SECI 1013

DISCRETE STRUCTURE

SEMESTER 1 2020/2021

TUTORIAL 1:

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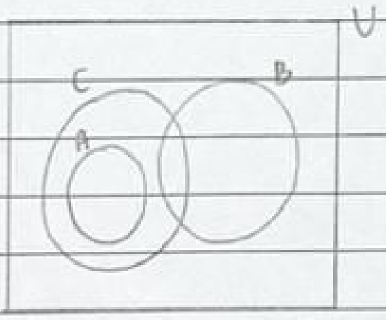
1. $A = \{x \in R \mid 0 < x \leq 2\}$
$B = \{x \in R \mid 1 \leq x < 4\}$
$C = \{x \in R \mid 3 \leq x < 9\}$

a) $A \cup C = \{x \in R \mid 0 < x \leq 2\} \cup \{x \in R \mid 3 \leq x < 9\}$
$= \{x \in R \mid 0 < x < 9\}$
$A \cup C = \{1, 2, 3, 4, 5, 6, 7, 8\}$

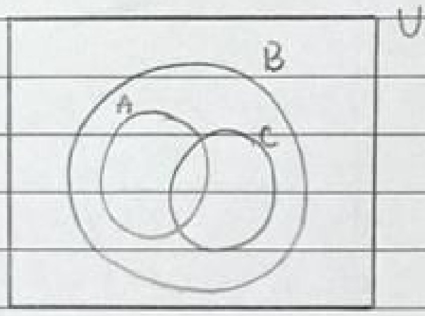
b) $(A \cup B)' = (\{x \in R \mid 0 < x \leq 2\} \cup \{x \in R \mid 1 \leq x < 4\})'$
$= \{x \in R \mid 0 < x < 4\}'$
$(A \cup B)' = \{x \in R \mid x \leq 0, x \geq 4\}$
$(A \cup B)' = \{4, 5, 6, 7, 8\}$

c) $A' \cup B' = (\{x \in R \mid 0 < x \leq 2\})' \cup (\{x \in R \mid 1 \leq x < 4\})'$
$= \{x \in R \mid x < 0, x > 2\} \cup \{x \in R \mid x < 1, x \geq 4\}$
$A' \cup B' = \{x \in R \mid x < 1, x > 2\}$
$A' \cup B' = \{3, 4, 5, 6, 7, 8\}$

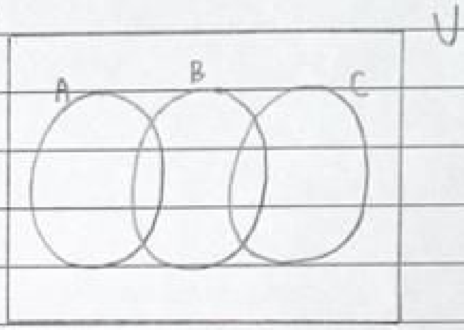
2. a)



b)



c)



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3. $A = \{-1, 1, 2, 4\}$
   $B = \{1, 2\}$

$A \times B = \{(-1,1), (-1,2), (1,1), (1,2), (2,1), (2,2), (4,1), (4,2)\}$ #

$xSy \leftrightarrow |x| = |y|$
$S = \{(-1,1), (1,1), (2,2)\}$ #

$xTy \leftrightarrow x - y$ is even
$T = \{(-1,1), (1,1), (2,2), (4,2)\}$ #

$S \cap T = \{(-1,1), (1,1), (2,2)\}$ #
$S \cup T = \{(-1,1), (1,1), (2,2), (4,2)\}$ #

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4. $\neg((\neg p \wedge q) \vee (\neg p \wedge \neg q)) \vee (p \wedge q) \equiv$

$\equiv (\neg(\neg p \wedge q) \wedge \neg(\neg p \wedge \neg q)) \vee (p \wedge q)$ - De Morgan's Law

$\equiv ((\neg\neg p \vee \neg q) \wedge (\neg\neg p \vee \neg\neg q)) \vee (p \wedge q)$ - De Morgan's Law

$\equiv ((p \vee \neg q) \wedge (p \vee q)) \vee (p \wedge q)$ - Double Negation Law

$\equiv (p \vee (\neg q \wedge q)) \vee (p \wedge q)$ - Distributive Law

$\equiv (p \vee (q \wedge \neg q)) \vee (p \wedge q)$ - Commutative Law

$\equiv (p \vee \varnothing) \vee (p \wedge q)$ - Negation Law

$\equiv p \vee (p \wedge q)$ - Identity Law

$\equiv p$ $\therefore$ shown - Absorption Law

5. $R_1 = \{(1,1), (1,2), (1,3), (1,4), (1,5), (2,1), (2,2), (2,3), (2,4), (3,1), (3,2), (3,3), (4,1), (4,2), (5,1)\}$

$R_2 = \{(2,1), (3,1), (3,2), (4,1), (4,2), (4,3), (5,1), (5,2), (5,3), (5,4)\}$

a)

$$A_1 = \begin{array}{c|ccccc|} & 1 & 2 & 3 & 4 & 5 \\ \hline 1 & 1 & 1 & 1 & 1 & 1 \\ 2 & 1 & 1 & 1 & 1 & 0 \\ 3 & 1 & 1 & 1 & 0 & 0 \\ 4 & 1 & 1 & 0 & 0 & 0 \\ 5 & 1 & 0 & 0 & 0 & 0 \\ \hline \end{array}$$

b)

$$A_2 = \begin{array}{c|ccccc|} & 1 & 2 & 3 & 4 & 5 \\ \hline 1 & 0 & 0 & 0 & 0 & 0 \\ 2 & 1 & 0 & 0 & 0 & 0 \\ 3 & 1 & 1 & 0 & 0 & 0 \\ 4 & 1 & 1 & 1 & 0 & 0 \\ 5 & 1 & 1 & 1 & 1 & 0 \\ \hline \end{array}$$

d) $\therefore R_2$ is irreflexive because A_2 has 0's on the main diagonal.

