DAA-Quiz#4-4thNov2021-NPTheory-1

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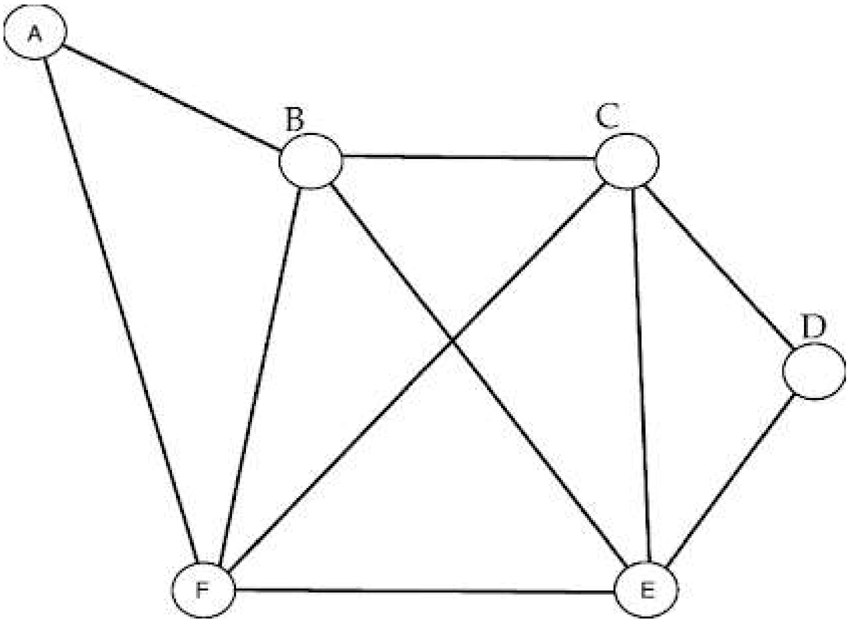
1. The quiz must be attempted using your SVNIT email ID only. If attempted using any other email ID, it would NOT be considered. There will not be any exceptions to this.
2. Please attend the quiz that is assigned to you.
3. Total Questions: 50, Total Marks: 100. TimeDuration: 50 minutes.There is NO negative marking in this quiz. But, in future quizzes there will be and then for every FOUR wrong answers, 1 mark would be deducted.
4. Google classroom may not show the scores. Please do not assume that is your real score.
5. Time: 50 minutes. So, any quiz that is received after 11:21 am, shall NOT be graded and shall be considered as Not Attempted. Therefore, do not continue attending till 11:20 - stop at 11:20 and let the quiz be submitted and received in the next one minute.
6. In the regular classes, randomly any student would be asked to answer one of the quiz questions. If the student is not able to answer the question correctly and if the same has been found to have been attempted correctly in the quiz, all the marks earned for that quiz would be treated as a zero, without any questions asked/entertained. So, answer a question only if you know the correct answer.

Consider the graph shown in the diagram. The Maximum Clique in the given graph is given by the vertices ____________ and is of size _________. 2 points



- (selected) {B, C, E, F}, 4
- {D, B, C, E, F}, 5
- {A, B, C, E, F}, 5
- {C, E, F}, 3

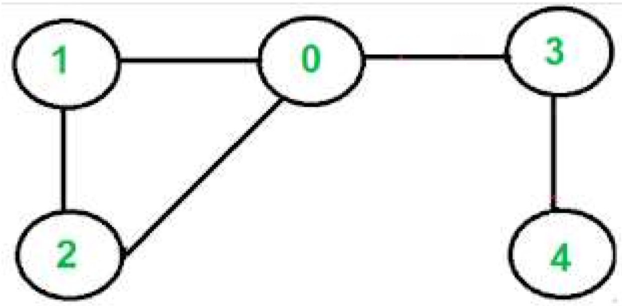
Clear selection

Given an undirected graph G = (V, E) and a probable circuit of the graph visiting every vertex once, the problem statement "Given a graph G=(V,E) and a circuit of vertices, does the given circuit indeed constitute a simple cycle that contains every node in V, exactly once, except for the start vertex" is an example of a _______ that _________. 2 points

