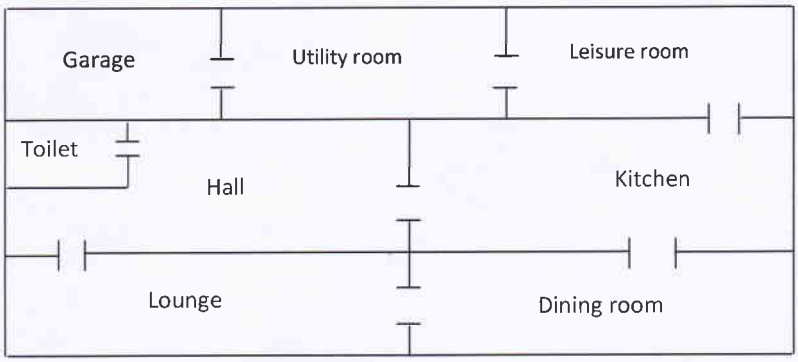
b. A cable TV company laying cable to a new neighborhood. It is constrained to bury the cable only along certain paths, and the possible paths with the relative distances are given in the table below. The company needs to find the paths that connect every house with the lowest total cost. The charge for the cables is directly proportional to the distance involved.

	A	B	C	D	E	F	G
A	-	3	2	5	-	-	-
B	3	-	-	2	-	13	-
C	2	-	-	2	5	-	-
D	5	2	2	-	4	6	3
E	-	-	5	4	-	-	6
F	-	13	-	6	-	-	2
G	-	-	-	3	6	2	-
H	-	-	-	-	-	3	6

I. Describe the type of the above network problem. *15*
II. Using a necessary algorithm find the minimum length of the cables needed. *25*
III. Draw the paths that connect every house with the lowest total cost. *15*

c. Compare the efficiency of Prim's and Kruskal's algorithm *20*

02. a. The ground-floor plan of a house is shown in the following diagram



Using appropriate symbolic notations and conditions generate the graph to represent the above floor diagram. **20**

b. Consider the shortest path problem with eight vertices. The arc and the costs are given in the following table

Arc	*Cost*	*Arc*	*Cost*	*Arc*	*Cost*	*Arc*	*Cost*
1 – 2	1	2 – 7	1	5 – 4	1	6 –7	3
1 – 3	4	7 – 2	1	4 – 8	4	7 – 6	3
1 – 4	6	3 – 4	3	5 – 6	1	6 – 8	4
2 – 3	3	3 – 5	5	6 – 5	1	7 – 8	7
2 – 6	5	4 – 5	1	5 – 8	2		

Write down the network explained by above table and find the shortest path from every node to the terminal node using Dijkstra's algorithm **30**

c. Using the following output of the Dijkstra's algorithm , find the path way which gives the minimum distance as ***14*** between node ***A*** and ***G***

Iteration	***A***	***B***	***C***	***D***	***E***	***F***	***G***
1	*0*	*4*	*6*	*8*	*M*	*M*	*M*
2	*0*	*4*	*5*	*8*	*11*	*M*	*M*
3	*0*	*4*	*5*	*7*	*8*	*9*	*M*
4	*0*	*4*	*5*	*7*	*8*	*9*	*14*
5	*0*	*4*	*5*	*7*	*8*	*9*	*14*
6	*0*	*4*	*5*	*7*	*8*	*9*	*14*
7	*0*	*4*	*5*	*7*	*8*	*9*	*14*

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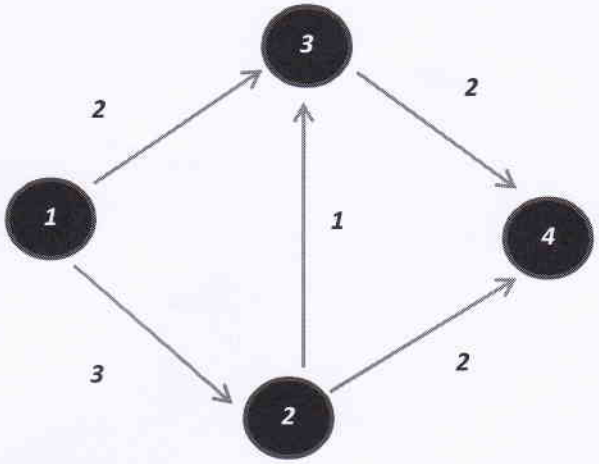
d. Discuss the limitations of the Dijkstra's algorithm using a counter example. **30**

03. a. Discuss the difference between label setting and label correcting algorithm 10

b. Explain the way that the augmenting path algorithm works in a maximum flow problem 15

Hence find the maximum flow that can flow from the network (***1 to 4***) explained below



