CISC 2210 (TR2) – Introduction to Discrete Structures

Midterm 1 Exam

September 25, 2025

Id: .....

Problem	Maximum Points	Your Points
Sets 1	10	
Sets 2	20	
Sets 3	20	
Logic 1	20	
Logic 2	20	
Logic 3	10	
Total	100	

Structure and credit:

- You have 120 minutes to complete the exam.
- There are two parts: one for the topic of Sets and one for the topic of Logic. Each part contains three problems. See the chart above for the credit that you can earn for each of the six problems, for a total of 100 credits.
- You will get only partial credit if you fail to justify your answers. You will get 20% of the credit if you do not answer a problem. You will get zero credit for wrong answers.

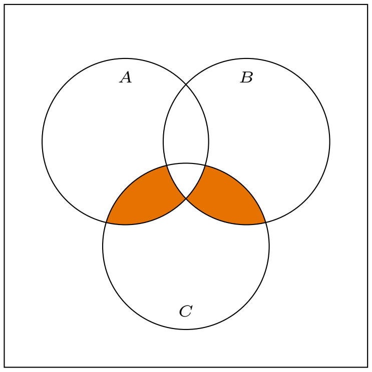
Honor code: Students are expected to do this exam **by themselves** without any external help from other people, the Internet, books, or notes. Cheaters will be punished severely. At minimum, they will fail the exam, but they may fail the whole class. In addition, students who cheat risk disciplinary measures by Brooklyn College and CUNY.

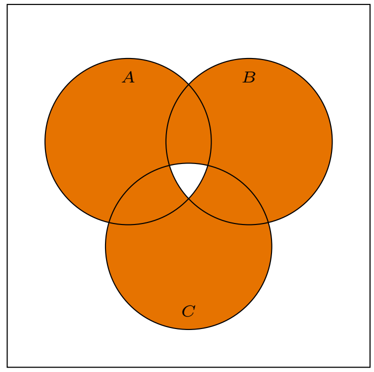
1. Let A, B, and C be three sets whose members are taken from a universal set $\mathcal{U}$. Justify your answers to the following two questions.

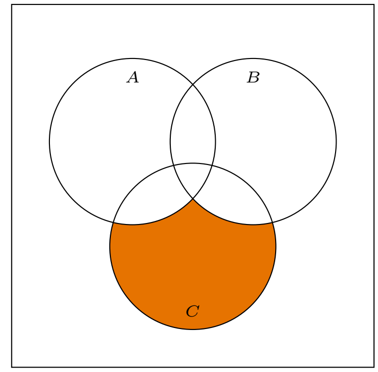
   Assume $(\neg A) \cup (\neg B) \cup (\neg C) = \mathcal{U}$. What is $A \cap B \cap C$?

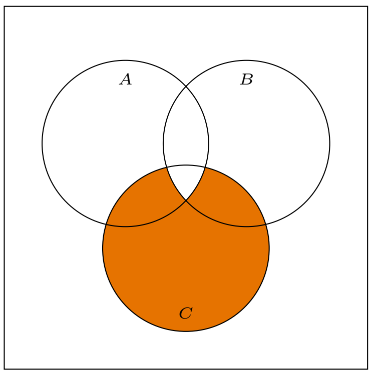
   Assume $(\neg A) \cap (\neg B) \cap (\neg C) = \mathcal{U}$. What can you say about the sets A, B, and C?

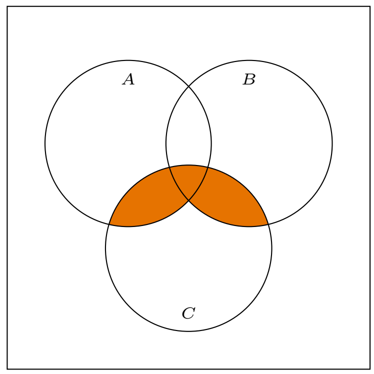
2. Match the four expressions on the next page with their corresponding Venn diagrams from the 12 provided below. Justify your choices.

