Northeastern University
College of Engineering
Department of Electrical & Computer Engineering

EECE7205: Fundamentals of Computer Engineering

Spring 2022 – Second Midterm Exam Review Questions

For questions **Q1** to **Q8** choose the **best** answer. Make a circle around your letter choice.

Q1. Suppose that we have numbers between 1 and 1000 in a binary search tree, and we want to search for the number 363. Which of the following sequences could **not** be the sequence of nodes examined?

a. 2, 252, 401, 398, 330, 344, 397, 363.
b. 924, 220, 911, 244, 898, 258, 362, 363.
c. 925, 202, 911, 240, 912, 245, 363.
d. 2, 399, 387, 219, 266, 382, 381, 278, 363.
e. 935, 278, 347, 621, 299, 392, 358, 363.

Q2. What is the maximum number of keys that can be stored in a B-tree of height 2 and minimum degree 3?

a. 24 b. 35 c. 124 d. 215

Q3. For a B-tree with a minimum degree 3, what is its possible maximum height to store 17 keys?

a. 2 b. 3 c. 4 d. 5

Q4. If x, y, and z are three distinctive vertices in an undirected graph, then the following path(s) cannot form a cycle in that graph:

a. (x, z, y) b. (x, x) c. (x, y, x) d. All of the previous.

Q5. Let *C* be the minimum cut in a flow network *G*. If we increase the capacity of every edge in *C* by amount *x*, what will happen to the G's maximum flow?

a. G's maximum flow will increase by *x*.
b. G's maximum flow will increase by the product of *x* times the number of edges in *C*.
c. G's maximum flow might remain the same.
d. None of the above.

Q6. For dynamic programming to be applied on a problem, the problem must have _____ sub-problems where their _____ solutions contribute to the solution of the problem.

a. dynamic , recursive b. small , fast
c. many , greedy d. overlapping , optimal.

Q7. Dynamic programming is appropriate to solve the _____ version of the knapsack problem to maximize the value of items packed in a luggage. However, the _____ version can be solved using a greedy algorithm.

a. 0/1 , fractional
b. fractional , 0/1
c. optimal substructure , non-optimal substructure
d. non-optimal substructure , optimal substructure.

Q8. Assume applying the Huffman encoding on a document that contains a text from the three characters {x, y, z}. If the frequency of each of these characters in the document is:
x = 50%, y = 30%, z = 20%.

The following is a possible Huffman encoding of these characters:.

a. `x = 01, y = 0,  z = 1`
b. `x = 1,  y = 01, z = 00`
c. `x = 0,  y = 01, z = 00`
d. `x = 10, y = 11, z = 0`

End of multiple-choice questions

Q9. Answer the following questions about the Binary Search trees:

a) Without drawing any trees, what are the minimum and maximum heights of binary trees with 63 nodes.

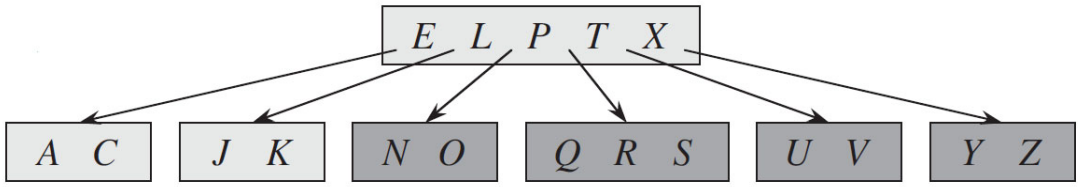
b) Starting from an empty binary search tree (BST), draw the tree after inserting the following values in the order given (from left to right).

`M, H, D, A, G, K, L, T, R, W, V, U`

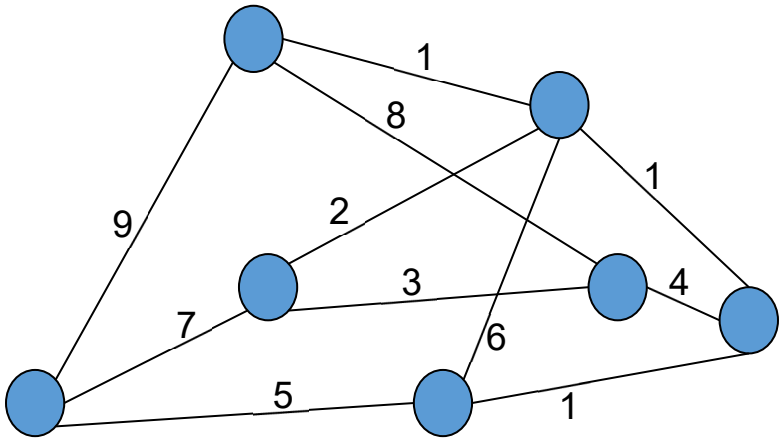
c) On the same BST you created in part (b), add the following values B then C

d) Redraw the BST you have from part (c) after removing the following values:
G → K → M (in this order)

