

## ICS 163 – Spring 2012 – Final Exam

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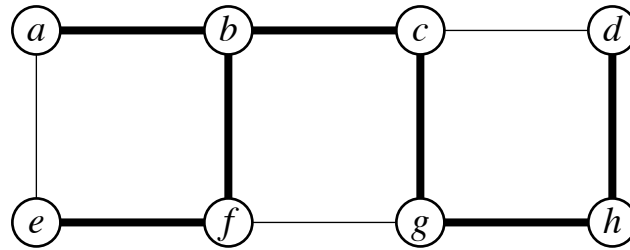
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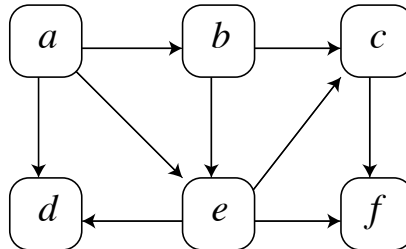
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Total:

1. (10 points) In the undirected graph below, the heavy edges form a depth first search tree. Based on this information, which vertex must have been the starting vertex of the depth first search?

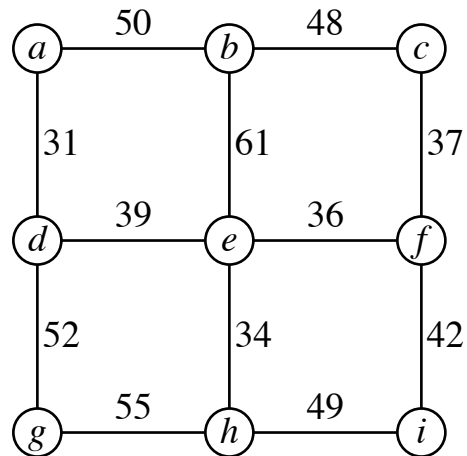


2. (15 points) Draw the transitive reduction of the directed acyclic graph  $G$  shown below.

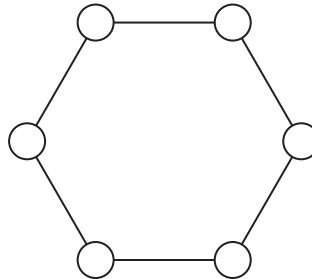


3. (15 points) Use pseudocode to describe the Bellman–Ford algorithm. You may assume the existence of a procedure  $\text{relax}(e)$  to relax a given edge  $e$  in the input graph; you do not need to describe the relax procedure.

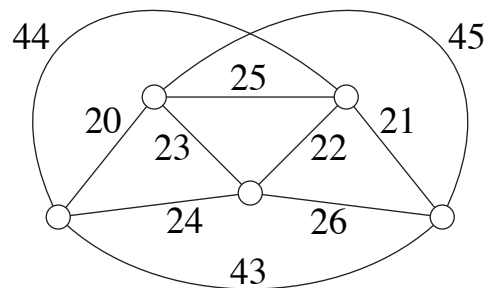
4. (15 points) What is the width of the widest path from  $a$  to  $i$  in the graph below? (Hint: use the maximum spanning tree.)



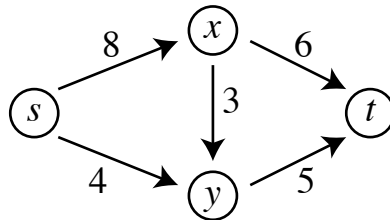
5. (10 points) For the graph shown below, draw or describe a matching that is maximal but not maximum.



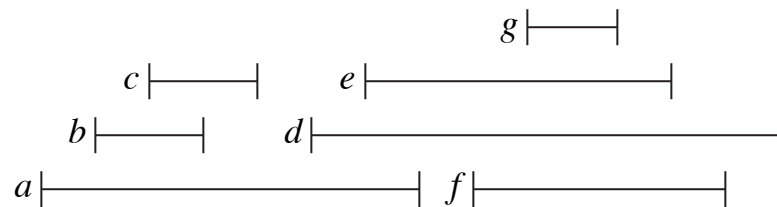
6. (15 points) For the graph shown below, (a) list the sequence of edge weights in the approximate TSP solution found by Christofides' heuristic, and (b) list the sequence of edge weights in a tour that is shorter than the one in your answer for part (a).



7. (15 points) In the graph drawn below, the numbers indicate the capacities of the edges. Suppose that we have a flow in this graph consisting of three units of flow along the path  $s-x-y-t$ . Draw the residual graph for this flow.



8. (15 points) List all of the maximal cliques in the interval graph defined by the set of intervals drawn below.



9. (10 points) Suppose that a planar graph  $G$  has ten vertices and sixteen edges. How many faces must a planar embedding of  $G$  have?

You may use this page (or the back of the other pages) as scratch paper.