Final Exam

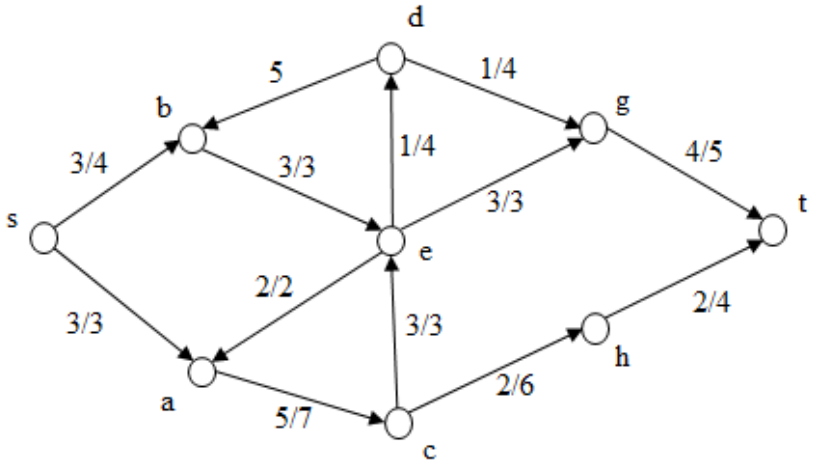
Started: Apr 28 at 5:23pm

Quiz Instructions

Question 1

5 pts

Consider the flow network below, with the flow and capacity values indicated in the graph. Take the cut(S,T), where S = {s,a,b,d} and T ={c,e,h,g,t}. What is the value of f(S,T)?



- 12
- 6
- 14
- 9
- 8
- 5
- 20

Question 2

10 pts

Select all the statements below which are TRUE:

- [x] Integer Linear Programming is NP-hard.
- [x]

In the Dynamic Programming - Memoization Technique, each subproblem is solved only once and the value is stored in a table. All future calls use the precomputed value.

- [ ] Let X= ALGORITHM and Y = LEGOTHM. Then {(1,2),(2,1),(3,3),(4,4),(7,5),(8,6),(9,7)} is a possible alignment.
- [x] Let G be a flow network. Consider two cuts (S_1,T_1) and (S_2,T_2). Then $f(S_1,T_1) \leq c(S_2,T_2)$.
- [ ] 0-1 Knapsack Problem is solved optimally using Greedy.
- [x] Traveling Salesman Problem (TSP) is solved using Brute-Force in RT = $\theta\left(2^n\right)$, where n is the number of cities.

Question 3

5 pts

We are solving the Fractional Knapsack Problem using the Greedy algorithm discussed in class. The number of objects is n = 5.

object	value v_i	weight w_i
1	12	8
2	15	11
3	9	3
4	20	15
5	12	6

The knapsack weight is W = 35. Which object is selected first?

- ( ) object 2
- ( ) object 4
- (•) object 3
- ( ) object 1
- ( ) object 5

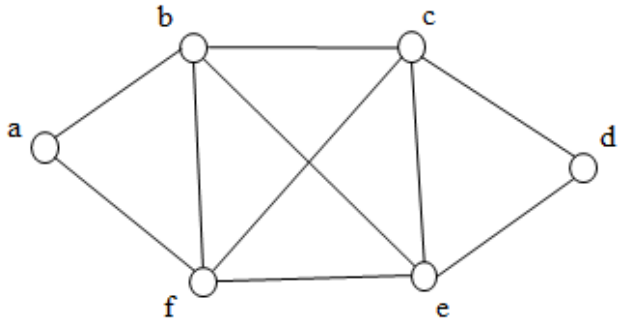
Question 4

10 pts

Select all the statements below which are TRUE:

- [x]

Consider the graph G below. {a,b,c,e,f} is a clique of size 5.



- [x] A cycle with 6 vertices is 2-colorable.
- [ ] The boolean formula Φ below is 3-CNF.

$$\Phi\left(x_1, x_2, x_3\right) = \left(x_1 \vee \overline{x_3} \vee x_2\right) \wedge \left(x_2 \vee \overline{x_1}\right)$$

- [x] The following is a decision problem: Given an undirected graph G and two vertices u and v, find the shortest path from u to v.
- [x] Consider a maximization problem. Let C be the solution returned by a ρ-approximation algorithm and let C* be the optimal solution. Then $\frac{C^*}{\rho} \leq C \leq C^*$.
- [ ] The Closest Pair problem is "tractable".

Question 5

10 pts

What is an optimal alignment for the sequences X = CATGA and Y = AACT ?

Take δ = 2 and consider the following matching/mismatching costs:

	A	C	G	T
A	0	3	3	2
C		0	4	4
G			0	1
T				0

- (7 points) Fill out the table A.
- (1 point) What is the cost of an optimal alignment?
- (2 points) Write the optimal alignment of X and Y.

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Question 6

10 pts

Consider the reduction algorithm discussed in class for showing that the CLIQUE problem is NP-hard. Show how this reduction algorithm works for the 3-CNF:

$$\Phi(x_1, x_2, x_3) = (x_1 \vee x_2 \vee \overline{x_3}) \wedge (\overline{x_1} \vee \overline{x_2} \vee x_3) \wedge (x_1 \vee x_2 \vee x_3) \wedge (\overline{x_1} \vee \overline{x_2} \vee \overline{x_3})$$

a) (6 points) Draw the graph obtained as result of applying the reduction algorithm.

b) (2 points) Find a satisfying assignment for Φ.

c) (2 points) Based on the satisfying assignment from b) and following the algorithm, compute a clique of the graph.

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