Discrete Mathematics (PCC-CS-401) PYQs analysis

Based on: May 2019, Oct 2020 Set 1, Set 2, May 2023, 2024

- Syllabus:
  - Module 1: Sets, Relations, and Functions
    - Sets, Set Operations, Principle of Inclusion-Exclusion, Relations, Equivalence Relations, Partial Orderings, Functions, Inverse Functions, Composition
  - Module 2: Mathematical Logic
    - Propositional Logic, Logical Connectives, Truth Tables, Normal Forms, Validity, Predicate Logic, Universal/Existential Quantifiers, Inference Rules
  - Module 3: Counting and Discrete Probability
    - Counting Principles, Permutations, Combinations, Binomial Theorem, Discrete Probability, Conditional Probability, Bayes Theorem
  - Module 4: Algebraic Structures and Morphism
    - Semi Groups, Monoids, Groups, Congruence Relations, Quotient Structures, Free/Cyclic Monoids and Groups, Permutation Groups, Normal Subgroups, Rings, Integral Domain, Fields, Boolean Algebra, Boolean Ring, Duality, Boolean Function Representation, Disjunctive/Conjunctive Normal Form
  - Module 5: Graphs and Trees
    - Graphs, Degree, Connectivity, Path, Cycle, Subgraph, Isomorphism, Eulerian/Hamiltonian Walks, Graph Coloring, Planar Graphs, Vertex/Edge Coloring, List Coloring, Perfect Graphs, Rooted Trees, Sorting, Weighted Trees, Prefix Codes, Bi-connected Components, Articulation Points, Shortest Distances
  - Repeated Questions (Identical or near-identical):
    - *Topic:*
      - Define *bijective functions/one-to-one correspondence.*
    - *Year:*
      - 1.5 marks: 2019 1(i), 2020 Set 1: 1(j), 2020 Set 2: 1(j), 2023: 1(j), 2024: 1(j)

- *Topic:*
  - Define *cut point and bridge* in graphs
- *Year:*
  - **1.5 marks:**
    - 2019 1(g), 2020 Set 1: 1(d), 2020 Set 2: 1(d), 1.5 marks each.
- *Topic:*
  - Define *Perfect Graph* with example
- *Year:*
  - 2019: 6(b), 2020 Set 1: 1(g), 2020 Set 2: 4th question, marks differ
- *Topic:*
  - Prove *Schroeder–Bernstein theorem*
- *Year:*
  - 2019: 6(a), 2020 Set 1: 5(b), 2020 Set 2: (5b), marks differ
- *Topic:*
  - Define *Cantor's Diagonal Argument*
- *Year:*
  - 2019: 2(c), 2020 Set 1: 2(c), 2020 Set 2: 2(c), 2023: 6(b), 2024: 6(b) prove uncountable sets, 5–7.5 marks
- *Topic:*
  - Define *ternary relation*
- *Year:*
  - **1.5 marks:** 2023: 1(i), 2024: 1(i)
- *Topic:*
  - *Composite functions* and *inverse function* values
- *Year:*
  - 2023: 2(a), 2(b), 2024: 2(a), 2(b), 15 marks in each
- *Topic:*
  - *CNF* and *DNF* for Boolean function

