Complete all of the following problems and hand in your solutions by the due date and time. Make sure that your name, student number and tutorial time are on each sheet of your answers. Textbook questions are taken from the third edition of Epp.

1. Complete the following questions from the textbook.
   - Section 1.4, pages 55-57: Questions 6, 10, 19.

2. In assignment 1 we defined the logical operation nand, denoted ↑, by \( p ↑ q \equiv \sim (p \land q). \) We then showed that \( p ∨ q \equiv ((\sim p) ↑ (\sim q)). \) Using that result, design and draw a circuit diagram for \( p ∨ q \) that uses only and-gates and not-gates (do not use or-gates in your answer).

3. Four friends (Aloysius, Bartholomew, Clementine and Dahlia) are having a joint brithday party. They get together to decide what music they will play there. Unfortunately, they have only four records from which to choose: Daft Punk, The Beatles, Sidney Bechet and Golden Country Classics. They listen to all four records and give the following opinions.
   - Aloysius likes only Daft Punk and Sidney Bechet.
   - Bartholomew likes The Beatles, Sidney Bechet and Golden Country Classics, but dislikes Daft Punk.
   - Clementine likes only the Beatles.
   - Dahlia doesn’t like any of the records.

   Let \( F \) be the set of four friends, \( R \) be the set of four records and \( e(x, y) \) be the predicate “person \( x \) likes record \( y \)” (with the domain of \( x \) being \( F \) and the domain of \( y \) being \( R \)). Then for each of the following statements
     (i) write the original statement in symbolic form;
     (ii) write the negation of the statement in symbolic form;
     (iii) write the negation of the statement in english; and
     (iv) determine whether the original statement or its negation is true, and explain why.

     (a) There is a record which nobody likes.
     (b) Everybody has a record which they do not like.
     (c) There is somebody who dislikes all the records.

4. For each of the following statements
   (i) write the original statement in words;
   (ii) write the negation of the statement in symbolic form; and
   (iii) determine whether the original statement or its negation is true, and explain why.

   (a) \( \exists x \in \mathbb{Z} \) such that \( \forall y \in \mathbb{Z}, xy = 0. \)
   (b) \( \forall x \in \mathbb{Z}, \exists y \in \mathbb{Z} \) such that \( xy = 0. \)
   (c) \( \forall x \in \mathbb{R}, \exists y \in \mathbb{R} \) such that \( xy = 1. \)
   (d) \( \forall x \in \mathbb{Q}, \exists y \in \mathbb{Q} \) such that \( x + y = 0. \)
   (e) \( \exists x \in \mathbb{Q} \) such that \( \forall y \in \mathbb{Q}, x + y = 0. \)

5. Complete the following questions from the textbook. Give full justification for your answers.
   - Section 2.3, pages 108-111: Questions 54, 55, 56.