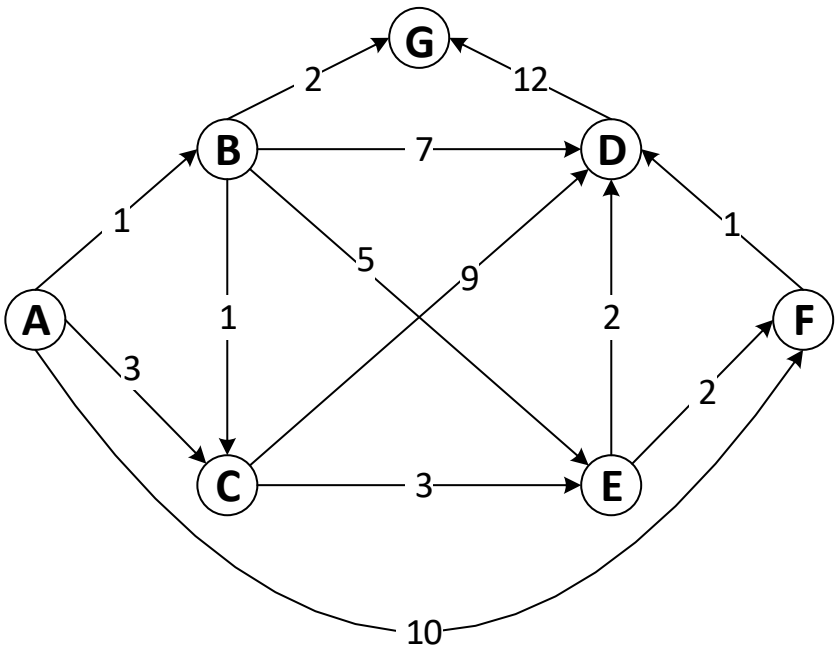
Q10. Show the results of deleting C, P, and V , in order, from the following B-Tree that has a minimum degree *t* = 3:



Q11. Find the MST of the following graph where the number on each edge represents the edge's weight. Show the steps of the algorithm you will apply.



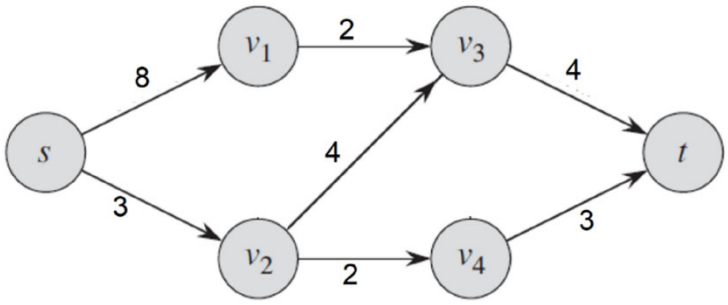
Q12. Apply Dijkstra's algorithm on the following directed-weighted graph to find the single-source shortest paths from *A*. Fill the shown table with the final cost of these shortest paths to each vertex.



Vertex	Cost
A	
B	
C	
D	
E	
F	
G	

Q13. Construct the string-matching automaton for the pattern *P* = aabab over the alphabet $\sum$ = {a, b}.

Q14. Apply the Ford-Fulkerson algorithm to find the max flow s to t in the following flow network.



Q15. Given a complete weighted undirected graph G, describe a naïve algorithm that can solve the Traveling-Salesperson problem (i.e., finding the minimum cost Hamilton cycle of G).
What is the efficiency of your algorithm?
Is it possible that the length of that optimal traveling-salesperson tour to be less than the total weight of the MST of G? explain why.

Q16. Assume we need to sort an array of n elements using one of the following versions of Quick Sort algorithm implementations:

Ver. 1: The implementation of the original algorithm we studied in class where the pivot is always the last element in the array.
Ver. 2: The implementation of the randomized version of the original algorithm by adding a procedure to select as a pivot a randomly chosen element from the array.
Ver. 3: The implementation of an enhanced version of the original algorithm by adding a procedure to select as a pivot the element with the median value among the first, middle, and last elements in the array.

Answer the following questions:

a) Which one of the above versions has the highest chance of avoiding the worst-case running time of $O(n^2)$?
b) What is the worst-case running time of the added procedures in **Ver .2** and **Ver. 3**?

End of the review questions
