LIT
DEPARTMENT OF
INFORMATION TECHNOLOGY

Semester: Semester 1 (Winter 2015/16)

Date/Time: Monday 14th December 2015, 2 PM – 4PM

Programme: Bachelor of Science (Honours) in Computing (Games Design and Development)
Bachelor of Science (Honours) in Computing (Software Development)
Bachelor of Science in Computing

Stage: Year 3

Module: ALGORITHMS

COMP 07002

Time Allowed: 2 hours

Instructions: Attempt any four (4) questions

Additional Attachments: None

External Examiners: Derek O'Reilly
Internal Examiners: Janice O'Connell, Eugene Kenny

Question No. 1 **(25 Marks)**

(a) Draw the graph represented by the following adjacency matrix. *(5 marks)*

	A	B	C	D	E	F	G	H
A	0	0	2	3	4	0	0	0
B	0	0	3	0	0	6	2	0
C	2	3	0	5	0	4	0	1
D	3	0	5	0	0	0	0	0
E	4	0	0	0	0	0	4	2
F	0	6	4	0	0	0	2	0
G	0	2	0	0	4	2	0	0
H	0	0	1	0	2	0	0	0

(b) Outline *Kruskal's* algorithm and show how it can be used to construct a minimum spanning tree using the graph from part (a) above. *(10 marks)*

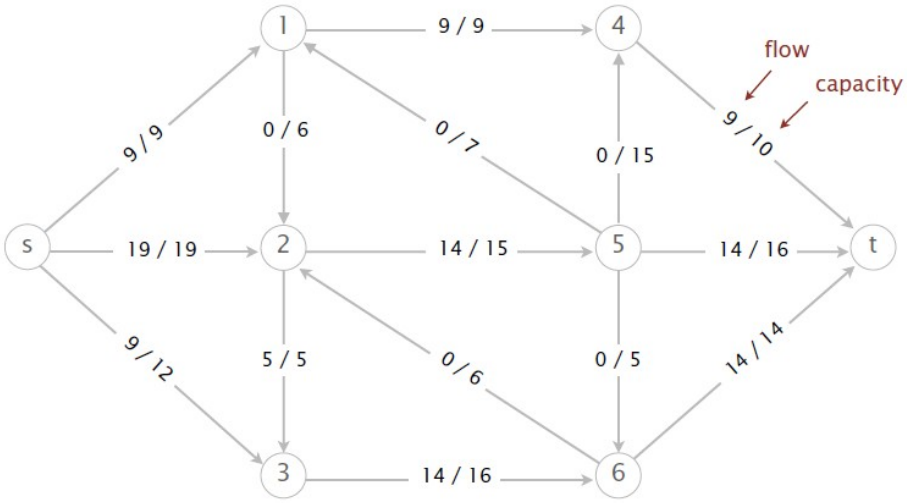
(c) Outline *Dijkstra's* algorithm and show how it can be used to calculate the shortest path from a given source vertex to all other reachable nodes in a graph using the graph from part (a) above and vertex *A* as the source vertex. *(10 marks)*

Question No. 2 **(25 Marks)**

(a) Outline the *Ford-Fulkerson* algorithm for computing the maximum flow in a flow network. *(10 marks)*

Does the algorithm always terminate? If so, after how many iterations?

(b) Consider the following *st-flow* network and feasible flow *f*. *(15 marks)*



(i) What is the value of the flow *f*?

(ii) Perform one iteration of the *Ford-Fulkerson* algorithm, starting from the flow *f*. Give the sequence of vertices on the augmenting path.

(iii) What is the value of the maximum flow?

(iv) List the vertices on the *s* side of the minimum cut.

(v) What is the capacity of the minimum cut?

Question No. 3 **(25 Marks)**

(a) Suppose that you run the *Boyer-Moore* algorithm to search for the pattern *(10 marks)*

M Y F A T H E

in the text

Y B R O T H E R T H A T F A T H E R W A S M Y F A T H E R T

Trace the running of the algorithm, highlighting the characters in the pattern that get compared with characters in the text.