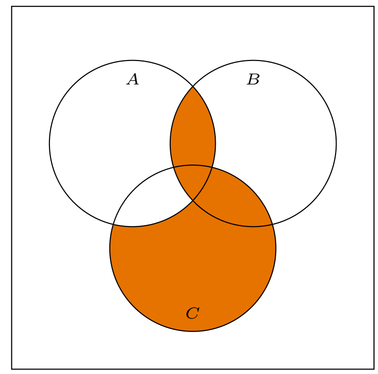


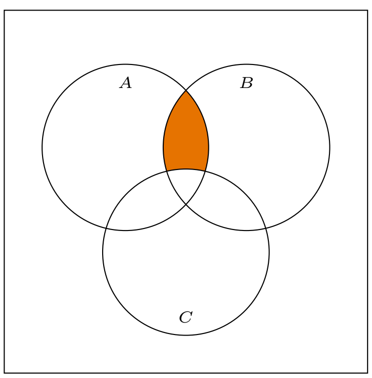


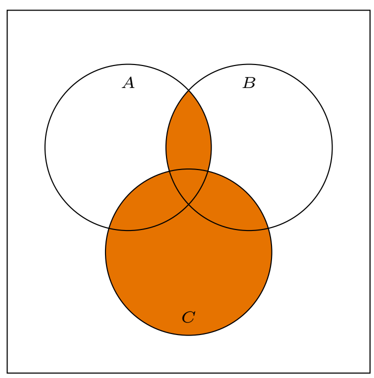


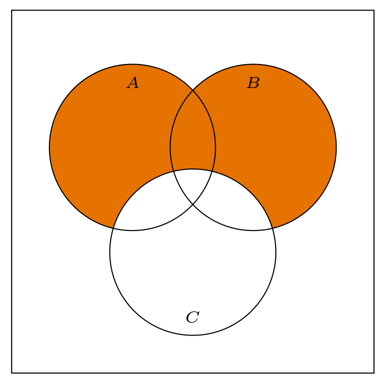


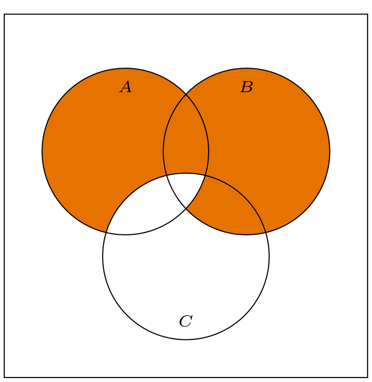


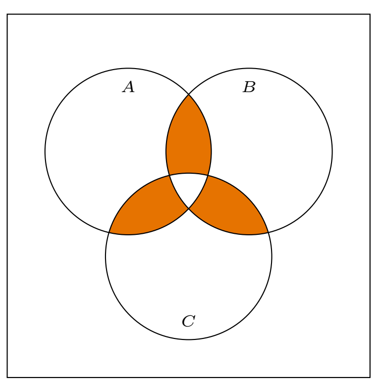


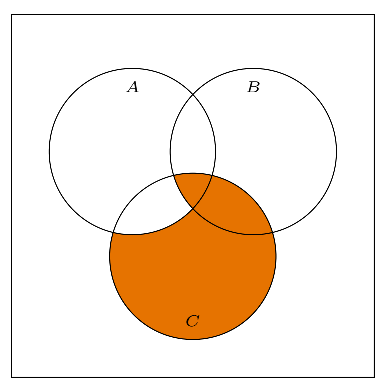












Which Venn Diagram represents the expression: $(\mathbf{A} \setminus \mathbf{C}) \cup (\mathbf{B} \setminus \mathbf{C})$?

Which Venn Diagram represents the expression: $(\mathbf{C} \setminus \mathbf{A}) \cup (\mathbf{C} \setminus \mathbf{B})$?

Which Venn Diagram represents the expression: $(\mathbf{A} \cup \mathbf{B} \cup \mathbf{C}) \setminus (\mathbf{A} \cap \mathbf{B} \cap \mathbf{C})$?

Which Venn Diagram represents the expression: $(\mathbf{A} \cup \mathbf{B}) \setminus (\mathbf{A} \cap \mathbf{C})$?

3. At a winter party, every student from the Red club arrived with either a Red shirt, or Red pants, or a Red coat (these students may arrived with more than one Red item of clothing).

   Based on the data below, determine the total number of students from the Red club who attended the party.

   - None of the students attended the party with less than two Red items of clothing.
   - 70 students showed up with a Red shirt and Red pants (and maybe also with a Red coat).
   - 50 students showed up with a Red shirt and a Red coat (and maybe also with Red pants)
   - 40 students showed up with Red pants and a Red coat (and maybe also with a Red shirt).
   - 20 students showed up with all of the three Red items of clothings.

   Justify your answer.

At a winter party, every student from the Blue club arrived with either a Blue shirt, or Blue pants, or a Blue coat (these students may arrived with more than one Blue item of clothing).

Based on the data below, determine the number of students from the Blue club who attended the party with all three Blue items of clothing.

- In total, 130 students attended the party.
- None of them wore exactly two Blue items of clothing.
- 60 students showed up with a Blue shirt (and maybe also with Blue Pants and a Blue coat).
- 50 students showed up with Blue pants (and maybe also with a Blue shirt and a Blue coat).
- 40 students showed up with a Blue coat (and maybe also with a Blue shirt and Blue Pants).

Justify your answer.

4. One of the following two expressions is True and one is False.

$$z \wedge \neg(x \wedge y) \equiv z \vee \neg(x \vee y) \tag{1}$$

$$(z \vee y) \wedge (\neg z \vee \neg x) \equiv (z \wedge \neg x) \vee (\neg z \wedge y) \tag{2}$$

Which one is False? Prove your answer.

Which one is True? Prove your answer.

5. The table below shows which flowers are liked by three students. A T in the table means the student in that row likes the flower in that column. For example, the T in the (Bob, Iris) entry means Bob likes Iris while the F in the (Carol,Lily) entry means Carol does not like Lily.

Student \ Flowers	Daisy	Iris	Jasmine	Lily	Magnolia	Rose	Tulip
Alice	F	T	F	F	T	T	T
Bob	F	T	T	T	F	T	F
Carol	F	F	T	F	F	T	T

Let S be the set containing the 3 students and let F be the set containing the 7 flowers:

$$S = \{\text{Alice}, \text{Bob}, \text{Carol}\} \qquad F = \{\text{Daisy}, \text{Iris}, \text{Jasmine}, \text{Lily}, \text{Magnolia}, \text{Rose}, \text{Tulip}\}$$

For each one of the following expressions determine if it is TRUE or FALSE. Justify your answers.

(a) $\exists_{x \in S} \exists_{y \in F} (x \text{ likes } y)$

(b) $\forall_{x \in S} \forall_{y \in F} (x \text{ likes } y)$

(c) $\exists_{x \in S} \forall_{y \in F} (x \text{ likes } y)$

(d) $\exists_{y \in F} \forall_{x \in S} (x \text{ likes } y)$

(e) $\forall_{x \in S} \exists_{y \in F} (x \text{ likes } y)$

(f) $\forall_{y \in F} \exists_{x \in S} (x \text{ likes } y)$

6. You meet A, B, and C.
   - A claims that B is lying.
   - B claims that C is lying.
   - C claims that both A and B are lying.

   Who is lying and who is telling the truth?

   Justify your answer.