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University Examinations 2022/2023

FIRST YEAR, SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN DATA SCIENCE

SMA 3212: DISCRETE STRUCTURES

DATE: AUGUST 2023

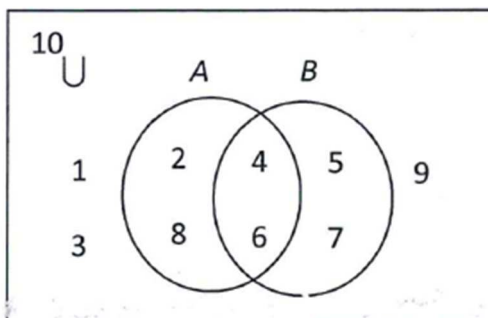
TIME: 2 HOURS

INSTRUCTIONS: Answer question one and any other two questions

QUESTION ONE (30 MARKS)

a) Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. Using the Venn diagram provided below find (6 marks)

- i) A
- ii) $(A \cup B)^c$
- iii) $A^c \cap B^c$



b) Can a simple graph have 5 vertices and 12 edges? If so, draw it; if not, explain why it is not possible to have such a graph. (3 marks)



- c) Determine the number of permutations of the letters of the word RECURRENCERELATION (3 marks)
- d) The English alphabet consists of 21 consonants and 5 vowels. (3 marks each)
- In how many ways can 4 consonants and 2 vowels be selected?
 - How many words consisting of 4 consonants and 2 vowels can be formed?
 - How many of the words in (ii) begin with R?
- e) Show that the functions $f(x) = x^3$ and $g(x) = x^{\frac{1}{3}}$ are inverses of each other (4 marks)
- f) Prove by mathematical induction that $n^3 - n$ is divisible by 3 whenever n is a positive integer (5 marks)

QUESTION TWO (20 MARKS)

- a) Suppose that in a group of 5 people A, B C D and E the following parts of people are acquainted with each other
- A and C
- A and D
- B and C
- C and D
- C and E
- Draw a graph G to represent this situation (5 marks)
 - List the vertex set, and the edge set, using set notation. In other words, show sets V and E for the vertices and edges, respectively, in $G = \{V, E\}$ (4 marks)
 - Draw an adjacency matrix for G (5 marks)
- b) For the functions illustrated below, state with a reason which one of them is an injection, surjection and a bijection (6 marks)



