Indian Institute of Technology, Madras - BS in Data Science and Applications

Notations :

1.Options shown in green color and with ✔ icon are correct.

2.Options shown in red color and with ✖ icon are incorrect.

Question Paper Name :	IIT M DEGREE AN2 EXAM QPE2 16 JULY 2023
Subject Name :	2023 July: IIT M DEGREE AN2 EXAM QPE2
Creation Date :	2023-07-10 17:54:46
Duration :	120
Total Marks :	575
Display Marks:	Yes
Share Answer Key With Delivery Engine :	Yes
Actual Answer Key :	Yes
Calculator :	Scientific
Magnifying Glass Required? :	No
Ruler Required? :	No
Eraser Required? :	No
Scratch Pad Required? :	No
Rough Sketch/Notepad Required? :	No
Protractor Required? :	No
Show Watermark on Console? :	Yes
Highlighter :	No
Auto Save on Console?	Yes
Change Font Color :	No
Change Background Color :	No

✖ (9x^2+6)/9 if $x \in [0, 1]$

6406531933120. ✖ (9x^2+6)/24 if $x \in [0, 0.5]$

Question Number : 168 Question Id : 640653579005 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Multiple Choice Question

Which of the following is/are true about the given code snippet?

Options :

6406531933121. ✔ Both Inverse Transform and Accept-Reject algorithms are implemented.

6406531933122. ✖ Only one of Inverse Transform and Accept-Reject algorithms are implemented.

6406531933123. ✖ The given implemented Accept-Reject is correct as the support of function g is the same as that of function f.

6406531933124. ✖ The given implemented Accept-Reject is incorrect for the given function f and g.

6406531933125. ✖ The given implemented Inverse Transform algorithm is correct as the cumulative distribution function of f is invertible.

Advanced Algorithms

Section Id :	64065339133
Section Number :	9
Section type :	Online
Mandatory or Optional :	Mandatory
Number of Questions :	12

Number of Questions to be attempted :	12
Section Marks :	50
Display Number Panel :	Yes
Group All Questions :	No
Enable Mark as Answered Mark for Review and Clear Response :	Yes
Maximum Instruction Time :	0
Sub-Section Number :	1
Sub-Section Id :	64065382973
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Number : 169 Question Id : 640653579007 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 0

Question Label : Multiple Choice Question

THIS IS QUESTION PAPER FOR THE SUBJECT "DEGREE LEVEL : ADVANCED ALGORITHMS (COMPUTER BASED EXAM)"

ARE YOU SURE YOU HAVE TO WRITE EXAM FOR THIS SUBJECT?
CROSS CHECK YOUR HALL TICKET TO CONFIRM THE SUBJECTS TO BE WRITTEN.

(IF IT IS NOT THE CORRECT SUBJECT, PLS CHECK THE SECTION AT THE TOP FOR THE SUBJECTS REGISTERED BY YOU)

Options :

6406531933130. ✔ YES

6406531933131. ✖ NO

Sub-Section Number :	2
Sub-Section Id :	64065382974
Question Shuffling Allowed :	Yes

Is Section Default? : null

Question Number : 170 Question Id : 640653579008 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Multiple Choice Question

In the activity selection problem, each activity **i** has a start time S_i and a finish time F_i where $S_i < F_i$. Two activities cannot be performed together if their associated time intervals are overlapping. In other words, activity **i** and **j** both **can** be performed if ____

Options :

6406531933132. ✖ $S_i \leq F_j$

6406531933133. ✖ $S_j \leq F_i$

6406531933134. ✔ $S_i \geq F_j$ or $S_j \geq F_i$

6406531933135. ✖ $S_i \leq F_j$ and $S_j \geq F_i$

Question Number : 171 Question Id : 640653579013 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Multiple Choice Question

A circuit in a matroid is a minimal dependent set. In other words, a subset **S** of the universe **U** is a circuit if **S** is not an independent set, but every proper subset of **S** is an independent set.

Which of the following would be a circuit for the graphic matroid?

Options :

6406531933143. ✔ A cycle on any number of vertices

6406531933144. ✖ A path on any number of vertices

6406531933145. ✖ A star with at least three leaves

6406531933146. ✖ A complete subgraph on 4 or more vertices

Question Number : 172 Question Id : 640653579015 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Multiple Choice Question

Consider the following set system:

● The universe is the set of edges of a graph G

● A subset S of U is an independent set if the subgraph induced by S is such that every vertex has even degree.

Is this set system hereditary?