- optimization problem, can be solved in polynomial time
- (selected) decision problem, can be solved in polynomial time
- optimization problem, cannot be solved in polynomial time
- decision problem, cannot be solved in polynomial time

Clear selection

Given the graph as shown in Fig , the two distinct cliques in the graph are as follows: one is a clique consisting of vertices _______ whereas the other is a ______ clique consisting of vertices __________. 2 points

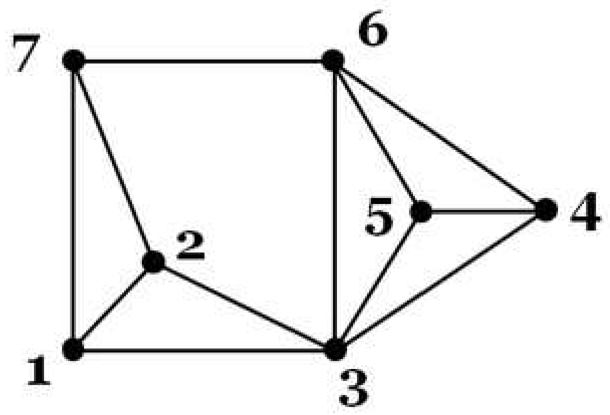


- 2; {0,3}; Maximal; {0,1,2,3}
- 2; {1,3}; Maximal; {0,1,2}
- 2; {3,4}; Maximum; {0,1,2}
- 3; {0,1,2}; Maximum; {0,1}

Clear selection

Consider the graph G = (V, E) shown in the figure. When reducing the vertex cover of this graph to a set-cover instance using appropriate gadget construction, the set cover would be given by the subsets __________. [Assume that Si depicts one of the subsets in the gadget constructed for this problem, corresponding to the vertex i in the graph, and so on].

2 points



- (selected) S2, S3, S4, S6, S7
- S2, S3, S6, S7
- S2, S3, S5, S6, S7
- S1, S3, S4, S6, S7

Clear selection

Given the two problems viz. P as find the sum of two integers and Q as find the sum of 2^n integers where n is any positive integer, one can prove that _____________.

2 points

- P ≡ Q
- (selected) P ≤ Q
- both P and Q belong to class NP.
- Q ≤ P

Clear selection

Suppose the given problem is as follows: Given the jobs j_1, j_2, j_3......j_5 with running times t_1, t_2, t_3,........t_5, where t_i's are respectively 2,2,2,3,3. Suppose the algorithm used to schedule the jobs is as follows: {Sort the jobs in descending order of their execution times. Then, schedule the first job on P_1, second job on P_2; but when scheduling j_3, schedule it on the least lightly loaded processor of the two processors.} Then, the final completion time is \fillin and is the \fillin.

2 points

- (x) 7, sub-optimal
- ( ) 6, sub-optimal
- ( ) 7, optimal
- ( ) 6, optimal

Clear selection

Suppose a polynomial time algorithm is discovered that correctly computes the largest clique in a given graph. In this scenario, the complexity class P would be ____________ of the complexity class NP.

2 points

- ( ) superset
- ( ) subset
- (x) equal to that
- ( ) none of these options.

Clear selection

The ______ problems are those computational problems that are solvable in _____ time whereas ______ are those that are not solvable in polynomial time. 2 points

- ○ tractable, exponential, tractable
- ◉ tractable, polynomial, intractable
- ○ intractable, exponential, tractable
- ○ intractable, polynomial, tractable

Clear selection

Suppose the given problem is as follows: Given the jobs j_1, j_2, j_3......j_7 with running times t_1, t_2, t_3,........t_7, where t_i's are respectively 2,100,2,100,2,100,2. Suppose the algorithm used to schedule the jobs is as follows: {Sort the jobs in descending order of their execution times. Then, schedule the first job on P_1, second job on P_2; but when scheduling j_3, schedule it on the least lightly loaded processor of the two processors.} Then, the final completion time is \fillin and is the \fillin. 2 points

- ○ 202, suboptimal
- ◉ 200, optimal
- ○ 204, suboptimal
- ○ 104, optimal

Clear selection

Consider two problems viz. P and Q defined for a given graph G=(V,E). The problem P is "Single Source Shortest Path" problem. The problem Q is "All Pairs Shortest Path" problem. Then _______of the following is true.

