



NATIONAL SCHOOL OF BUSINESS MANAGEMENT

BSc (Honours) in Software Engineering (NSBM)– 19.2/20.1

BSc (Honours) in Computer Science (NSBM)– 19.2/20.1

2nd Year 2nd Semester Examination

25/08/2021

CS203.3 – Algorithms & Complexity

Instructions to Candidates

- 1) **Answer the first question and seven (07) other questions.**
- 2) Time allocated for the examination is five (05) hours (Including downloading and uploading time)
(Note: No email submissions are accepted under any condition)
- 3) Weightage of Examination: 60% out of final grade
- 4) Provide answers to the selected questions in the given format under the question
- 5) Please upload the document with answers (Answer Script) to the submission link before the submission link expires
- 6) Answer script should be uploaded in PDF Format
- 7) Under any circumstances E-mail submissions would not be taken into consideration for marking. Incomplete attempt would be counted as a MISSED ATTEMPT
- 8) The Naming convention of the answer script – Module Code_Subject name_Index No
- 9) You must adhere to the online examination guidelines when submitting the answer script to N-Learn
- 10) Your answers will be subjected to Turnitin similarity check, hence, direct copying and pasting from internet sources, friend's answers etc. will be penalized
- 11) All answers **must be typed** except for those with equations in which hand-drawn or hand-written answers are accepted.

1. [Mandatory] An algorithm is a method for solving a class of problems on a computer, but one can relate to solve day-to-day life problems with them. When conducting formal exams at NSBM, students are provided with seat numbers by the examination unit. Students finish their three-hour papers at different times. Exam invigilators collect the papers and stack them in the order of collection. At the end of the exam the invigilators should sort the papers by the seat numbers. Based on your knowledge about the algorithms and their complexities answer the following questions.

- I. Suggest a sorting mechanism that could be used in this occasion. Your answer should include analysis, comparisons of three possible sorting algorithms, complexities, and a conclusion. (20 Marks)
- II. The invigilators should file a complaint in case an exam offence is reported. Suggest the best possible algorithm to find an exam offenders paper as quickly as possible based on the suggested algorithms' complexities. (10 Marks)

2. Time complexity is the computational complexity that measures or estimates the time taken for running an algorithm.

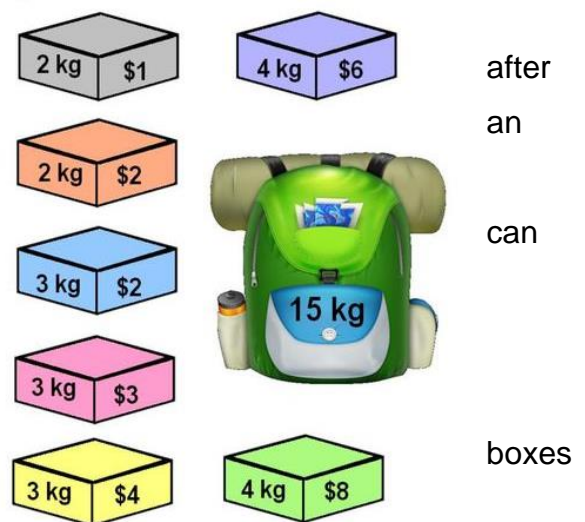
- I. Express the Big O notations of constant, log-logarithmic, linear, quadratic, cubic [e.g. $O(n^3)$], exponential, factorial and plot them on a single graph. (2 Marks)
- II. Simplify (show steps) the analysis of following running times. (2 Marks)
 - i. $n \cdot \log n - 3^{98}n + 10^{30}$
 - ii. $8,8768^n - 10^{\text{Googol}} n! - n^n$
- III. Derive the complexities of the following algorithms mathematically. You must also include assumptions and explanations. (6 Marks)
 - A. Binary Search
 - B. Jump Search
 - C. Merge Sort
 - D. Monkey Puzzle Problem

3. Suppose, one of your FB friends came to meet you suggesting financial deal. He would give you \$ 10,000 each day for a month and in return you would have to pay a dollar for the first day, two dollars for the second day, four dollars for the third day, basically double the amount you paid previous day for a whole month.

- I. Will you accept this offer? Explain the reasons behind your decision. You must do calculations and prove your choice is the best. (4 Marks)
- II. Explain when (after n days) you would start winning or losing? (2 Marks)
- III. Approximate the total amount you may receive and lose if you accepted the offer. (2 Marks)
- IV. How do you *pronounce* the total amounts you and your friend receive using the following dictionary (e.g.: seven decitillion)? (2 Marks)
[Trillion (10^{12}), Quadrillion (10^{15}), Quintillion (10^{18}), Sextillion (10^{21}), Septillion (10^{24}), Octillion (10^{27}), Nonillion (10^{30})]

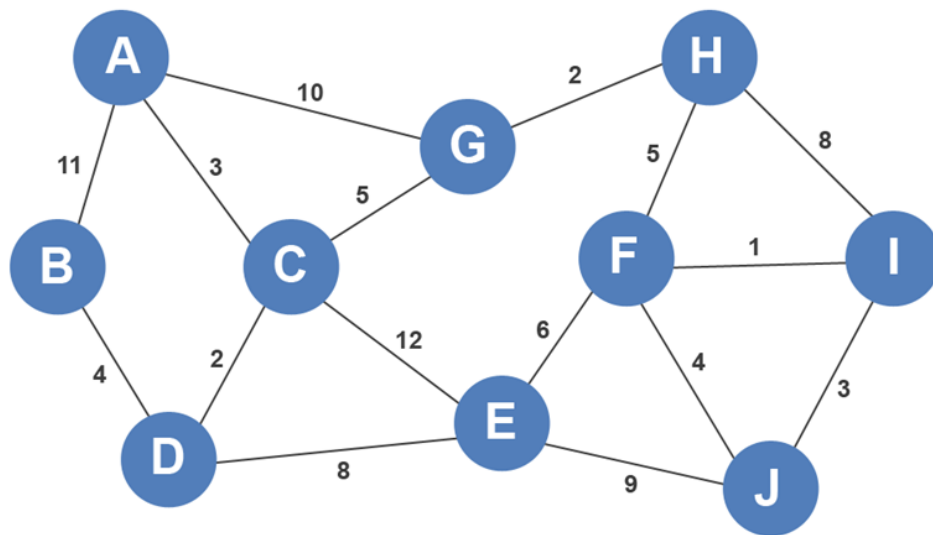
4. Algorithm strategy is defined as an approach to solving a problem.