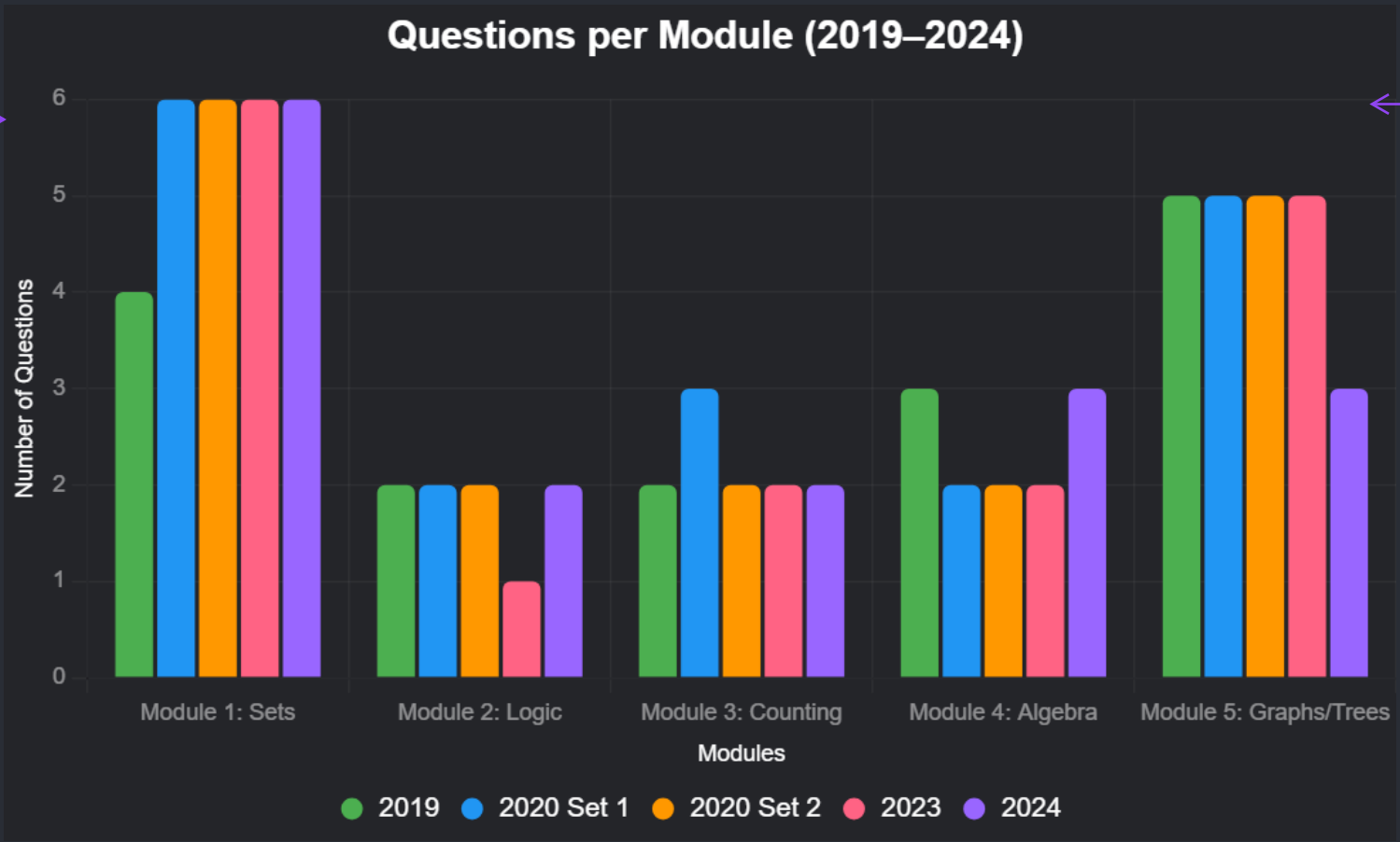
    - *Year:*
        - 2023: 4, 2024: 4, 15 marks each.
    - *Topic:*
        - *Properties* of *binary relation* (reflexive, symmetric, antisymmetric, transitive)
    - *Year:* 2023: 5(a), 2024: 5(a), 10 marks in each.
- Similar Questions (Same topic, minor deviations):
    - *Topic:*
        - Equivalence relation/partition
    - *Year:*
        - *1.5–5 marks:* 2019: 1(b) *define*, 2020 Set 1: 1(f) *prove*, 2020 Set 2: 1(e) *partition*, 1(f) *prove*, 2023: 5(b) *define*, 2024: 5(b) *define*
    - *Topic:*
        - Inverse functions
    - *Year:*
      2019: 2(a) (f(x) = x+1), 2020 Set 1: 1(h) (f(a) = (2a-1)/3), 2020 Set 2: 1(h) (f(a) = (4a-2)/3), 2023: 2(b), 2024: 2(b), marks differ
    - *Topic:*
        - Permutations
    - *Year:*
      2019: 1(c) "INSTITUTION", 2020 Set 1: 1(i) "EXAMINATION", 2020 Set 2: 1(i) "APPLE", 2023: 1(b), 1.5 marks.
    - *Topic:*
        - Logical inference/validity/contradiction
    - *Year:*
      2019: 3(b), 2020 Set 1: 3(b), 2020 Set 2: 3(b), 2023: 1(h) *validity/satisfiability*, 2024: 1(f) *contradiction*, 3(a) *proposition*, 1.5–7.5 marks
    - *Topic:*
        - Mathematical induction
    - *Year:*
      2019: 1(d) (n^2), 2020 Set 1: 2(b) (2^n), 2020 Set 2: 2(b) (n^2), 3–6 marks

- *Topic:*
  - Inclusion–Exclusion
- *Year:*
  2020 Set 1: 2(a) *students*, 2020 Set 2: 2(a) *canteen*, 2023: 1(g), 2024: 1(c) *Venn diagram*, 1.5–6 marks
- *Topic:*
  - *Group/monoid* properties
- *Year:*
  2019: 7(b) (a * b = a + b - ab), 2020 Set 1: 6(a) (a * b = ab/4), 2020 Set 2: 6(a) (a * b = a + b - ab), 2023: 1(f) *define*, 2024: 1(d) *define monoid*, 7(a) *monoid/group/semi-group*, marks differ
- *Topic:*
  - Minimum Spanning Tree
- *Year:*
  2020 Set 1: 7(b), 2020 Set 2: 7(b), 5 marks each
- *Topic:*
  - Well Ordering Principle
- *Year:*
  2023: 1(a), 2024: 1(a), 1.5 marks each