2 points

- ◯ Q polynomially reduces to P
- ◉ P is polynomially equivalent to Q
- ◯ Neither P nor Q can be reduced to the other; either way.
- ◯ P polynomially reduces to Q

Clear selection

Consider a connected graph G = (V, E), | V | = 12 and | E | = 11. with the size of the Independent set S of this graph be | S | =5. Then, the size of the Maximum clique in the complement graph G' is ________.

2 points

- ◉ 5
- ◯ 8
- ◯ 7
- ◯ 6

Clear selection

Let us assume on the first day in your cherished job, you are asked to design an algorithm to solve the following problem viz. "Π1 : Given m available pieces of software of a system A and a set U of n capabilities that your organization would like your system A to have. Assume that the ith piece of software provides the set Si ⊆ U of capabilities." You are asked to design an algorithm to achieve all n capabilities using fewest pieces of software. Assume that you only can prove the relationship between the 3-SAT problem and the Maximum Independent Set (MIS) of a graph problem and then those that derive from this basic relationship. Then, to convince your Boss that it is futile to design an algorithm to solve the problem Π1 in polynomial time on arbitrary inputs, you would prove one of the following viz. ________. 2 points

- ◯ Π1 ≤ MIS ≤ Vertex-Cover ≤ 3SATOption
- ◯ 3SAT ≤ MIS ≤ Vertex-Cover ≤ Π1
- ◯ Π1 ≤ Vertex-Cover ≤ MIS ≤ 3SAT
- ◯ 3SAT ≤ Vertex-Cover ≤ MIS ≤ Π1

The polynomial time bound is preferable to use to depict the efficient algorithms because ______________. 2 points

- ◉ most of the algorithms that have this time bound, exhibit complexity O(n^c), with c<=2.
- ◯ most of the algorithms that have this time bound, do not exhibit complexity O(n^c), with c<=2.
- ◯ most of the algorithms that have this time bound, exhibit complexity O(2^n).
- ◯ most of the algorithms that have this time bound, exhibit complexity O(n^c), with c<=4.

Clear selection

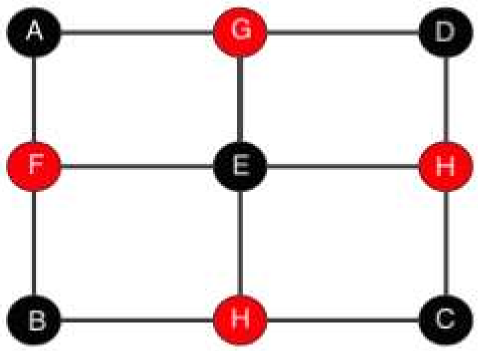
Let SHAM3 be the problem of finding a Hamiltonian cycle in a graph G = (V,E) with | V | divisible by 3 and DHAM3 be the problem of determining (i.e. verifying) if a Hamiltonian cycle exists in such graphs. Then, _______ is true.

2 points

- none of these
- SHAM3 polynomially reduces to DHAM3
- all of these
- DHAM3 is equivalent to SHAM3
- DHAM3 polynomially reduces to SHAM3

Consider the graph shown in the diagram. The Maximum Clique in the complement graph is given by the vertices _____________ and is of size __________.

