

**Course/ Batch:** BTech/ SCSET  
**Course Code:** CSET244  
**Semester:** Even  
**Session:** 2024-2025

**Course Type:** Core  
**Course Name:** Design and Analysis of Algorithms

**Tutorial Assignment: Week 13**

**Tutorial title: NP Complete, NP Hard**

**CO Mapping**

| Question no | CO1 | CO2 | CO3 |
|-------------|-----|-----|-----|
| Q1          | ✓   | ✓   |     |
| Q2          | ✓   | ✓   |     |
| Q3          | ✓   | ✓   |     |
| Q4          | ✓   | ✓   |     |

**Q1.** Ram and Shyam have been asked to show that a certain problem  $\Pi$  is NP-complete. Ram shows a polynomial time reduction from the 3-SAT problem to  $\Pi$ , and Shyam shows a polynomial time reduction from  $\Pi$  to 3-SAT. Which of the following can be inferred from these reductions ?

- A.  $\Pi$  is NP-hard but not NP complete
- B.  $\Pi$  is in NP, but is not NP-complete
- C.  $\Pi$  is NP-complete
- D.  $\Pi$  is neither NP-hard, nor in NP complete

**Q2.** The problems are 3-SAT and 3SAT are

- A. Both in P
- B. Both NP complete
- C. NP-complete and in P respective
- D. Undecidable and NP complete Respective

**Q3.** The subset-sum problem is defined as follows:

Given a set  $S$  of  $n$  positive integers and a positive integer  $W$ , determine whether there is a subset of  $S$  whose elements sum to  $W$ . An algorithm  $Q$  solves this problem in  $O(nW)$  time. Which of the following statements is false?

- A.  $Q$  solves the subset-sum problem in polynomial time when the input is encoded in Unary
- B.  $Q$  solves the subset-sum problem in polynomial time when the input is encoded in binary**
- C. The subset sum problem belongs to the class NP
- D. The subset problem is NP hard

**Q4.** Let  $SHAM_3$  be the problem of finding a Hamiltonian cycle in a graph  $G = (V, E)$  with  $|V|$  divisible by 3 and  $DHAM_3$  be the problem of determining if a Hamiltonian cycle exists in such graphs. Which one of the following is true?

- A. Both  $SHAM_3$  and  $DHAM_3$  are NP hard**
- B.  $SHAM_3$  is NP hard,  $DHAM_3$  but is not
- C.  $DHAM_3$  is NP hard,  $SHAM_3$  but is not
- D. Neither  $SHAM_3$  Nor  $DHAM_3$  is NP hard