- I. Name *four* of such different algorithm strategies along with one example for each related to your life. (4 Marks)
- II. Suppose you are planning to go abroad receiving a scholarship as undergraduate. Since the traveling is restricted you bring only 15kg as a luggage. You have already sorted your stuff putting in to various boxes with their weights and values.



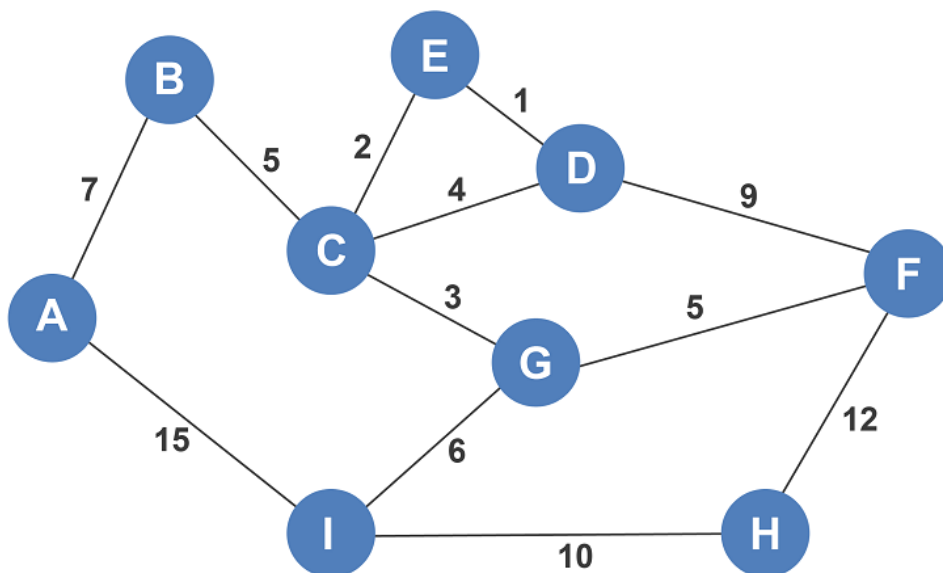
- I. What is the best possible scenario to maximize the value for the weight that you are allowed? (2 Marks)
- II. Explain how would solve this knapsack problem using the four strategies you have answered. (4 Marks)

5. Solve (in the table given below) the following undirected graphs for minimum spanning tree (MST) using *Kruskal's algorithm* and answer the following questions.



- I. State the two main steps of Kruskal's algorithm. (2 Marks)
- II. Complete a table including your hypothesis and compute the cost of weights for the above graph. (5 Marks)
- III. Draw the MST after solving the graph. (1 Mark)
- IV. Explain three occasions where this algorithm is useful. (2 Marks)

6. Solve (in the table given below) the following undirected graphs for minimum spanning tree (MST) using *Prim's algorithm* and answer the following questions.



- I. State the main steps of Prim's algorithm. (2 Marks)
- II. Complete a table including your hypothesis and compute the cost of weights for the above graph. (5 Marks)
- III. Draw the MST after solving the graph. (1 Marks)
- IV. Explain three occasions where this algorithm is useful. (2 Marks)

7. “*Tower of Hanoi*” is based on a legend that tells of a Hindu temple. At the beginning of time, the priests were given three poles and a stack of 64 gold disks, each disk a little smaller than the one beneath it. They must transfer all 64 disks from one of the three poles to another, move one disk at a time, and never place a larger disk on top of a smaller one.

- I. Draw the steps for three disks, how many moves required complete this task? (3 Marks)
- II. Based on the previous no, derive the no of moves required to correctly moving a tower of 64 disks (such as $x^y - z$)? (3 Marks)
- III. Approximate that number. Explain your hypothesis. (2 Marks)
- IV. How do you pronounce the approximated number using the following dictionary (e.g.: seven decitillion)? (2 Marks)

8. A distributed algorithm (DS) is an algorithm designed to run on computer hardware constructed from interconnected processors.

- I. Discuss *pros* and *cons* of such DS stating two facts each. (4 Marks)
- II. Explain two algorithms related to computer clock synchronization. (6 Marks)

9. Deterministic Finite Automaton (DFA), for each input symbol, one can determine the state to which the machine will move.

- I. A DFA can be represented by five tuples $A = (Q, \Sigma, \delta, q_0, F)$. Identify those tuples. (4 Marks)
- II. Consider a one-way automatic door and draw a state diagram to reflect all states in the scenario. (6 Marks)
 - This door has two pads that can sense when someone is standing on them, a front and rear pad.
 - We want people to walk through the front and toward the rear, but not allow someone to walk the other direction.
 - Let's assign the following codes to our different input cases:
 - a: Nobody on either pad
 - b: Person on front pad
 - c: Person on rear pad
 - d: Person on front and rear pad