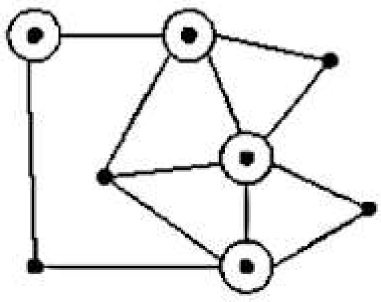
2 points



- none of these are correction options
- {A, B, C, D, E , F , G, H}, 8
- (selected) {A,B, C, D, E}, 5
- {E, F, G, H}, 4

Clear selection

Given the graph as shown in the figure, it has a minimum vertex cover of size _________ nodes. 2 points



- 3, circled
- 3, uncircled-dotted
- 4, circled
- 4, uncircled-dotted,

Clear selection

Consider a set U defined as U= { Red, Yellow, Green, Blue } . Let Si be the given subsets of this set, with | Si | =9. Then, when a gadget to relate this problem with a graph problem is designed, with graph G = (V, E), the number of vertices | V | in G, must be equal to ______. 2 points

- 9
- 3
- 5
- cannot be computed.

"Given a CNF formula with F distinct clauses, each clause having 3 literals", the complexity of the function to determine whether F is satisfiable or not is ______. Such a function can be designed using _____ approach. 2 points

- ○ O(|F|^8), dynamic programming
- ○ none of the choices given here
- ◉ O(|F|^8), brute-force
- ○ O(|F|8), brute-force

Clear selection

Let X be a problem that belongs to the class NP. Then which one of the following is not TRUE? 2 points

- ◉ there is A polynomial time certifier which can be used to certify that given an instance and an answer to X, that answer is correct or incorrect in polynomial time.
- ○ it can be proved that the optimisation version of the problem X cannot be solved polynomially.
- ○ it can be proved that all the problems in class P can be verified polynomially
- ○ there is no polynomial time certifier which can be used to certify that given an instance and an answer to X, that answer is correct or incorrect in polynomial time.

Clear selection

Given the two problems viz. P as find the sum of two integers and Q as find the sum of 2^n integers where n is any positive integer, one can prove that _____________. 2 points

- ○ P ≡ Q
- ○ P ≤ Q
- ○ Q ≤ P
- ○ both P and Q belong to class NP.

Consider a graph G = (V, E), with | V | =9 and | E | =15, and the Independent set of this graph S with | S | = 5. Then, the size of the corresponding set cover instance in the gadget constructed for this graph is _______.

2 points

- 5
- cannot be computed
- 9
- 4

The complexity of the non-deterministic comparison based sorting algorithm NonDeterministicSorting(A, n) that takes a vector A of size n as input is _________.

2 points

- O(1)
- O(n lg n)
- O(lg n)
- O(n)
- Option 1

Ram and Shyam have been asked to comment on the solvability of a certain problem Π. Ram shows a polynomial time reduction from the 3-SAT problem to Π, and Shyam shows a polynomial time reduction from Π to 3-SAT. Which of the following can be inferred from these reductions ?

2 points

- Shyam is able to prove than Π is hard to solve, but Ram is not.
- Option 5
- Shyam is able to prove that 3-SAT is easier to solve as compared to Π
- Ram is able to prove that Π is hard to solve, but Shyam is not.
- Ram is able to prove that Π is easier to solve as compared to 3-SAT

Consider the reduction viz. 3-SAT α SAT problem. Given a collection C= { C1, C2, C3, ...Cm } of clauses, where each clause consist of a set of literals drawn over a finite set of the Boolean variables U= { u1 , u2 , u3 , u4 , ..un } . Consider that we have to design an appropriate 3-SAT expression from the given SAT expression, one may use clauses ci ∈ C drawn on literals { z1 , z2 , z3 , ..zk } , where the z j 's are literals over U and auxiliary variables y{i,k−i} where i is the clause number to which a literal belongs to and k is the index of a literal in the clause. Then, say, we have a SAT expression as C = { z1 , z2 , z3} , consisting of three literals, the converted 3-SAT expression C" is ___________.

2 points

- C = { z1 , z2 , z3}
- C = { z1 , z2 , y_i,1}{y_i,1', y_i,2, z3)
- C = { z1 , z2 , y_i,1}{z3, z4, z5)
- none of these

"Given a CNF formula with F distinct clauses, with |F|=4 and with each clause having 5 literals", the complexity of the function to determine whether F is satisfiable or not is given by ______. Such a function can be designed using _____ approach.