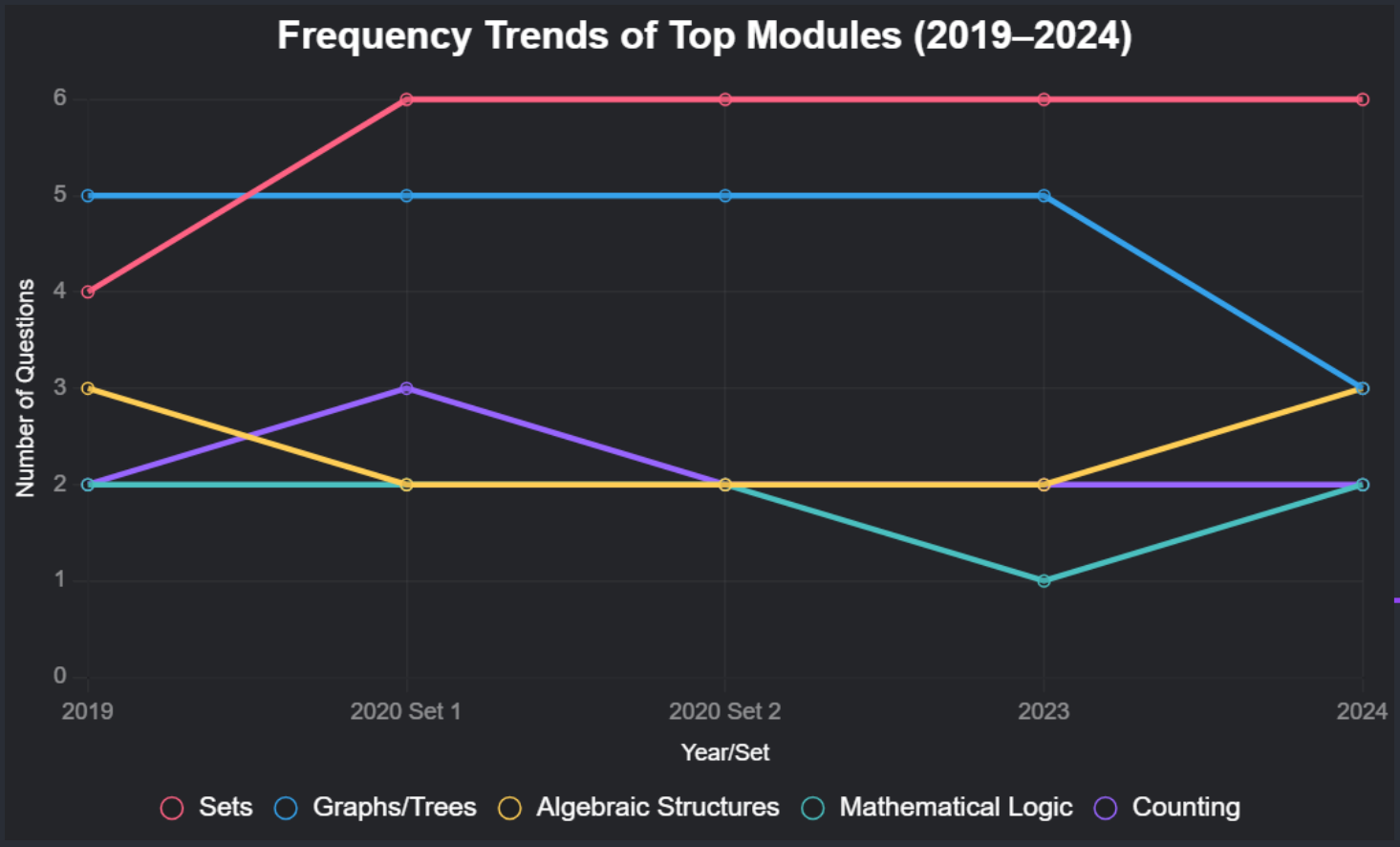
- **Latest Questions (2024, not in 2019–2023):**
  - *Topic:*
    - Place 3 red balls in 10 boxes
  - **May 2024:**
    - 1(b), 1.5 marks, Module 3: *Counting*
  - *Topic:*
    - Minimum number of people with same birthday month
  - **May 2024:**
    - 1(h), 1.5 marks, Module 3: *Counting*
  - *Topic:*
    - Define *weighted graph*

- May 2024:
  - 1(g), 1.5 marks, Module 5: Graphs
- *Topic:*
  - Algebraic system with two binary operations
- May 2024:
  - 7(b), 5 marks, Module 4: Algebraic Structures

