Reg No.: _____ Name: _____

Jyothi Engineering College(Autonomous)

M.Tech Degree S2 (R) Examination, May 2026 (2025 Scheme)

25PCST201- ADVANCED DATA STRUCTURES AND ALGORITHMS

Total Mark: 60 **Total Time: 2hr 30min**

CO MARK

PART A

Answer All Questions

1. A research scholar is analyzing the performance of different algorithms designed for large-scale data processing. To compare their efficiency, the scholar uses asymptotic notations to describe the growth of time complexity as the input size increases. Illustrate the various asymptotic notations with examples. CO1 (5)

2. Define Binomial Tree. What is the number of binomial trees in a binomial heap with n nodes? Justify your answer. CO3 (5)

3. A city water supply department is managing the distribution of water from a main reservoir to different areas through a network of pipelines. Each pipeline has a maximum capacity, and water flows through these pipelines to reach the final destination areas. Based on this scenario, answer the following: CO4 (5)

   1. What is meant by **flow** in this network?
   2. What does **capacity** represent for each pipeline?
   3. Explain the concept of an **augmenting path** in the context of improving water distribution.
   4. What is **residual capacity**, and how does it help in adjusting the flow?
   5. Identify and explain the roles of **source and sink** in this system.

4. Apply Miller Rabin algorithm to test whether 127 is prime or not. CO5 (5)

5. Differentiate between polynomial-time approximation scheme and fully polynomial-time approximation scheme. CO6 (5)

PART B

Answer Any Five Question(s)

6. A cybersecurity analyst is developing a tool to detect specific patterns (signatures) within large streams of data, such as identifying a known malicious code sequence inside a file. To perform this task efficiently, the analyst uses the **Rabin–Karp algorithm**, which relies on hashing techniques. CO2 (7)

   Suppose the data stream is represented by the text:

   T = "ABCDABCDEABC"

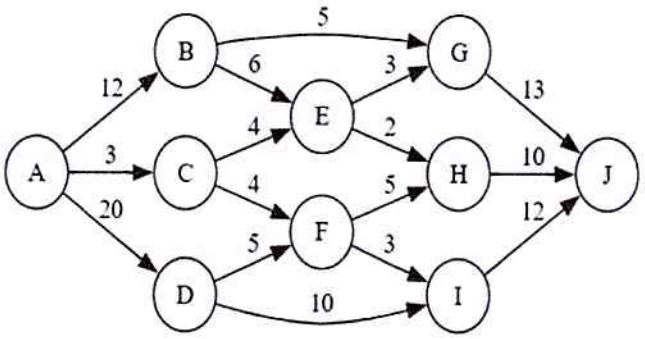
   The suspicious pattern to be detected is:

   P = "ABC", and a prime number **q = 101** is used for hash computation. Apply the

algorithm to find all occurrences of the pattern in the given text.

7. Construct a Binomial heap by inserting numbers 23,25,1,3 ,9,12,27,33. Delete 33 from the heap. List the steps involved in the deletion operation. CO3 (7)

8. A transportation company is managing the movement of goods from a central warehouse (**A**) to a final distribution hub (**J**) through a network of intermediate transfer points. Each route between locations has a limited carrying capacity, and the company wants to maximize the total flow of goods from the source to the destination efficiently. CO4 (7)
   Show the execution of the Edmonds-Karp algorithm on the given flow network. (source: A and sink: J)



9. Verify the correctness of the matrix multiplication AB = C using Monte - Carlo algorithm where, CO5 (7)

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}, B = \begin{pmatrix} 9 & 8 & 7 \\ 6 & 5 & 4 \\ 3 & 2 & 1 \end{pmatrix} \text{ and } C = \begin{pmatrix} 30 & 24 & 18 \\ 84 & 69 & 54 \\ 138 & 114 & 90 \end{pmatrix}$$

10. Consider each of the following words as a set of letters: {arid, dash, drain, heard, lost, nose, shun, slate, snare, thread}. Show which set cover GREEDY-SET-COVER produces when we break ties in favour of the word that appears first in the dictionary? CO6 (7)

11. A computer scientist is designing an efficient algorithm for handling large numbers in cryptographic computations. During the process, they encounter repeated calculations of powers modulo a prime number and seek a mathematical result to simplify these computations. Based on this situation, Demonstrate **Fermat's theorem** and its proof to simplify this problem. CO5 (7)

12. A developer is building a search feature for a document processing system that needs to quickly locate specific keywords within large text files. To improve efficiency and avoid repeated comparisons, the developer decides to use the **Knuth–Morris–Pratt (KMP) algorithm** for pattern matching.
    Suppose the document contains the text:
    T = "ABABDABACDABABCABAB" CO2 (7)
    The keyword to be searched is:
    P = "ABABCABAB"
    Based on this scenario, apply the KMP algorithm to find all occurrences of the pattern in the text.

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