2 points

- 132, brute force
- 128, dynamic programming
- 128, brute force
- 132, dynamic programming

Suppose the given problem is as follows: Given the jobs j_1, j_2, j_3......j_7 with running times t_1, t_2, t_3,........t_7, where t_i's are respectively 2,100,2,100,2,100,2. These are required to be scheduled on say TWO processors such as to minimize the final completion time. Then, the optimal final completion time is ________ and the algorithm that could be used to achieve the schedule is _______.

2 points

- 200, sort the jobs in the descending order of their finish time and schedule them alternately on each processor.
- 202, sort the jobs in ascending order of their finish time and schedule them alternately on each processor.
- 200, schedule the first job on first processor, second on the second processor and then alternate the jobs between the processors.
- 200, brute-force

Consider the following claim, that you are asked to prove viz. "Given that for a graph G=(V,E), if S is an independent set, then V-S is a vertex cover", then ______ of the following argument is a most appropriately valid statement useful in the proof.

2 points

- for an edge (u,v) not in S, either u in S or v in S.
- for an edge (u,v) in S, either u not in S or v not in S.
- for an edge (u,v) in S, both u, v in S.
- for an edge (u,v) in V-S, either u in V-S or v in V-S.

A solution to a problem is generally considered to be efficient if its running time T(n) is _______. 2 points

- Omega(n^c), where c is some integer and n is the input size.
- O(n^c), where c is some integer and n is the input size.
- Theta(n^c), where c is some positive integer lesser than or equal to 3 and n is the input size.
- O(n^c), where c is some positive integer and n is the input size.

The halting problem is an example of a/an _______ problem i.e. _________. 2 points

- decidable, cannot be solved on any machine
- decidable, can be solved on a turing machine
- undecidable, can be solved on a turing machine.
- undecidable, cannot be solved on a turing machine

Let S be a hard problem decision problem and Q and R be two other decision problems not known to be hard. Q is polynomial time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true? 2 points

- R is at least as hard a problem to solve as is Q.
- Given an algorithm to solve S, we can solve the problem R also.
- R is at the most as hard a problem to solve as in S.
- The problem Q is at least as much hard to solve as S.

Suppose the given problem is as follows: Given the jobs j_1, j_2, j_3......j_7 with running times t_1, t_2, t_3,........t_7, where t_i's are respectively 2,100,2,100,2,100,2. These are required to be scheduled on say TWO processors such as to minimize the final completion time. Then, the schedule shown in Fig is a/an ______ schedule and _____ approach can be used to design the algorithm.

2 points

P_1	P_2	Comment
$j_1(2)$	$j_3(2)$	
$j_5(2)$		$t_1<=t_3$
	$j_7(2)$	$t_1+t_5<t_3$
$j_2(100)$		$t_1+t_5<=t_3+t_7$
	$j_4(100)$	$t_3+t_7<t_1+t_5+t_2$
$j_6(100)$		....

- (selected) suboptimal, greedy
- optimal, dynamic programming
- suboptimal, logical-argument-based
- suboptimal, dynamic programming

Clear selection

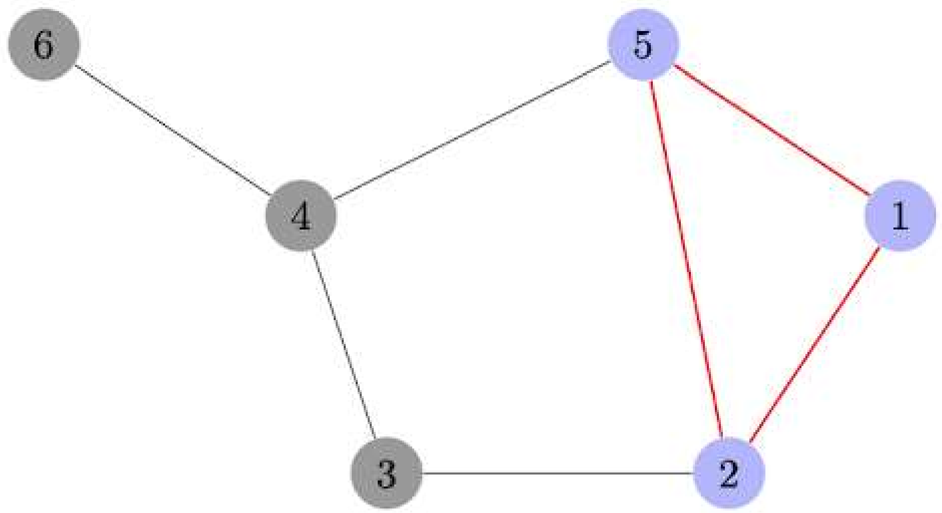
Finding as large group of students as possible so that each pair therein is compatible to each other can be modeled as a __________.