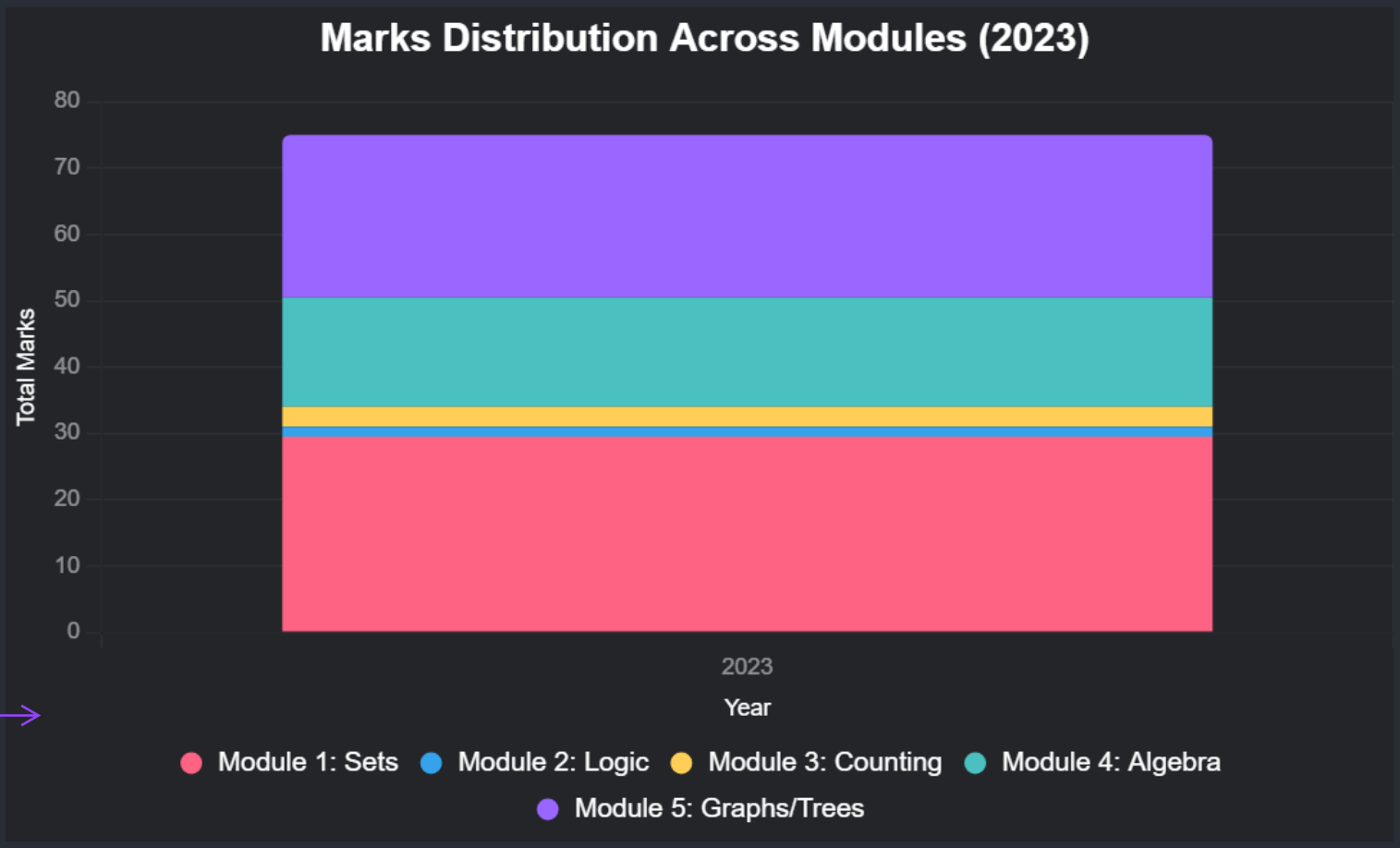
Visual Data Insights



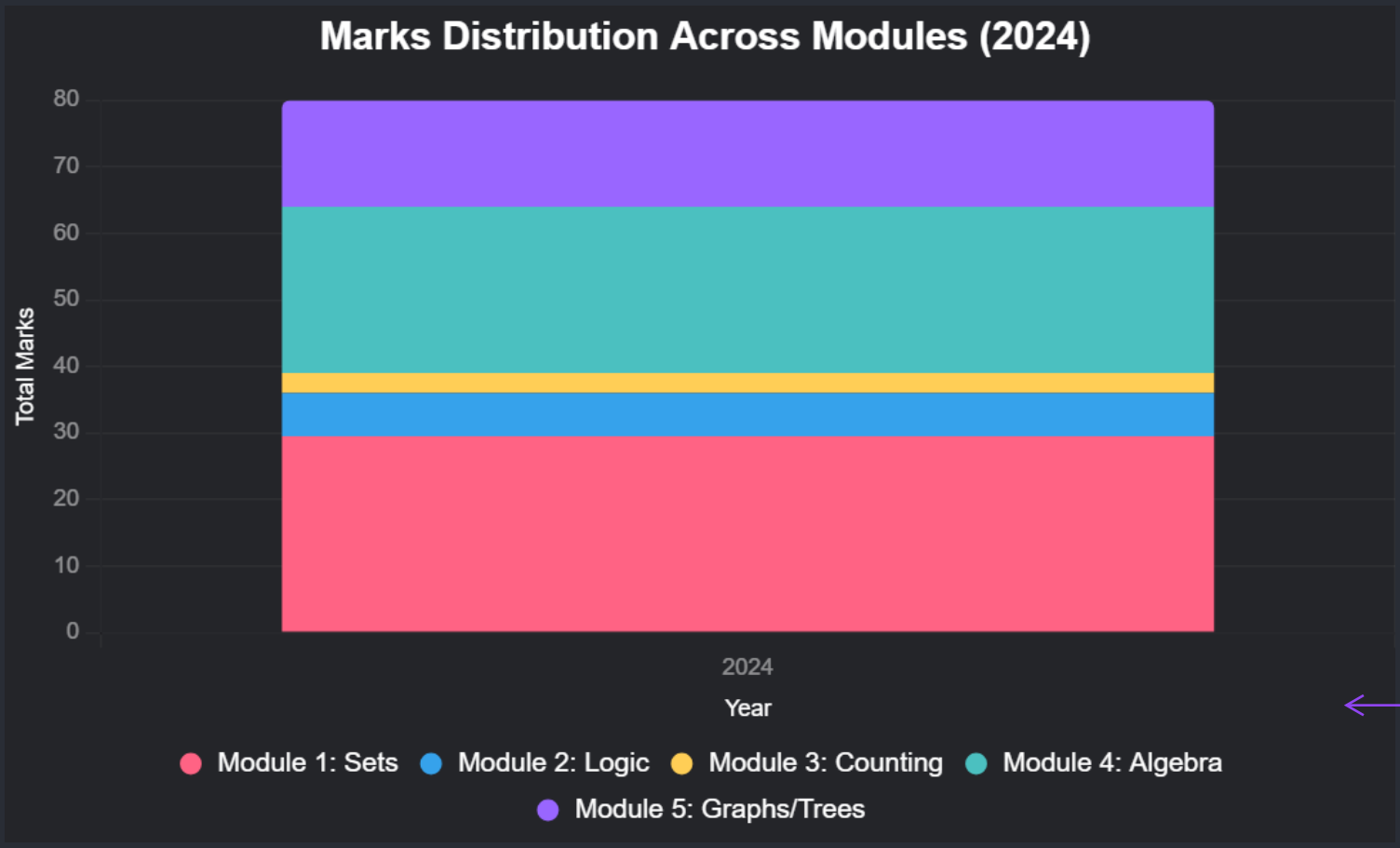
Bar Chart: Number of Questions per Module



Line Graph: Frequency trends of top 5 topics



Stacked Bar Chart: Marks Distribution Across Modules (2023)



Stacked Bar Chart: Marks Distribution Across Modules (2024)

Original Data

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Roll No. ..... Total Pages : 4

301401

May 2019

B.Tech. (CE/IT/CSE)- IVth Semester

DISCRETE MATHEMATICS

(PCC-CS-401)

Time : 3 Hours] [Max. Marks : 75

Instructions :

(i) It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.

(ii) Answer any four questions from Part-B in detail.

(iii) Different sub-parts of a question are to be attempted adjacent to each other.