Options :

6406531933151. ✖ Yes

6406531933152. ✔ No

Question Number : 173 Question Id : 640653579021 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Multiple Choice Question

Suppose there are **M** mice out on a field and there are **H** holes scattered across the ground that the mice can hide in. Each hole $1 \leq i \leq H$ has a capacity $\mathbf{H}_i$. You are given the locations of the mice at time t = 0 and the holes (the locations of the holes are fixed).

Each mouse runs at the same velocity **v** and remains vulnerable if it does not reach a hole within **s** seconds when hungry owls arrive and instantaneously catch all the mice that are not in hiding.

Consider the following approach to determine the maximum number of mice that can be safe:

● We design a flow network, which consists of a bipartite graph with **M** “mice nodes”, one representing each mouse, and **H** “hole nodes”, one representing each hole.

● If a mouse can reach a particular hole, as determined by the distance between the initial position of the mouse and the given position of the hole , then place an edge between the mouse and the hole with capacity = 1.

● Connect a source node with all the Mice nodes with edge capacities = 1.

● Connect all the Hole nodes with a sink node via edges of capacities = capacity of the particular holes .

● Run Ford−Fulkerson max flow algorithm and the most Mice that are safe equal to the maxFlow obtained .

Options :

6406531933163. ✖ Cannot say! Depends on the velocity v, time s seconds, hole locations and other factors.

6406531933164. ✔ Yes, this approach will always work.

6406531933165. ✖ This approach will work if the edges from the source to mice nodes have infinite capacity.

6406531933166. ✖ This approach will work under some scenarios but not always.

Sub-Section Number :	3
Sub-Section Id :	64065382975
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 174 Question Id : 640653579020 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 5

Question Label : Multiple Choice Question

Let **L** be an array of **n** integers. Our array indices start from 0.

Let maxSum[i] denote the largest contiguous sum possible in the subarray of **L** ending at the i^{th}

element. Note that maxSum[0] = L[0].

Which of the following recurrences are true?

Options :

6406531933159. ✔ maxSum[i] = max(maxSum[i - 1] + L[i], L[i])

6406531933160. ✖ maxSum[i] = max(maxSum[i - 1], L[i])

6406531933161. ✖ maxSum[i] = max(maxSum[i - 1], maxSum[i - 1] + L[i])

6406531933162. ✖ maxSum[i] = max(maxSum[i - 1] - L[i], L[i])

Sub-Section Number :	4
Sub-Section Id :	64065382976
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 175 Question Id : 640653579014 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3 Max. Selectable Options : 0

Question Label : Multiple Select Question

Recall the task scheduling problem: suppose you have **n** tasks to complete in **n** days; each task requires your attention for a full day. Each task comes with a deadline, the last day by which the job should be completed. A collection of tasks is called *realistic* if there is a way to schedule all of them in a manner that all of them finish within their deadlines. Given job IDs and deadlines as below, which of the following subsets of jobs is/are realistic?

{ J1: 5, J2: 1, J3: 1, J4: 2, J5: 4, J6: 3, J7: 4, J8: 4, J9: 5, J10: 3 }

Options :

6406531933147. ✔ {J1, J9, J2, J4, J8}

6406531933148. ✖ {J1, J9, J2, J3, J4, J8}

6406531933149. ✖ {J1, J4, J5, J6, J7, J8, J9}

6406531933150. ✔ {J2, J4, J10, J7, J1}

Sub-Section Number :	5
Sub-Section Id :	64065382977
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 176 Question Id : 640653579009 Question Type : SA Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Short Answer Question

We have a set of jobs to be performed, and we are given the following information about each job: a job ID, the duration required to complete the job, and the time by which the job is due.

All jobs have to be performed on a single machine, which can perform one job at a time.

Given a schedule for the jobs, the lateness of a job is defined as 0 if it is completed before it is due, and is defined as the difference between the completion time and the time it is due otherwise.

This machine has to rest for an hour mandatorily after every 5 hours of continuous work but the machine can take rest for one hour even before 5 hours.

If the jobs are executed in an optimal sequence, what is the total lateness?

$$Lateness = \sum_{id=0}^{3} L(i)$$

$$L(i) = \left\{ \begin{matrix} if\ \ TimeDelivered(i) > TimeDue(i),\ \ TimeDelivered(i) - TimeDue(i) \\ else, 0 \end{matrix} \right\}$$

Id	Time required	Due time
0	2	10
1	1	2
2	4	8
3	3	7

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Equal

Text Areas : PlainText

Possible Answers :

3

Sub-Section Number :	6
Sub-Section Id :	64065382978
Question Shuffling Allowed :	Yes
Is Section Default? :	null

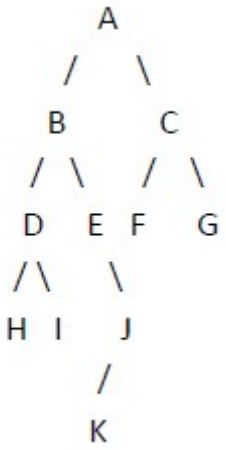
Question Number : 177 Question Id : 640653579016 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Short Answer Question

Consider the following tree:



What is the size of the maximum-size independent set for this tree?