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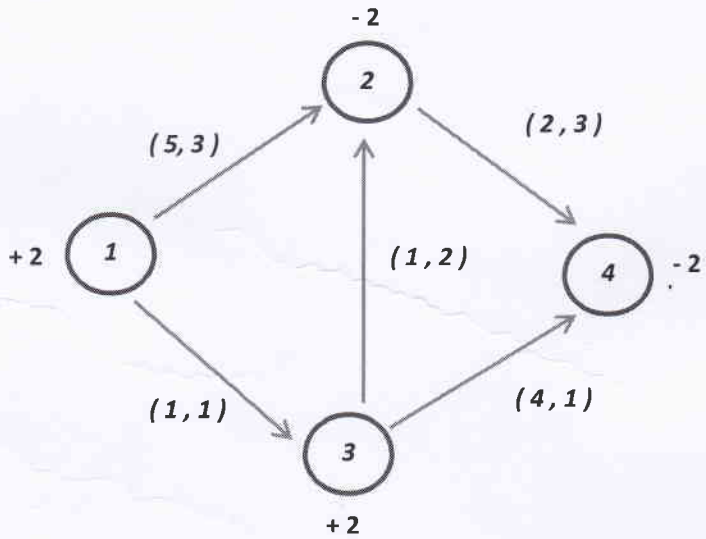
c. Using an appropriate theorem verify the answer obtained by part ***b***. 25

04. a. Explain what kind of techniques used in thesuccessive shortest path algorithm to solve minimum cost flow problem. ***10***

b. What is the specialty of multi commodity flow problem in network flow problems? ***10***

c. Using successive shortest path algorithm obtained the minimum cost flow for the given network



$c_{i,j}$, $u_{i,j}$

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05. a. I. Consider a transportation problem of three factories and three warehouses. The supplies of a product from the factories are respectively *10, 5* and *7*. The demands of the product for the three warehouses are respectively *8, 8* and *6*. The unit shipping cost from factory x to warehouse y is denoted by $c(x, y)$.
Hence we have a unit cost matrix $\{c(x, y)\}$:

$$\begin{bmatrix} 5 & 4 & 10 \\ 4 & M & 5 \\ M & 6 & 6 \end{bmatrix}$$

Generate a network to explain this situation. *15*

II. Write down flow balance rule used in network flow problems. *10*

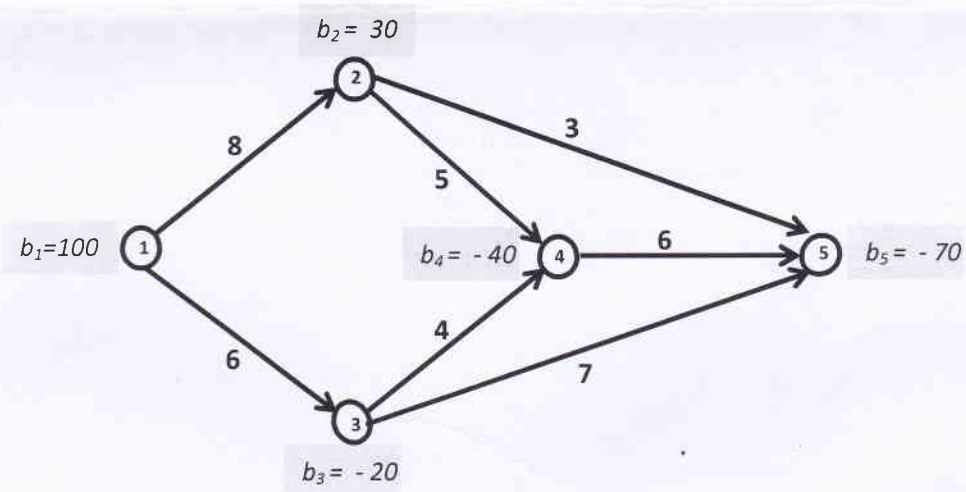
III. Write down linear programming model to minimize the shipping cost *15*

b. I. Considering upper and lower bound conditions write down the general formula for above Linear Programing model *10*

II. Transform the lower bound of above model into zero *15*

III. Eliminate the upper boundary from the model obtained in b(II). *35*

06. The data for a minimum cost flow problem is shown in the figure given below,



Hint: You can start with the feasible solution $x_{13} = 100, x_{25} = 30, x_{34} = 40$ *and* $x_{35} = 40$ *with cost = 1130.*

a. Find the minimum cost flow and the associated cost. *40*

b. If the maximum flow allowable in any arc is 60, find the optional solution. *60*

07. a. What is meant by CPM method? Describe its importance to decision making.

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b. JMC is a company specializing in door opening solutions. One part of the company focuses on manufacturing pin tumbler and lever locks for multiple brands including Union, Yale and Multi-Lock. The line used to produce padlocks is a perfect example of a network system. Following figure summarizes the production information of padlocks along with the precedence relationships among the activities.

Activity	Description	Time required (in hours)	Immediate Predecessor Activity
A	Receive raw materials	0.5	-
B	Bolt cutting	1.0	A
C	Transfer machine (series of drilling and cutting operations)	1.5	B
D	Transfer machine(barrels)	1.4	B
E	Barrel pinning	1.2	D
F	Shackle groove cutting	0.8	B
G	Shackle Bending	1.0	F
H	Insert shackle into body	0.4	C,E,G
I	Insert barrel into body and test key set	1.4	H
J	Packaging of padlock	0.5	I

I. Draw the activity on arc (AOA) network.
II. Using the forward pass calculate the earliest start time for each activity.
III. Using the backward pass determine the latest times at which the project activities can start and finish without delaying the project.

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