PART–A

1. (a) For any set A and B, show that

$(A \cap B) \cup (A - B) = A$. (1.5)

(b) Define equivalence relation with example. (1.5)

(c) How many 11 letter words can be formed using letters from the word "INSTITUTION" ? (1.5)

(d) Show that $1^2 + 2^2 + 3^2 + \ldots\ldots + n^2 = n(n + 1)(2n + 1)/6$. (1.5)

(e) What is a bipartite Graph? (1.5)

(f) Define Euler Formula. (1.5)

(g) What is a cut point and bridge in graphs ? (1.5)

(h) What are quantifiers in propositions? (1.5)

(i) What are bijective functions? (1.5)

(j) List the applications of trees. (1.5)

PART–B

2. (a) Let f be a function from the set of integers such that $f(x) = x + 1$. Is f invertible, and if it is what is its inverse? (5)

(b) Seven women and nine men are on faculty in the mathematics department in a university. In how many ways a committee of five members of the department can be constructed if at least one woman and atleast one man must be in the committee?

(c) Define Cantor's Diagonal Argument. (5)

3. (a) Show that following implication is tautology :

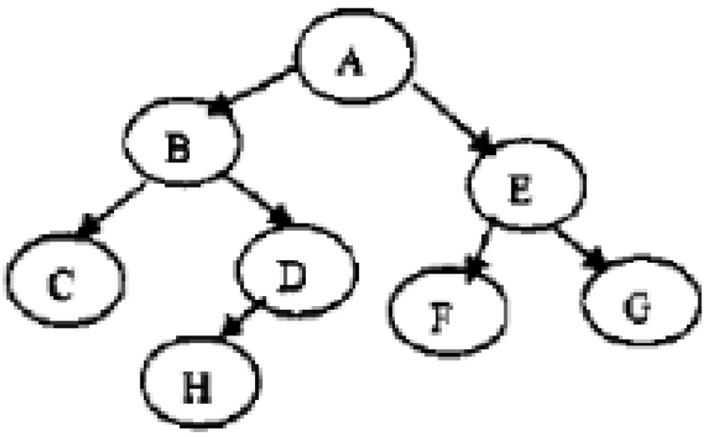
(i) $(p => q) \vee r \Leftrightarrow [(p \vee r) => (q \vee r)] =>$

(ii) $(p \wedge q => r) \Leftrightarrow (p => r) \vee (q => r)$ (10)

(b) Find the validity of the following Argument :

Either Ram is a good boy or Rahul is a good boy. Ram is not a good boy therefore Rahul is a good boy. (5)

4. (a) Determine the Inorder, preorder and postorder Traversal of following tree : (6)



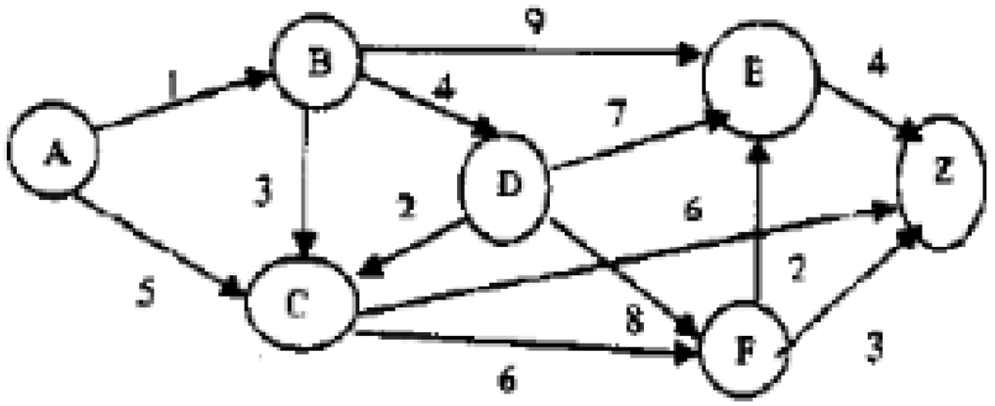
(b) Write short notes on following :

(i) CNF.

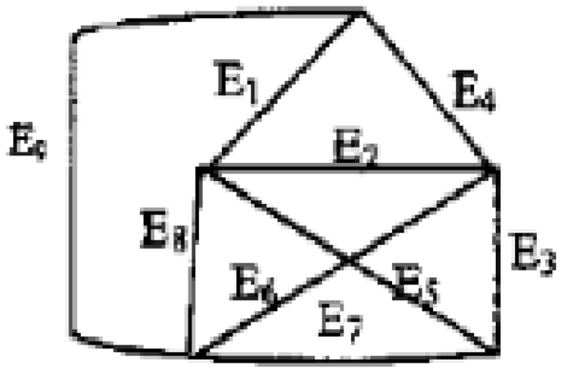
(ii) Hamiltonian Graph.

(iii) Subgroups in algebraic structures. (9)

5. (a) Find the shortest distance between A and Z : (10)



(b) What is a chromatic number in a graph?. Determine the chromatic number for the following graph : (5)



6. (a) Explain and prove Schroeder Bernstein theorem. (10)

(b) What is a Perfect Graph? Explain with example. (5)

7. (a) What is Integral domain? Explain with example. (5)

(b) Consider an algebraic system (Q,*) where Q is a set of rational numbers and * is binary operation defined by:

$$a*b=a+b-ab$$

Determine whether (Q,*) is a group. (10)

Roll No. ..... Total Pages : 4

301401

October, 2020

B.Tech. (CE/IT/CSE) - IV SEMESTER

Discrete Mathematics (PCC-CS-401)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail out of 7 questions.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART - A

1. (a) State and Prove Demorgan's Law. (1.5)

   (b) What are quantifiers? Give Example. (1.5)

   (c) Define multisets and various operations on them. (1.5)