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Equal

Text Areas : PlainText

Possible Answers :

7

Sub-Section Number :	7
Sub-Section Id :	64065382979
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Id : 640653579010 Question Type : COMPREHENSION Sub Question Shuffling Allowed : No Group Comprehension Questions : No Question Pattern Type : NonMatrix Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Question Numbers : (178 to 179)

Question Label : Comprehension

Consider the following instance of the stable matching problem. Suppose there are 3 women (A, B, C) and 3 men (X, Y, Z), and their preferences as given below and answer the subquestions:

Men	1	2	3
X	A	B	C
Y	B	A	C
Z	A	B	C

Women	1	2	3
A	Y	X	Z
B	X	Y	Z
C	X	Y	Z

Sub questions

Question Number : 178 Question Id : 640653579011 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Multiple Choice Question

Is assignment X-A, Y-B, Z-C stable?

Options :

6406531933137. ✔ Yes

6406531933138. ✖ No

Question Number : 179 Question Id : 640653579012 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Multiple Choice Question

Consider the following matching: M = (X-C), (Y-B), (Z-A). Which of the following forms a blocking pair in the matching above?

Options :

6406531933139. ✖ (Y-A)

6406531933140. ✔ (X-B)

6406531933141. ✖ (Y-C)

6406531933142. ✖ (Z-B)

Sub-Section Number :	8
Sub-Section Id :	64065382980
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Id : 6406535790 17 Question Type : COMPREHENSION Sub Question Shuffling Allowed : No Group Comprehension Questions : No Question Pattern Type : NonMatrix Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Question Numbers : (180 to 181)

Question Label : Comprehension

There is a row of n chairs and two types of people attending a party: C for chess players and S for comedians. You want to assign one person to each seat but you can never seat two chess players together or they will start talking about strategy and everyone else in the room will get bored. For example, if n = 3, the following are some valid seating arrangements: SSS, CSC, and SSC. However, the following is an invalid seating: CCS. Let f(n) denote the number of valid seating arrangements when n chairs are available.

Note that f(1) = 2, since both S and C count as valid seating arrangements; while f(2) = 3, since SS, SC, CS are valid seating arrangements but CC is not. Note that we do not need to count the arrangement SS more than once to account for the actual people seated swapping places, we are only interested in the “form” of the seating arrangement. Based on this, you can check that of the eight possible seating arrangements of three chairs, we have five that are valid: CSC, SSC, SSS, SCS, CSS, so f(3) = 5.

Based on the above data, answer the given subquestions.

Sub questions

Question Number : 180 Question Id : 640653579018 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Short Answer Question

What is the value of f(6)?

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Equal

Text Areas : PlainText

Possible Answers :

21

Question Number : 181 Question Id : 640653579019 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Multiple Choice Question

Which of the following is a valid recurrence for f(n)?

Options :

6406531933155. ✖ f(n) = f(n - 1) - f(n - 2)

6406531933156. ✔ f(n) = f(n - 1) + f(n - 2)

6406531933157. ✖ f(n) = 2 * f(n - 1) - 1

6406531933158. ✖ f(n) = 2 * f(n - 1) + 1

Sub-Section Number :	9
Sub-Section Id :	64065382981
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Id : 640653579022 Question Type : COMPREHENSION Sub Question Shuffling Allowed : No Group Comprehension Questions : No Question Pattern Type : NonMatrix Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Question Numbers : (182 to 185)

Question Label : Comprehension

You have a collection of n elements with weights, which may be positive or negative numbers (but never zero). You want to choose a subset of these elements such that their total weight is maximized. There are constraints to make your life difficult, which are of the form: “If you include element X in your subset, then you must include element Y too.” Let’s abbreviate that $X \rightarrow Y$. The total weight of the empty subset of elements is zero and note that weights may be negative.

For instance, if your elements are A with a weight of 1 and B with a weight of -1 and no constraints, you may pick A, with the constraint that $A \rightarrow B$, you can either pick both elements or neither with the same outcome (note that picking only B is suboptimal and picking only A is not valid), while with the constraint that $B \rightarrow A$, you can pick only A and that would be optimal.