2 points

- graph n-coloring problem
- Vertex Cover problem
- Minimal Independent Set problem
- (selected) Maximum Clique problem

Clear selection

Given the graph as shown in Fig , the two distinct cliques in the graph are as follows: one of the maximal clique consists of vertices _______ whereas ______ is not a maximal clique. 2 points



- (selected) {1,2,5}
- {3,4}, {4,5}
- {4,6}, {2,3}
- {4,6}, {4,5}

Clear selection

A ________ approach/algorithmic-approach is the one in which an attempt is made to search the entire solution space of the problem instance to look for the optimal answer and has complexity __________ typically for input size n. 2 points

- (selected) brute-force based, O(2^n)
- Dynamic Programming, O(n)
- Greedy, (O(n lg n))
- Divide and Conquer, O(lg n)

Clear selection

Consider that for a graph g=(V,E), you are given that S is an independent set of the graph G. Consider an edge (u,v) in E. Then __________ is true. 2 points

- ◯ either u notin V-S or v notin V-S
- ◯ u notin V-S and v notin V-S
- ◯ u in S and v in S
- ◯ u notin S or v in S

Suppose the given problem is as follows: Given the jobs j_1, j_2, j_3......j_5 with running times t_1, t_2, t_3,........t_5, where t_i's are respectively 4,4,4,5,5. Suppose the algorithm used to schedule the jobs is as follows: Then, the optimal final completion time is ___________. 2 points

- ◉ 12
- ◯ 13
- ◯ 8
- ◯ 10

Clear selection

Consider the following claim, that you are asked to prove viz. "Given that for a graph G=(V,E), if V-S is a vertex cover, then S is an independent set", then ______ of the following argument is a most appropriately valid statement useful in the proof. 2 points

- ◯ if u not in S and v notin S, then (u,v) is not a valid edge because V-S is a vertex cover.
- ◯ if u in S and v in S, then (u,v) is a valid edge in E.
- ◯ if u in S and v in S, then (u,v) is not a valid edge in E because V-S is a vertex cover.
- ◯ if u in S and v not in S, then (u,v) is not a valid edge because V-S is a vertex cover.

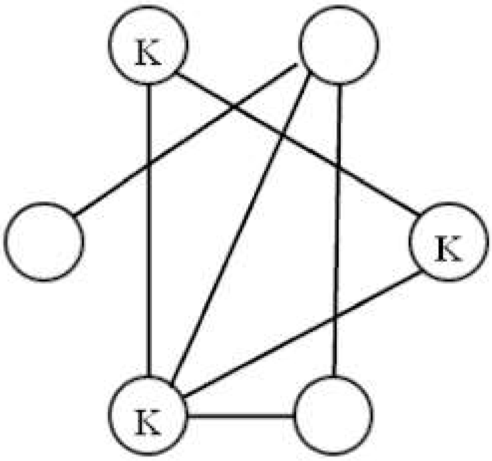
Let S be a hard problem decision problem and Q and R be two other decision problems not known to be hard. Q is polynomial time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true?

2 points

- ◯ R is at least as hard a problem to solve as is Q.
- ◯ The problem Q is at least as much hard to solve as S.
- ◯ R is at the most as hard a problem to solve as in S.
- ◯ Given an algorithm to solve S, we can solve the problem R also.