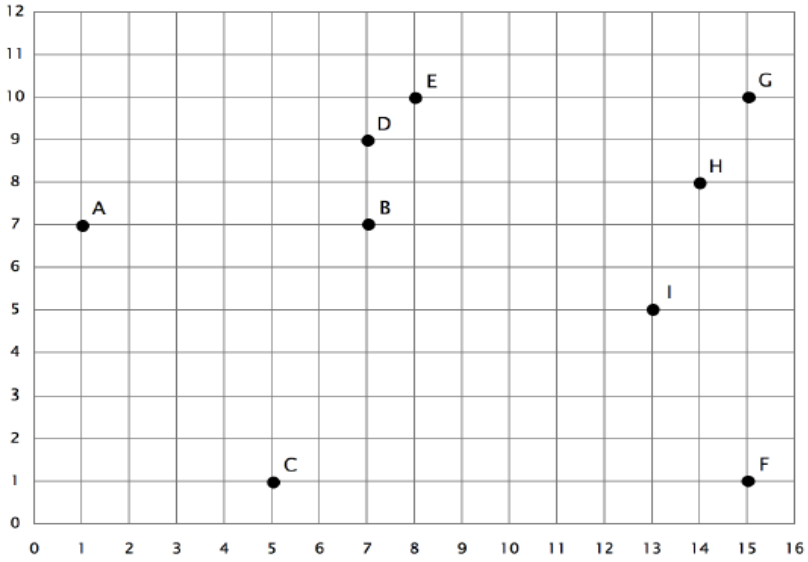
(b) Draw the NFA corresponding to the regular expression `((MOBY)|DI*K).` *(10 marks)* Clearly distinguish between your epsilon and match transitions.

(c) If *M* is the length of the pattern string to be matched and *N* is the length of the text string, what is the running time for the Brute-force substring matching algorithm for typical inputs (in English texts say) and in the worst case. Justify your answer in each case. *(5 marks)*

Question No. 4 **(25 Marks)**

(a) Outline the *Graham Scan* algorithm to compute the convex hull of a set of points in the plane. *(15 marks)*

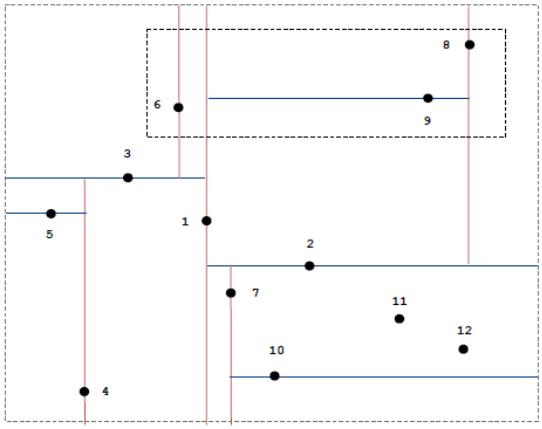
Demonstrate the workings of the algorithm on the 9 points below, using F as the base point, and continuing counterclockwise starting at G.

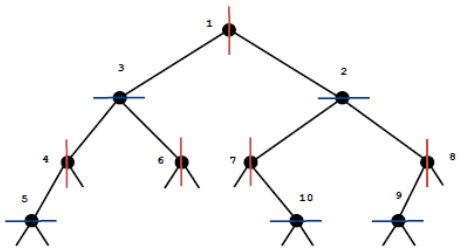


(i) List the points in the order that they are considered for insertion into the convex hull.

(ii) Give the points that appear on the trial hull (after each of the 8 remaining points are considered) in the order that they appear.

(b) The figures below illustrate the results of inserting points 1 through 10 into a 2d-tree. *(10 marks)*





(i) List all of the the points in the 2d-tree that are examined (not necessarily just those inside the query rectangle) during the range search for the query rectangle specified above.

(ii) Draw the result of inserting point 11, then point 12 in the two figures above.

Question No. 5 **(25 Marks)**

(a) A school is preparing a trip for 400 students. The company who is providing the transportation has 10 buses of 50 seats each and 8 buses of 40 seats, but only has 9 drivers available. The rental cost for a large bus is €800 and €600 for the small bus. *(15 marks)*

(i) Give a *linear programming* formulation of the problem above
(ii) Calculate how many buses of each type should be used for the trip for the least possible cost.

(b) What does in mean for a problem to be *intractable*? What approaches can taken when faced with an intractable problem. *(10 marks)*