1.

2.

3.

4.

5. Grader: Fang-Yu Rao

(a) If $A = \{1, 2, 3\}$, $B = \{3, 4, 5\}$, and $C = \{1, 3, 4\}$, then we can see $(A \cup C) \subset (A \cup B)$ but $C \not\subset B$.

Note:

- 0 pt will be given if nothing is written down on the paper.
- 1 pt will be given if the counterexample given is wrong.
- 4 pts will be given if the answer is correct.

(b) To prove $C \subset B$, we need to prove that for all $x \in C$, x is also in B.

Let $x \in C$, then it is true that "$x \in A$ or $x \in C$," i.e., $x \in (A \cup C)$. Because we are given that $(A \cup C) \subset (A \cup B)$, $x \in (A \cup B)$, i.e., $x \in A$ or $x \in B$.

If $x \in B$, then we are done. Consider the case when $x \in A$. Then we know it is true that $x \in A$ and $x \in C$, which implies $x \in (A \cap C)$. By the given condition that $(A \cap C) \subset (A \cap B)$, we have $x \in (A \cap B)$, i.e., it is true that "$x \in A$ and $x \in B$".

In either case, $x \in B$.

Note:

- 0 pt will be given if nothing is written down on the paper.
- 1 pt will be given if the argument as a whole is incorrect.
- 2 pts will be given if you are able to prove the implication that $(x \in C) \rightarrow (x \in A \text{ or } x \in B)$.
- Another 1 pt will be given if the case when $x \in B$ is discussed or mentioned.
- Another 3 pts will be given if the case when $x \in A$ is discussed, i.e., you are able to prove that $(x \in C) \rightarrow (x \in B)$ when $x \in A$.
- Since Venn diagram is allowed in this problem, 6pts will be given if the constructed Venn diagram makes sense.

- Generally, if the notations are used incorrectly, then the answer would fall in the second case, i.e., it will be considered incorrect as a whole. For example, something like the following would be considered incorrect:

$$[(x \in A) \text{ or } (x \in C)] \subset [(x \in A) \text{ or } (x \in B)].$$

6. Grader: Ravi Kiran Rao Bukka

   (a) 0 pt for wrong answer and 1 pt for correct answer. Answers are False, True, False, False for i,ii,iii,iv respectively.

   (b) Proving R is reflexive and an equivalence relation. The definitions of reflexive, symmetric and transitive are as per the text book.

   - 1 pt for explaining symmetric property seperately or as part of the proof.
   - 1 pt for explaining transitive property seperately or as part of the proof.
   - 3 pt for proving R is reflexive especially when b is not equal to a. If b is equal to a then $(a, a) \in R$ for all a. Hence reflexive. If b is not equal to a then: If $(a, b) \in R$ from symmetric property $(b, a) \in R$. Now, from transitive property if $(a, b), (b, a) \in R$ then $(a, a) \in R$ by definition. Hence R is reflexive.
   - 1 pt for proving R is an equivalence relation. Just a line stating that R is reflexive, symmetric and transitive and hence an equivalence relation.

7.

8.

9.

10.