Consider the graph shown in the figure and the vertices marked as K. These vertices are forming a(n) _______ in the graph, whereas the compliment vertices in the compliment graph of this graph form a(n) ________ of size _________.

2 points



- ◯ Indenpendent set, Vertex cover, 3
- ◉ 3-clique, Independent set, 3
- ◯ Indenpendent set, maximum clique, 3
- ◯ 3-clique, Vertex-cover, 3

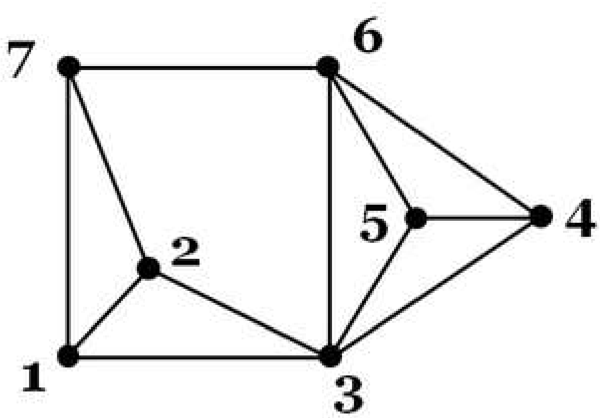
Clear selection

Consider a connected graph G = (V, E), | V | = 12 and | E | = 11 with the size of the Vertex cover S of this graph be | S | =5. Then, the size of the Maximum clique in the complement graph G' is _________. 2 points

- ○ 6
- ○ 8
- ◉ 7
- ○ 5

Clear selection

Given the graph as shown in Fig , the graph has ________ maximal 3-clique, ________ 4-clique and the independent set in the compliment graph has maximum ________ vertices. 2 points



- ○ 5,2,4
- ○ 6,1,3
- ○ 6, 1, 4
- ○ 5,1, 3

Assume that G=(V,E) be a given connected graph that has a clique S of vertices such that | S | = k. Let GC be its compliment graph. Let (u,v) be any edge in GC . Then, ________ and ________are true.

2 points

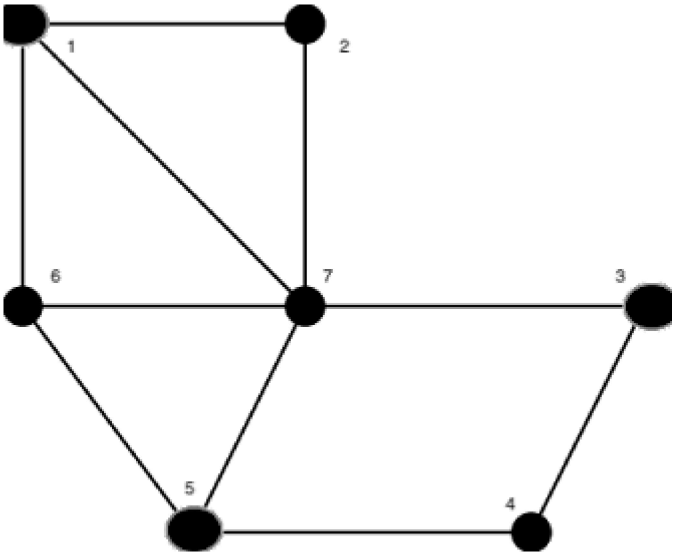
- Either u OR v is not in S, At least one of u or v belong to V-S.
- none of the above can be inferredption 1
- Both of u and v are not in S, None of u or v belong to V-S.
- Both of u and v are not in S, At least one of u or v belong to V-S.

The asymptotic complexity of Nondeterministic Search algorithm NonDeterministicSearch(x, A), that takes a vector A with n elements as input and returns the index of an element x in A, if found and a 0, otherwise is ____________.