We will build a flow network to help us find an answer. First, choose a number bigger than the maximum positive value among the given input weights. Call that number **B**. We will have, as usual, a source node **S** and a sink node **T**. Additionally, introduce a vertex for every element in the set.

You have an edge from **S** to each node, whose capacity is **B**, and you have an edge from each node to **T**. For the edge from a node **v** representing an element whose weight is w(v), the edge from **v** to the sink node has capacity B - w(v). For each constraint of the form $X \rightarrow Y$, you will have an edge from nodes representing elements X to Y with infinite capacity.

For the given subquestions, we call an element positive if its weight is positive, and an element is called negative if its weight is negative.

Sub questions

Question Number : 182 Question Id : 640653579023 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 2

Question Label : Multiple Choice Question

Consider the edges (S, v) and (v, T), where **v** is a vertex representing some element. If **f** is a maximum flow in the network described in the main question, then is it possible that both of these edges are saturated? For this question, recall that all weights are non-zero.

Options :

6406531933167. ✖ Yes, provided that **v** has an infinite-capacity edge incident on it (either incoming or outgoing).

6406531933168. ✔ Yes, provided that either **v** has positive weight and has an infinite-capacity edge going out of **v** or that **v** has negative weight and has an infinite-capacity edge coming into it.

6406531933169. ✖ Yes, provided that either **v** has negative weight and has an infinite-capacity edge going out of **v** or that **v** has positive weight and has an infinite-capacity edge coming into it.

6406531933170. ✖ No, this is always impossible.

Question Number : 183 Question Id : 640653579024 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 2

Question Label : Multiple Choice Question

If the input has no constraints (i.e, there are no infinite-capacity edges in the flow network), and the total weight of all the positive elements in **P**, and the absolute value of the sum of the weights of negative elements is **Q**, what is the value of the maximum flow in the network that we have built? Recall that **n** is the total number of elements.

Options :

6406531933171. ✖ nB - Q

6406531933172. ✔ nB - P

6406531933173. ✖ nB - (P + Q)

6406531933174. ✖ P + Q

6406531933175. ✖ P - Q

Question Number : 184 Question Id : 640653579025 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 2 Max. Selectable Options : 0

Question Label : Multiple Select Question

Consider the case when we have two elements **X** and **Y** , with weights w(X) = p and w(Y) = -q, where **p** and **q** are positive integers. In other words, **X** has a positive weight **p** and **Y** has a negative weight whose absolute value is **q**. Suppose we have the constraint X → Y . Let B = p + 1. Also let the label of the vertex representing **X** be **x** and the label of the vertex representing **Y** be **y**. If q > p, then which of the following is/are true?

Options :

6406531933176. ✔ There is a flow saturating both the edges (S, x) and (S, y).

6406531933177. ✖ There is no flow that saturates both the edges (S, x) and (S, y).

6406531933178. ✖ There is a flow saturating both the edges (x, T) and (y, T).

6406531933179. ✔ There is no flow that saturates both the edges (x, T) and (y, T).

Question Number : 185 Question Id : 640653579026 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3 Max. Selectable Options : 0

Question Label : Multiple Select Question

Consider the case when we have two elements **X** and **Y**, with weights w(X) = p and w(Y) = -q, where **p** and **q** are positive integers. In other words, **X** has a positive weight **p** and **B** has a negative weight whose absolute value is q. Suppose we have the constraint X → Y.

Let B = p + 1. Also let the label of the vertex representing **X** be **x** and the label of the vertex representing **Y** be **y**. Consider the residual graph with respect to some maximum flow **f**. Which of the following is true if q < p? Note that if a directed edge (u, v) has infinite capacity in the flow network, then with respect to any flow that uses this edge, the residual graph will have edges (u, v) with infinite residual capacity and (v, u) as an edge with the same residual capacity as f(u, v).

Options :

6406531933180. ✔ Both **x** and **y** are always reachable from **S** in the residual graph.

6406531933181. ✖ It is possible that both (S, x) and (S, y) are saturated with respect to **f**.

6406531933182. ✔ Both (x, T) and (y, T) are saturated with respect to **f**.

6406531933183. ✖ At most one of (x, T) and (y, T) can be saturated with respect to **f**.

Data Viz

Section Id :	64065339134
Section Number :	10
Section type :	Online
Mandatory or Optional :	Mandatory
Number of Questions :	5
Number of Questions to be attempted :	5
Section Marks :	100
Display Number Panel :	Yes
Group All Questions :	No
Enable Mark as Answered Mark for Review and Clear Response :	Yes
Maximum Instruction Time :	0
Sub-Section Number :	1
Sub-Section Id :	64065382982
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Number : 186 Question Id : 640653579027 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 0