   (d) Define Cut point and Bridge in Graphs. (1.5)

   (e) Define Circular permutation. (1.5)

   (f) Let A = {1, 2, 3, 4, 6, 7, 8, 9} and let R be the relation on A×A defined as (a, b) R (c, d) if a + d = b + c. Prove that R is an equivalence relation. (1.5)

(g) What is a Perfect Graph? Explain with example. (1.5)

(h) Let f be a function from A to B, where A = B = Set of real numbers R and f(a)= (2a-1)/3. Find f^{-1}. (1.5)

(i) In the different permutations of the word 'EXAMINATION' are listed as in a dictionary, How many items are there in the list before the first word starting with E. (1.5)

(j) What are bijective functions? Explain with Example. (1.5)

PART - B

2. (a) Among 100 Students, 32 study Mathematics, 20 study physics, 45 study Biology, 15 study mathematics & Biology, 7 study Mathematics & Physics, 10 study Physics & Biology and 30 do not study any of the three subjects.

(i) Find the number of students studying all three subjects.

(ii) Find the number of students studying exactly one of the three subjects. (6)

(b) Use mathematical induction to show that

$1 + 2 + 2^2 + ... + 2^n = 2^{n+1} - 1$

for all nonnegative integers n. (5)

(c) Define Cantor's Diagonal Argument (4)

3. (a) Find whether the following implication is tautology, contradiction or contingency :

(i) $(p \Rightarrow q) \vee r \Leftrightarrow [(p \vee r) \Rightarrow (q \vee r)]$

(ii) $(p \wedge q \Rightarrow r) \Leftrightarrow (p \Rightarrow r) \vee (q \Rightarrow r)$ (10)

(b) Find the validity of the following Argument :

If I study then I will not fail in mathematics, If I donot play football then I will study, But I failed in Mathematics. Therefore I must have played football (5)

4. Explain the following(with proper Example) :

(i) Bipartite Graph.

(ii) Euler Formula.

(iii) Partial Order Relation. (15)

5. (a) Construct the binary tree for following traversals of a tree :

Preorder : a b d e h c f g i j

Inorder : d b h e a f c i j g (5)

(b) Explain and prove Schroeder Bernstein theorem. (10)

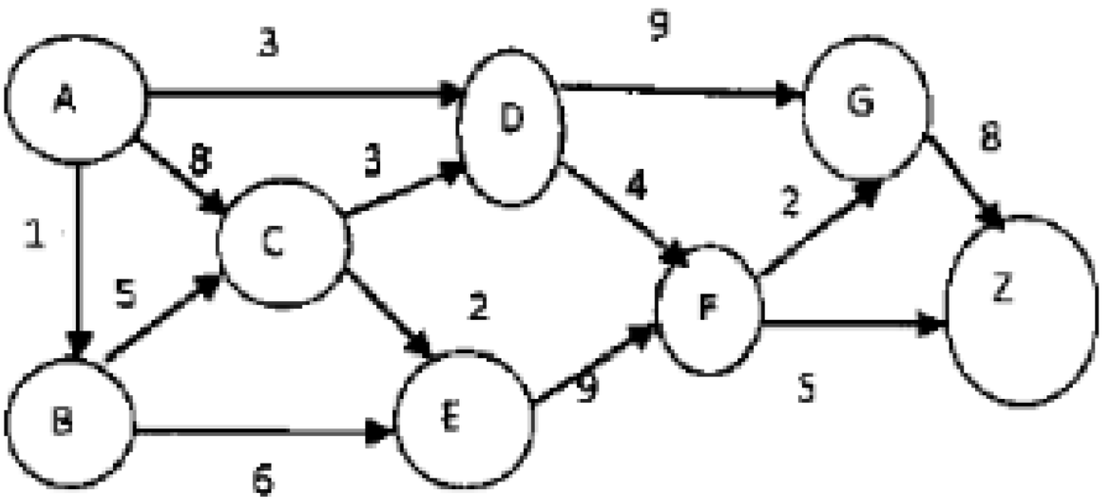
6. (a) Consider an algebraic system (G. *), where G is the set of all non-zero real numbers and * is a binary operation defined by

$a*b=(ab)/4$

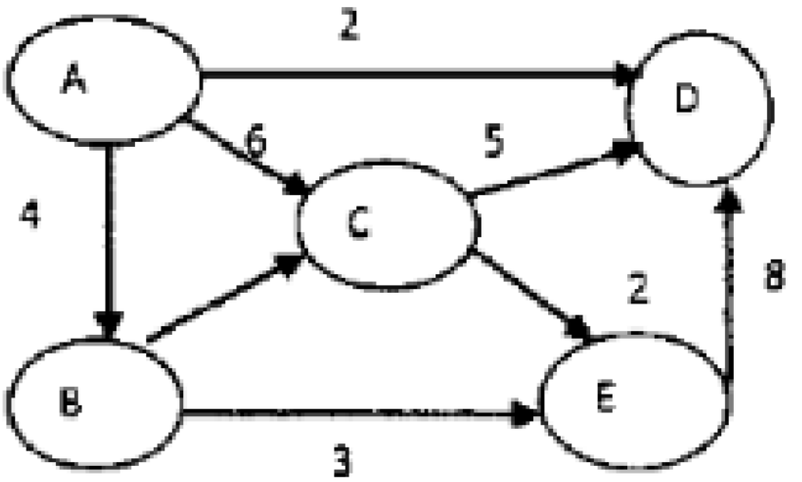
Show that (G, *) is an abelian group. (10)

(b) What is Field in algebraic systems? Explain with example. (5)

7. (a) Find the shortest distance between A and Z using Dijkstra algorithm stepwise: (10)



(b) Draw the Minimum Spanning tree for following graph: (5)