2 points

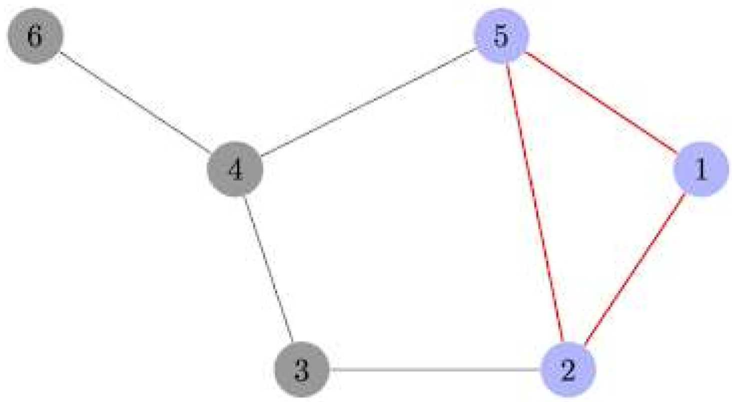
- O(1)
- n O(lg n)
- O(n)
- O(lg n)

Given the graph as shown in the figure, it has a minimum vertex cover of size _________ , given by the nodes _____________. 2 points



- 4, {2,4,6,7}
- 3, {1,3,5}
- 3, {2,4,7}
- 4, {1,3,6,5}

Given the graph as shown in Fig , the graph has ________ maximal cliques and ________ maximum 3-clique. 2 points



- (selected) 4,1
- 6,1
- 5,1
- 2,2

Clear selection

Consider that you are given an art-gallery problem Π1 in which the question is to place guards within the art gallery so that all corridors are visible at any time. In order to either design an algorithm to solve this problem or to prove that the problem is hard to solve, you would use ____________. 2 points

- the independent-set problem as the basis for reduction
- (selected) the vertex-cover problem as the basis for reduction.
- the 3-SAT problem as the basis for reduction
- the maximum-clique problem as the basis for reduction

Clear selection

A Complexity Class P or NP or EXP - **each** individually - is a collection of ______________. 2 points

- ◯ of decision problems all of which cannot be solved in SAME resource bounds
- ◯ of optimization problems all of which can be solved in SAME resource bounds
- ◉ of decision problems all of which can be solved in the SAME, respective, resource bounds
- ◯ of optimization problems that are hard to solve.

Clear selection

A polynomial time bound of an algorithm's complexity is considered as ____________ . One of the reasons not true (not applicable to this observation) is ________. 2 points

- ◯ efficient, most algorithms have polynomial time bounds
- ◯ inefficient, if an algorithm's time complexity is O(n^c), then c for most algorithms is normally lesser than 3.
- ◯ inefficient, polynomial operation does not satisfy closure property.
- ◉ efficient, polynomial operation satisfies closure as well as graph properties.
- ◯ efficient, polynomial bounds allow machine independence.
- ◯ efficient, if an algorithm's time complexity is O(n^c), then c for most algorithms is normally lesser than 3.

Clear selection

An algorithm with ______ time bound is considered to be efficient, because it exhibits a property known as _____ property; which implies that _______. 2 points

- [x] polynomial, closure, if we add/combine two algorithms with polynomial time bounds, the resulting algorithm also has polynomial time bound.
- [ ] polynomial, machine independence, if we add/combine two algorithms with polynomial time bounds, the resulting algorithm also has a polynomial time bound.
- [ ] polynomial, closure, using multiple algorithms with polynomial time bounds has no effect on the overall time taken by the algorithm to execute.
- [ ] polynomial, closure, if we add/combine two algorithms with polynomial time bounds, the resulting algorithm has an exponential time bound.

Clear selection

For the two problems P and Q, if we are given that problem P ≤ Q (polynomially), it implies that _____ and also that __________. 2 points

- [ ] the problem P is at least as difficult as Q; given an algorithm to solve P, one can solve Q using the algorithm and some function(s).
- [ ] the hardness of solving Q does not exceed that of solving P; given an algorithm to solve, given an algorithm to solve P and some function, one can solve the problem Q
- [x] the hardness of solving Q may equal or exceed that of solving P; given an algorithm to solve Q, one can solve P using that algorithm and some function(s).
- [ ] the problems P and Q are equally hard to solve; using an algorithm for one, the other problem can be solved

Clear selection

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