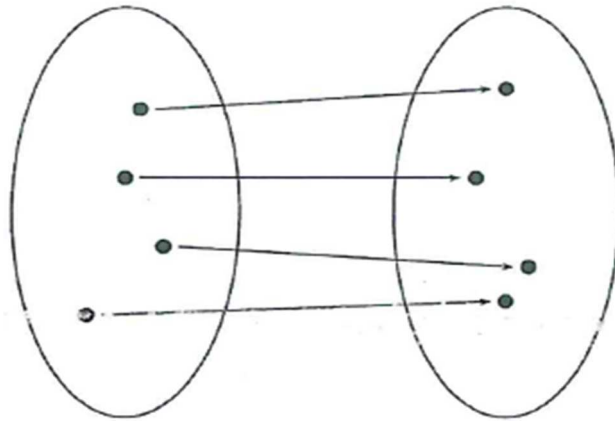


Figure a

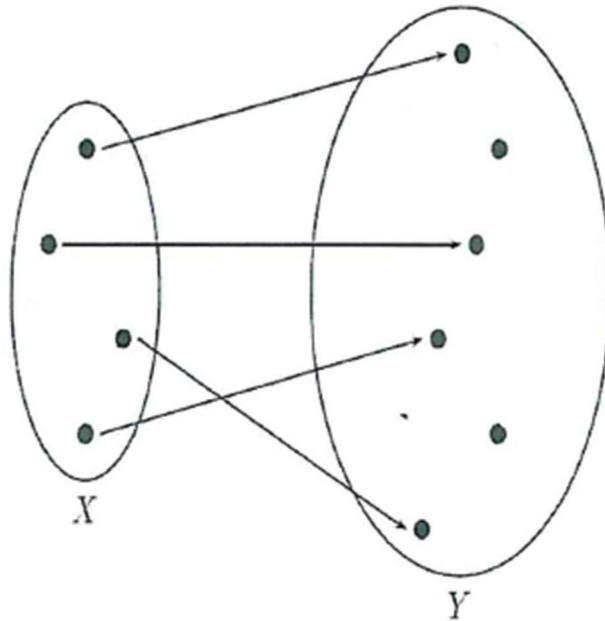


Figure b

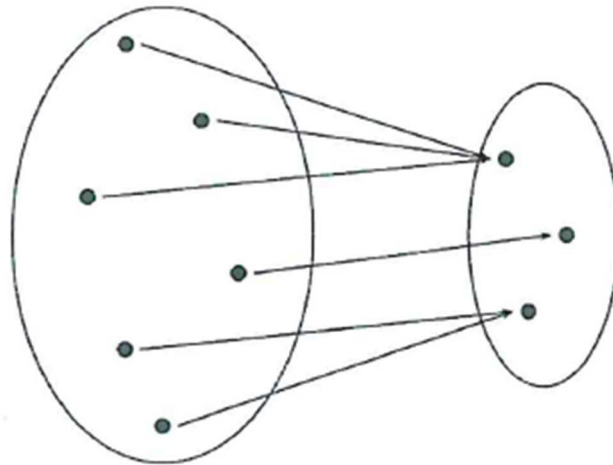


Figure c

QUESTION THREE (20 MARKS)

- a) How many 3-digit odd numbers greater than 600 can be formed using the digits (2, 3, 4, 5, 6 and 7)? (3 marks)
- b) There are 9 dots randomly placed on a circle. How many triangles can be formed within the circle? (3 marks)
- c) Draw a logic gate circuit for the output states
 - i) $Q = A \text{ AND NOT } B$ (4 marks)
 - ii) $Q = (\text{NOT } (A \text{ OR } B) \text{ OR } (B \text{ AND } C))$ (5 marks)
- d) Use a truth table to prove that $A(A' + B) = AB$ (5 marks)

QUESTION FOUR (20 MARKS)

- a) Prove by mathematical induction that $1^3 + 2^3 + \dots + n^3 = \frac{1}{4}n^2(n + 1)^2$ (4 marks)
- b) Provide a truth table for the not functions as used in Boolean algebra (3 marks)
- c) Simplify the Boolean expression $\bar{P} \cdot \bar{Q} + \bar{P} \cdot Q + P \cdot \bar{Q}$ (3 marks)
- d) Let f be a function from a, b, c to $1, 2, 3$ such that $f a = 2, f b = 1$, and $f c = 3$. Determine whether f is invertible and if so find its inverse (5 marks)
- e) For the function f defined by $f x = 2x^2 + 3x - 1$ evaluate



- i) $f(2)$ (2 marks)
- ii) $f(a + h)$ (3 marks)

QUESTION FIVE (20 MARKS)

- a) How many different license plates can be made of each plate contains a sequence of three uppercase English letters followed by three digits (and no sequences of letters or digits are prohibited)? (2 marks)
- b) The first four terms of the binomial expansion of $(1 + 2x)^8$ in ascending powers of x are $1 + ax + bx^2 + cx^3$ find the values of integers a, b and c (4 marks)
- c) In how many ways can 20 committee members sit around a circular conference table if the chairman must sit between the secretary and the treasurer? (4 marks)
- d) Suppose that there are 9 faculty members in the mathematics department and 11 in the computer science department. How many ways are there to select a committee to develop a discrete mathematics course if the committee is to consist of three faculty members from the mathematics depart and four from the computer science department? (4 marks)
- e) Draw a graph G corresponding to the adjacency matrix (6 marks)

$$A = \begin{bmatrix} 0 & 1 & 2 & 0 \\ 1 & 0 & 1 & 1 \\ 2 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