Oct 2020

B.Tech.(CSE)- IV SEMESTER

Discrete Mathematics (PCC-CS-401)

Time: 3 Hours **Max. Marks:75**

Instructions :
1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail out of 7 questions.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART -A

Q1 (a) Prove that Intersection of sets is distributive with respect to union of sets. (1.5)

(b) Prove that $p \wedge (\sim p)$ is a contradiction. (1.5)

(c) Define multisets and various operations on them. (1.5)

(d) Define Cut point and Bridge in Graphs. (1.5)

(e) Explain Partition with proper example. (1.5)

(f) State and proveequivalence relation with example. (1.5)

(g) Explain Euler formula with example. (1.5)

(h) Let f be a function from A to B, where A=B=Set of real numbers R and $f(a)= (4a-2)/3$. Find f^{-1} . (1.5)

(i) How many permutations of the letters of the word 'APPLE' are there. (1.5)

(j) What are bijective functions? Explain with Example. (1.5)

PART -B

Q2 (a) In a canteen, out of 123 students, 42 students buy ice-cream, 36 buy bums and 10 buys cakes, 15 students buy ice-cream and buns, 10 buys ice-cream and cakes, 4 buys cakes and buns but not ice-cream and 11 buys ice-cream and buns but not cakes. Draw venn diagram to illustrate the above information and find: (6)

a. How many students buy nothing at all?

b. How many students buy at least two items?

c. How many students buy all the three items?

(b) Use mathematical induction to show that (5)
$1^2 + 2^2 + \ldots + n^2 = \frac{n(n+1)(2n+1)}{6}$, $n>=1$

(c) Define Cantor's Diagonal Argument.(5)

Q3 (a) Find whether the following implication is tautology, contradiction or contingency : (10)

a. $(p \Rightarrow q) \vee r \Rightarrow [(p \vee r) \Rightarrow (q \vee r)]$

b. $(p \wedge q \Rightarrow r) \vee (p \Rightarrow r) \vee (q \Rightarrow r)$

(b) Find the validity of the following Argument : (5)

Robbery was the motive for the crime only if the victim had money in his pockets. But robbery or vengeance was the motive for the crime.Therefore, vengeance must have been the motive for the crime.

Q4 Explain the following(with proper Example): (15)
i) Perfect Graph
ii) Articulation point
iii) Partial Order Relation

Q5 (a) Construct the binary tree for following traversals of a tree: (5)
Preorder : a b d h e i c f g
Inorder : h d b i e a f c g

(b) Explain and prove Schroeder Bernstein theorem. (10)

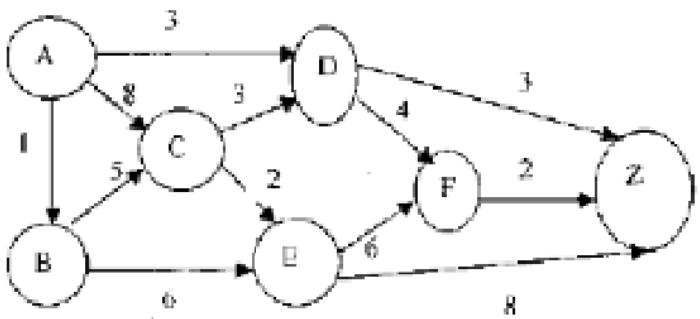
Q6 (a) Consider an algebraic system (G, *), where G is the set of all non-zero real numbers and * is a binary operation defined by (10)

$$a*b=a+b-ab$$

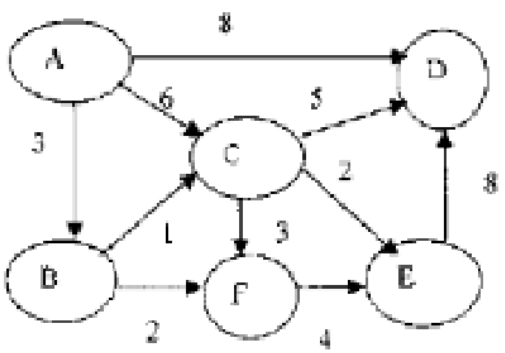
Show that (G, *) is a group.

(b) What is Integral Domain in algebraic systems? Explain with example (5)

Q7 (a) Find the shortest distance between A and Z using Dijkstra algorithm stepwise: (10)



b) Draw the Minimum Spanning tree for following graph: (5)



Sr. No. 003401

May 2024

B.Tech. (CE/IT/CSE(AIML)/CE(Hindi) 4th Sem.

Discrete Mathmeatics (PCC-CS-401)

Time: 3 Hours **Max. Marks:75**

Instructions **:**
1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART -A

Q1 (a) Define Well Ordering Principle- (1.5)

Well Ordering सिद्धांत को परिभाषित करें।

(b) Three red balls are to be placed in ten numbered boxes but one box can contain exactly one ball. Find the number of distinct ways in which the balls can be placed. (1.5)

तीन लाल गेंदों को दस संख्यांकित बक्सों में रखा जाना है लेकिन एक डिब्बे में ठीक एक गेंद हो सकती है। गेंदों को कितने अलग-अलग तरीकों से रखा जा सकता है, इसकी संख्या ज्ञात कीजिए।

(c) Every student of a class participates in either one or two or all the three games being played in the school. Make the Venn diagram for this. (1.5)

एक कक्षा का प्रत्येक छात्र स्कूल में खेले जाने वाले कम से कम एक, दो या तीन खेल में भाग लेता है। इसके लिए Venn diagram बनाइए।

(d) Define monoid in relevance to Algebraic Structure? (1.5)

बीजगणितीय संरचना की प्रासंगिकता में monoid को परिभाषित करें।

(e) What do you mean by Non-Planar Graph? (1.5)

Non-Planar Graph से आप क्या समझते हैं?

