# Discrete Structures.

*Lecture 1*

→ Basics of this Course:
- Sets
- Sequence
- Integers
- Matrix
- Logic
- Relations

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## *Sets*

$A = \{a, b, c\}$ , $B = \{1, 2, 3\}$ , $C = \{\text{"apple"}, \text{"orange"}\}$

$D = \{\#, \&, /\}$

→ The Set is well defined Collection of elements.

- Another way to define a set:

→ $x = \{x \mid x \text{ is a positive integer less than } 10\}$
$\therefore x = \{1, 2, 3, \ldots 9\}$

→ $z = \{x \mid x \text{ is a letter in Car}\}$
$\therefore z = \{c, a, r\}$

* Note: In sets, No order and No Repetition.

Example: $\{1,2,3\} = \{2,1,3\} = \{3,1,2\}$

$\{1,2,3,1\} = \{1,2,3\}$ «repetition is useless»

* $\emptyset$ "phi" = $\{\}$ empty set

- Some operations:

$$x = \{1, 2, 3, 4, 5\}$$

- $1 \in x$
- $7 \notin x$
- $\{2, 3\} \notin x$
- $\{1, 2\} \subseteq x$
- $\{1, 7\} \not\subseteq x$

- Note: $\emptyset$ is subset « $\subseteq$ » of any set but it doesn't belong « $\in$ » to any set unless it is an element in it.

* $\{See\} \subseteq \{yes\}$

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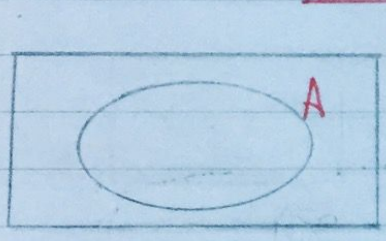
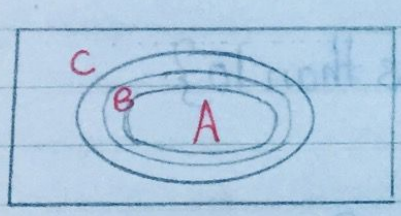
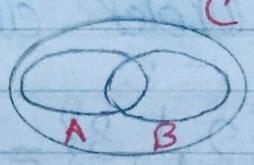



$A \subseteq B \;\&\; B \subseteq C$
$\therefore A \subseteq C$

* If $A \subseteq C \;\&\; B \subseteq C$

$\therefore$ it can be represented by

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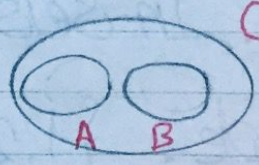


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⇒ $A = \{2,4,6\}$ , $|A| = 3$ "Cardenality" عدد عناصر المجموعة

, $P(A)$ "power set of A" $= \{\emptyset, \{2\}, \{4\}, \{6\}, \{2,4\}, \{2,6\}, \{4,6\}, \{2,4,6\}\}$

, $|P(A)| = 8 = 2^{|A|}$

$\rightarrow |P(x)| = 2^{|x|} \leftarrow$

* if we can count the elements of a set, so the set is finite but if we can't count them, so the set is infinite.

$Z^+$ "Set of positive integers" $= \{1,2,3,\dots\}$
$N$ "Set of natural numbers" $= \{0,1,2,\dots\}$
$Z^-$ "Set of negative integers" $= \{-1,-2,-3,\dots\}$

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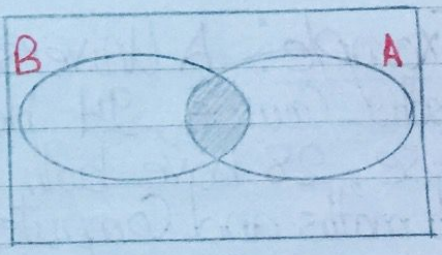
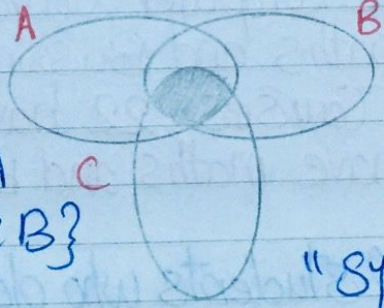
→ $A \cap B = \{x \mid x \in A \text{ and } x \in B\}$ "intersection"




$A \cap B \cap C \Rightarrow$




* $\bar{A}$ = all elements that $\notin A$
* $A - B = \{x \mid x \in A \text{ and } x \notin B\}$
* $A \oplus B = A \cup B - A \cap B$ "symmetric difference"

→ if we have $A = \{2,3,5\}$, we can get another set by multip it by a constant, for example $B = 6A$

$\therefore B = \{y \mid y = 6 * x \ \forall \ x \in A\} = \{12,18,$

$\forall$ for all

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- Important Notes:-

* $A \cup B = B \cup A$
* $A \cup (B \cup C) = (A \cup B) \cup C$
* $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$
* $A \cup A = A$
* $\bar{\bar{A}} = A$
* $A \cap B = B \cap A$
* $A \cap (B \cap C) = (A \cap B) \cap C$
* $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$
* $A \cap A = A$
* $\bar{\emptyset} = U$
* $\bar{U} = \emptyset$

* Demorgan:
  - $\overline{(A \cup B)} = \bar{A} \cap \bar{B}$
  - $\overline{(A \cap B)} = \bar{A} \cup \bar{B}$

* $A \cup U = U$
* $A \cup \emptyset = A$
* $A \cap U = A$
* $A \cap \emptyset = \emptyset$

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- Example: A University has 260 students, 64 of them have maths Course, 94 have Computer Course, 58 have Bussiness Course, 28 have both maths and Bussiness Courses, 26 have both maths and Computer Courses, 22 have both Computer and Bussiness Courses, 14 have maths and Bussiness and Computer Courses.

1- find number of students who don't have any Courses.
2- find number of students who have ONLY Computer Course.

→ Answer:- $|U| = 260$, $|M| = 64$, $|C| = 94$, $|B| = 58$, $|M \cap B| = 28$, $|M \cap C| = 26$, $|C \cap B| = 22$, $|M \cap B \cap C| = 14$

1→ $|\overline{M \cup B \cup C}| = |U| - |M \cup B \cup C|$

- we will use "Addition principle" to get $|M \cup B \cup C|$

∴ $|M \cup B \cup C| = |M| + |B| + |C| - |M \cap B| - |M \cap C| - |C \cap B| + |C \cap B \cap M|$

$= 64 + 58 + 94 - 28 - 26 - 22 + 14 = 154$

$\therefore |\overline{M \cup B \cup C}| = 260 - 154 = 106$ Students

2→ Students who have only Computer Course $= |C| - |C \cap M| - |C \cap B| + |M \cap B \cap C|$
$= 94 - 26 - 22 + 14$
$= 60$ Students.

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* Practically, We will use python language.

- Some python functions:-

$x = \{1, 2, 3, 4, 5, 6\}$

- x = print
- type(x) → Set
- 3 in x → true
- 2 not in x → False
- x. function → add, clear, remove
- x. add 7 → $x = \{x, 7\}$
- x. pop → remove 1st element
- alt + B → repeat last Command
- x. intersection(y) = $x \cap y$
- x. union(y) = $x \cup y$
- x. difference(y) = $x - y$
- x. symmetric(y) = x. difference(y). union (y. difference(x))

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- To learn more about python language, You Can visit Doctor's youtube channel via his facebook page "programming Community".

- Solve the practical in first two videos and send it to doctor's mail "Kareem_ahmed@hotmail.co.uk" with your name, Code, College and Subject name.

- Solve Ex 1.1, 1.2 in the book in a sheet.

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