

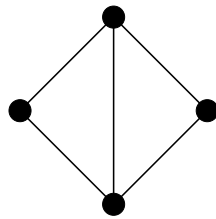
Sample Test 2.

This list of sample test questions is subject to updates until we review for the test.

Last update: Wednesday, October 27, 2021

The real test will have less questions and you will have about 55 minutes to answer them. The usage of books or notes, or communicating with other students will not be allowed. You will have to give the simplest possible answer and show all your work. Besides looking at the sample questions below, also review all homework exercises, as questions similar to them might occur on the test.

1. Prove that the number $\chi(G, n)$ of valid n -colorings of a multigraph satisfies the formula $\chi(G, n) = \chi(G - e, n) - \chi(G/e, n)$. Explain the meaning of this formula when there are several edges connecting the endpoints of the edge e .
2. Define the chromatic polynomial of a graph and prove that it is a polynomial.
3. Using the formula stated in question 1 at least once, find the chromatic polynomial of the graph shown below.



4. State the three equivalent definitions of a tree.
5. Explain why each tree must have at least one leaf. (Also define leafs.)
6. State the number of edges in a tree on n vertices and prove your formula using induction and the statement in the previous question.
7. Explain how and why the formula on the number of edges in a tree follows from Euler's formula.
8. Draw the tree whose Prüfer code is 311. *Show all your work!*
9. Find the Prüfer code of the tree shown in Fig. 1 below. *Show all your work!*
10. Use bubble sort to put the following list of numbers into increasing order: 4, 1, 3, 2. List all steps.
11. What is the number of comparisons in the bubble sort algorithm, if it is used to sort a list of n -entries? Justify your formula.
12. Use merge sort to put the following list of numbers into increasing order: 4, 1, 5, 3, 2. Indicate all steps in your illustration.

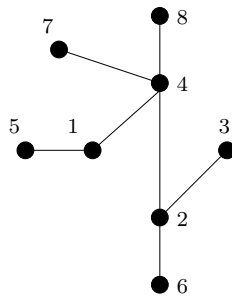
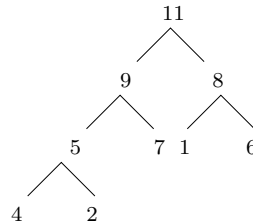


Figure 1: Labeled tree to exercise finding the Prüfer code

13. What is the maximum number of comparisons used to sort a list of n items using merge sort? Prove your formula.
14. Define what is a “heap” used in the heap sort algorithm.
15. Use heap sort to sort the entries at the nodes of the heap below. Show all phases.



16. Find a breadth-first search and a depth-first search spanning tree in the edge graph of the cube.
17. Explain how depth-first search may be used to find your way out of a maze.
18. (Bonus only!) Explain how search trees may be used to solve the missionaries and cannibals puzzle, and present a solution to this puzzle.
19. Explain why Dijkstra’s algorithm finds the shortest path. Illustrate the algorithm by finding the shortest path between s and t in Figure 2.
20. Prove that Kruskal’s algorithm finds a minimum weight spanning tree.
21. Using Kruskal’s algorithm find a minimum weight spanning tree for the graph shown in Figure 3. List the edges of the tree in the order you included them during the algorithm.

Good luck.

Gábor Heteyi

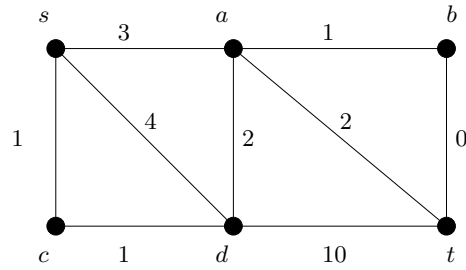


Figure 2: Graph to exercise Dijkstra's algorithm

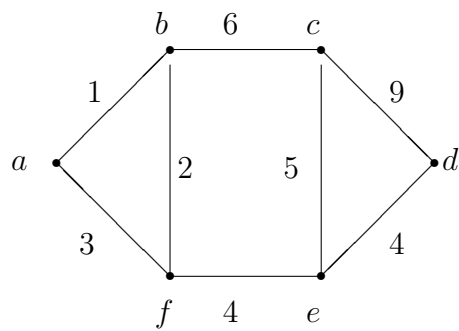


Figure 3: Graph to exercise Kruskal's algorithm