(f) What do you mean by contradiction? (1.5)

contradiction से आप क्या समझते हैं।

(g) What do you mean by weighted Graph? (1.5)

Weighted Graph से आप क्या समझते हैं?

(h) In a group of 45 people, How many minimum number of people have their birthday in the same month? (1.5)

45 लोगों के समूह में, उसी महीने में कम से कम कितने लोगों का जन्मदिन है?

(i) What do you mean by Ternary Relation? (1.5)

Ternary Relation से आप क्या समझते हैं?

(j) What do you mean by one-to-one and on-to functions. (1.5)

One-to-one and on-to Function से आप क्या समझते हैं?

PART -B

Q2 (a) If $f(x)$ and $g(x)$ be the function from the set of integers defined as $f(x) = 2x^2 +$ (10)
2 and $g(x) = 3x^2 + 3$ then determine following

(i) $f\ o\ g$

(ii) $g\ o\ f$

यदि $f(x)$ और $g(x), f(x) = 2x^2 + 2$ और $g(x) = 3x^2 + 3$, के रूप में परिभाषित पूर्णांकों के समुच्चय से function हो तब निम्न निर्धारित करें-

(i) $f\ o\ g$

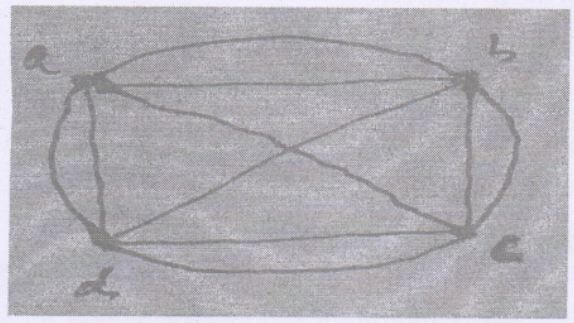
(ii) $g\ o\ f$

(b) If $f(x)$ be a function from the set $\{1,2,3,4\}$ to the set $\{a, b, c, d\}$ with $f(1) =$ (5)
$a, f(2) = b, f(3) = c, f(4) = d$, then determine $f^{-}(a), f^{-}(b), f^{-}(c), f^{-}(d)$.
यदि $f(x)$ एक function समुच्चय $\{1,2,3,4\}$ से समुच्चय $\{a, b, c, d\}$ में $f(1) = a, f(2) = b, f(3) = c, f(4) = d$ है, तब निर्धारित करें $f^{-}(a), f^{-}(b), f^{-}(c), f^{-}(d)$.

Q3 (a) Consider three propositions- 1. The temperature exceeds 70 degree celcius 2. (5)
The alarm will be sounded. 3. If the temperature exceeds 70 degree celcius then
The alarm will be sounded.
In what situation propositions 3 will be true?

तीन propositions पर विचार करें- 1. तापमान 70 डिग्री सेल्सियस से अधिक हो 2. अलार्म बज जाएगा। 3. यदि तापमान 70 डिग्री सेल्सियस से अधिक हो गया तो अलार्म बज जाएगा।
propositions 3 के सत्य होने निर्धारित करें?

(b) Determine the chromatic number for the given graph. (10)
दिए गए ग्राफ के लिए chromatic number निर्धारित करें।



Q4 Obtain the, both, CNF and DNF for the given Boolean Function without using the truth table- $(y + x')z$ (15)

Truth table का उपयोग किए बिना दिए गए Boolean Function के लिए, CNF और DNF दोनों प्राप्त करें- $(y + x')z$

Q5 (a) If R is a binary relation on the set of integers *i. e.* $\{0, 1, 2, 3, \ldots\}$ such that $(a, b) \in$ R if and only if $(a - b) \geq 1$) then determine whether the relation R is (10)

(i) Reflexive
(ii) Symmetric
(iii) Antisymmetric
(iv) Transitive

यदि R पूर्णांक के समुच्चय पर एक द्विआधारी relation है अर्थात $\{0, 1, 2, 3, \ldots\}$ ऐसा है कि $(a, b) \in R$ अगर और केवल अगर $(a - b) \geq 1$) निर्धारित करें कि relation R क्या है-

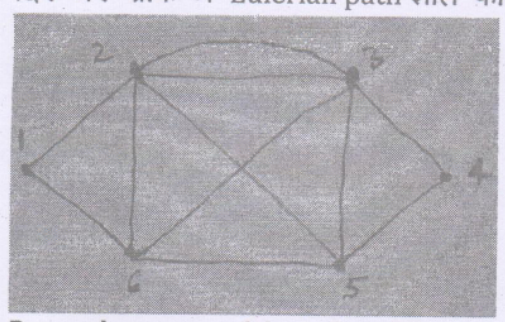
(i) Reflexive
(ii) Symmetric
(iii) Antisymmetric
(iv) Transitive

(b) Define Partial Ordering Relation and Equivalence Relation. (5)

Partial Ordering Relation और Equivalence Relation परिभाषित करें

Q6 (a) Find the Eulerian path in the given graph. (10)

दिए गए ग्राफ में Eulerian path ज्ञात कीजिए।



(b) Proov that some of the infinite sets are not countable. (5)

सिद्ध कीजिए कि कुछ अनंत समुच्चय गणनीय नहीं हैं।

Q7 Write short note on the following- (15)

(a) Monoid, Group and Semi-group
(b) Give example of algebraic system with two Binary operations
(c) Give an example of Infinite Set

निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए-

(a) Monoid, Group and Semi-group
(b) Algebraic system with two Binary operations का एक उदाहरण दीजिए
(c) Infinite Set का एक उदाहरण दीजिए

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