Nirma University
Institute of Technology
MCA, Semester-I
3CA1155 Mathematical Foundations
Tutorial-1 (Set Theory)

1. Consider the sets

$$A = \{4, 7, 8, 9, 15, 12, 13, 20\}$$
$$B = \{5, 7, 9, 12, 20\}$$
$$C = \{7, 2, 4, 5, 13, 20\}$$
$$D = \{1, 17, 2, 24, 5, 3, 20\}$$

Find $(A \cup B) \cap C,\ A \cap D, A \cap D, A^c, B^c, C^c,\ (A\Delta B)$, $(A \backslash B)$, $(B \backslash A)$.

2. Given sets $C = \{x \in \mathbb{N}: x \leq 15, x\ is\ even\}, D = \{x \in \mathbb{N}: x\ is\ a\ divisor\ of\ 20\}$.

If the universal set is $U = \{x \in \mathbb{N}: 1 \leq x \leq 20\}$, verify De Morgan's law.

3. Given sets $A = \{x \in \mathbb{N}: 1 \leq x \leq 15, x\ is\ even\}$,

$$B = \{x \in \mathbb{N}: x\ is\ a\ divisor\ of\ 30\ and\ x < 20\}.$$

Is $A \subset B?\ Is\ B \subset A?$

If the universal set is $U = \{x \in \mathbb{N}: 1 \leq x \leq 20\}$, Find $A^c, B^c, A^c \cap B^c, A^c \cup B^c,\ A \cup B, A \cap B$. Check whether $A^c \cap B^c = (A \cup B)^c,\ A^c \cup B^c = (A \cap B)^c$.

4. Given sets $A = \{x \in \mathbb{N}: 1 \leq x \leq 15\}$,

$$B = \{x \in \mathbb{N}: x\ is\ a\ divisor\ of\ 30\ and\ x < 20\}.$$

Is $A \subset B?\ Is\ B \subset A?$

If the universal set is $U = \{x \in \mathbb{N}: 1 \leq x \leq 20\}$, Find $A \backslash B, B \backslash A, A^c, B^c, A^c \cap B^c, A^c \cup B^c,\ A \cup B, A \cap B$. Check whether $A^c \cap B^c = (A \cup B)^c,\ A^c \cup B^c = (A \cap B)^c$.

5. In a class of 110 students 70 like the subject Hindi 60 like the subject English and 10 do not like both. Then find the number of students who like both the subjects. Use set theory to solve the problem.

6. There are 120 students in a class. Among them 50 students are learning both Mathematical Foundations and Probability subjects. A total of 70 are learning Mathematical Foundations. If every student is learning at least one subject, how many students are learning Probability in total?

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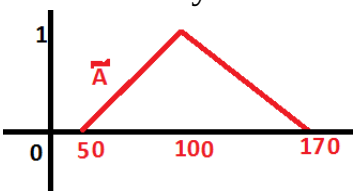
Tutorial-2 (Fuzzy Set Theory)

1. Define the fuzzy sets $\bar{A}: X \to [0,1], \bar{B}: X \to [0,1]$ by

$$\mu_{\bar{A}}(x) = \begin{cases} 0 & if\ x \le 100 \\ \frac{x-100}{200-100} & if\ 100 \le x \le 200 \\ \frac{300-x}{300-200} & if\ 200 \le x \le 300 \\ 0 & otherwise \end{cases}, \quad \mu_{\bar{B}}(x) = \begin{cases} 0 & if\ x \le 150 \\ \frac{x-150}{250-150} & if\ 150 \le x \le 250 \\ \frac{350-x}{350-250} & if\ 250 \le x \le 350 \\ 0 & otherwise \end{cases}$$

Find the fuzzy subsets $\bar{A} \cup \bar{B},\ \bar{A} \cap \bar{B}$

2. Given fuzzy sets



Obtain the fuzzy sets $\tilde{A} \cup \tilde{B}, \tilde{A} \cap \tilde{B}$.

3. Define the fuzzy sets $\bar{A}: X \to [0,1], \bar{B}: X \to [0,1]$ by

$$\bar{A} = \left\{\frac{0.5}{1} + \frac{0.6}{2} + \frac{0.4}{3} + \frac{0.4}{4} + \frac{0.9}{5}\right\}$$

$$\bar{B} = \left\{\frac{0.4}{1} + \frac{0.3}{2} + \frac{0.2}{3} + \frac{0.6}{4} + \frac{0.8}{5} + \frac{0.3}{6}\right\}$$

Obtain the fuzzy sets $\tilde{A} \cup \tilde{B}, \tilde{A} \cap \tilde{B}, \widetilde{A^c}, \widetilde{B^c},\ \widetilde{A^c} \cup \widetilde{B^c}, \widetilde{A^c} \cap \widetilde{B^c}$.

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Tutorial-3 (Relation)

1. Represent the relation
$$R = \{(1,1), (2,2), (3,3), (4,4), (1,2), (2,1), (3,4), (4,3)\}$$
on the set $A = \{1, 2, 3, 4\}$ pictorially.
Determine whether R is reflexive, symmetric, and/or transitive.

2. Define a relation R on the set of integers $\mathbb{Z}$ by
$$R = \{(x, y): x - y \; is \; divisible \; by \; 2 \}$$
Check whether the relation is Reflexive, Symmetric and/or Transitive.

3. Define a relation R on the set of integers $\mathbb{Z}$ by
$$R = \{(x, y): x - y \; is \; divisible \; by \; 3 \}$$
Check whether the relation is Reflexive, Symmetric and/or Transitive.

4. Define a relation R on the set of integers $\mathbb{Z}$ by
$$R = \{(x, y): 3x - y = 5 \}$$
Check whether the relation is Reflexive, Symmetric and/or Transitive.

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Tutorial-4 (Function)

1. Let $f: \mathbb{R} \to \mathbb{R}, g: \mathbb{R} \to \mathbb{R}$, be two functions defined by $f(x) = x^2 - 3x + 2$, and $g(x) = 2x - 3$. Find the expressions for $f \circ g$ and $g \circ f$.
Are $f \circ g$ and $g \circ f$ same? Also find $(f \circ g)(3)$ and $(g \circ f)(3)$.

2. Given $f: \mathbb{Z} \to \mathbb{Z}$ and $g: \mathbb{Z} \to \mathbb{Z}$ defined by
$$f(x) = x^2, \qquad g(y) = 3y - 2$$
Calculate $(f \circ g)(y)$ and $(g \circ f)(x)$.
Also find $(f \circ g)(3)$ and $(g \circ f)(3)$.

3. Given the function $f: \mathbb{Z} \to \mathbb{Z}$ defined by
$$f(x) = 3x - 5$$
Is f one-to-one, onto?

4. Given the function $f: \mathbb{Z} \to \mathbb{Z}$ defined by
$$f(x) = 3x^2$$
Is f one-to-one, onto?

5. Given the function $f: \mathbb{R} \to \mathbb{R}$ defined by
$$f(x) = 3x - 5$$
Is f one-to-one, onto?

6. Given the function $f: \mathbb{R} \to \mathbb{R}$ defined by
$$f(x) = 3x^2$$
Is f one-to-one, onto?

7. Given $A = \{1, 2, 3, 4, 5\}, B = \{-6, 0, 8, 18, 30\}$.
Define $f: A \to B$, by
$$f(x) = x^2 + 3x - 10.$$
Determine whether the function is (i) one-to-one, (ii) onto, (iii) both, (iv) neither.

Do a pictorial representation of the function.