$$A_2^T = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

$\therefore R_2$ is not symmetric because $A_2 \neq A_2^T$

$\therefore R_2$ is transitive because $(3,2), (2,1) \in R_2, (3,1) \in R_2$

$(4,2), (2,1) \in R_2, (4,1) \in R_2$

$(4,3), (3,1) \in R_2, (4,1) \in R_2$

$(4,3), (3,2) \in R_2, (4,2) \in R_2$

$(5,2), (2,1) \in R_2, (5,1) \in R_2$

$(5,3), (3,1) \in R_2, (5,1) \in R_2$

$(5,3), (3,2) \in R_2, (5,2) \in R_2$

$(5,4), (4,1) \in R_2, (5,1) \in R_2$

$(5,4), (4,2) \in R_2, (5,2) \in R_2$

$(5,4), (4,3) \in R_2, (5,3) \in R_2$

$\therefore R_2$ is not partial order relation because R_2 is antisymmetric and transitive, but R_2 is irreflexive.

6. $R_1 = \{(1,1), (2,2), (2,3), (3,1), (3,3)\}$

$R_2 = \{(1,2), (2,2), (3,1), (3,3)\}$

a) $R_1 \cup R_2 = \{(1,1), (1,2), (2,2), (2,3), (3,1), (3,3)\}$

$$M_{R_1 \cup R_2} = \begin{array}{c} \\ 1 \\ 2 \\ 3 \end{array} \begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix} \end{array}$$

b) $R_1 \cap R_2 = \{(2,2), (3,1), (3,3)\}$

$$M_{R_1 \cap R_2} = \begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline 1 & 0 & 0 & 0 \\ 2 & 0 & 1 & 0 \\ 3 & 1 & 0 & 1 \end{array}$$

c) $\therefore R_1$ is not reflexive because because $(4,4), (5,5) \notin R_1$

$$A_1^T = \begin{array}{c|ccccc|} & 1 & 2 & 3 & 4 & 5 \\ \hline 1 & 1 & 1 & 1 & 1 & 1 \\ 2 & 1 & 1 & 1 & 1 & 0 \\ 3 & 1 & 1 & 1 & 0 & 0 \\ 4 & 1 & 1 & 0 & 0 & 0 \\ 5 & 1 & 0 & 0 & 0 & 0 \\ \hline \end{array}$$

$\therefore R_1$ is symmetric because $A_1 = A_1^T$

$\therefore R_1$ is not transitive because $(2,1), (1,5) \in R_1$, but $(2,5) \notin R_1$

$(3,1), (1,4) \in R_1$, but $(3,4) \notin R_1$

$(3,1), (1,5) \in R_1$, but $(3,5) \notin R_1$

$(3,2), (2,4) \in R_1$, but $(3,4) \notin R_1$

$(4,1), (1,3) \in R_1$, but $(4,3) \notin R_1$

$(4,1), (1,4) \in R_1$, but $(4,4) \notin R_1$

$(4,1), (1,5) \in R_1$, but $(4,5) \notin R_1$

$(4,2), (2,3) \in R_1$, but $(4,3) \notin R_1$

$(4,2), (2,4) \in R_1$, but $(4,4) \notin R_1$

$(5,1), (1,2) \in R_1$, but $(5,2) \notin R_1$

$(5,1), (1,3) \in R_1$, but $(5,3) \notin R_1$

$(5,1), (1,4) \in R_1$, but $(5,4) \notin R_1$

$(5,1), (1,5) \in R_1$, but $(5,5) \notin R_1$

$\therefore R_1$ is not equivalence relation because R_1 is symmetric but R_1 is not reflexive and not transitive.

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7. $f: R \rightarrow R$ $\quad g: R \rightarrow R$ $\quad R =$ set of real numbers

let $f(x) = x$, $g(x) = -x$

$$f + g = (f+g)(x)$$
$$= f(x) + g(x)$$
$$= x + (-x)$$
$$= 0 \Rightarrow \text{for all real numbers } x$$ #

Since $f: R \rightarrow R$ and $g: R \rightarrow R$ are both one-to-one function, but when $f+g$, it is not one-to-one function because there exist only one answer for all real numbers

8. $C(n)$ = ways to climb the stairs.

$n = 1$, $C(n) = 1$
$n = 2$, $C(n) = 2$

when $n \geq 3$ there are two possible ways :

i. last step is a single stair : $C(n-1)$
ii. last step are two stairs : $C(n-2)$

Thus, $C(n) = C(n-1) + C(n-2)$ for $n \geq 3$ #

9 $t_0 = t_1 = t_2 = 1$, $t_n = t_{n-1} + t_{n-2} + t_{n-3}$ for all $n \geq 3$

a. $t_7 = t_6 + t_5 + t_4$
$= 17 + 9 + 5$
$= 31$ #

$t_3 = t_2 + t_1 + t_0$
$= 1 + 1 + 1$
$= 3$

$t_4 = t_3 + t_2 + t_1$
$= 3 + 1 + 1$
$= 5$

$t_6 = t_5 + t_4 + t_3$
$= 9 + 5 + 3$
$= 17$

$t_5 = t_4 + t_3 + t_2$
$= 5 + 3 + 1$
$= 9$

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b. t (n)

```
{   if n = 0
    return 0
    else if (n=1 or n=2)
    return 1
    else
    return t(n-1) + t(n-2) + t(n-3)
}
```