SENG 11232 · Engineering Foundation

STUDENT PRE-LECTURE NOTES · LECTURE 03

Mathematical Foundations for Software Engineering

Module 1 — Thinking Like an Engineer

HOW TO USE Read these notes BEFORE the lecture. Highlight terms you don't recognise. Bring your questions to class. Use the blank spaces for your own notes.

Learning Objectives

By the end of this lecture, you should be able to:

- 1. Apply set theory notation and operations to model data collections
- 2. Construct and evaluate propositional and predicate logic expressions
- 3. Apply De Morgan's theorems to simplify logical expressions
- 4. Prove statements using direct proof, contradiction and mathematical induction

Set Theory

A set is a well-defined collection of distinct objects. Notation: A = {1, 2, 3}

Key Operations

- Union: A ∪ B — all elements in A or B
- Intersection: A ∩ B — elements in both A and B
- Difference: A \ B — elements in A but not B
- Complement: Ā — everything not in A (relative to universe U)

KEY Sets appear in SE as: SQL tables (set of tuples), type systems (set of valid values), permissions (set of capabilities), regular expressions (set of strings).

Your notes:

Propositional & Predicate Logic

Propositional Logic

- ¬ (NOT), ∧ (AND), ∨ (OR), → (implies), ↔ (iff)
- De Morgan's: ¬(P∧Q) ≡ ¬P∨¬Q and ¬(P∨Q) ≡ ¬P∧¬Q
- Modus ponens: (P → Q) ∧ P ∴ Q — most common inference rule

Predicate Logic

- ∀x.P(x): P is true for every x (universal quantifier)

- ∃x.P(x): P is true for at least one x (existential quantifier)
- ¬(∀x.P(x)) ≡ ∃x.¬P(x): not all = at least one is not

Your notes:

Proof Techniques

Mathematical Induction

- Base case: prove P(1) is true
- Inductive step: assume P(k) is true; prove P(k+1) is true

NOTE	Induction proves properties of loops and recursive programs. A loop invariant is a predicate that is true before, during, and after every iteration.

Your notes:

Key Terms for This Lecture

Term	Your Definition (fill in during/after lecture)
Set	
Union	
Intersection	
Propositional Logic	
Predicate Logic	
Quantifier	
Tautology	
Mathematical Induction	
Loop Invariant	

Self-Check Questions

Answer these after the lecture to test your understanding:

- Q1. Given A = {1,2,3,4} and B = {3,4,5,6}, compute A∪B, A∩B, A\B.

Answer:

- Q2. Apply De Morgan's theorem to simplify: ¬(x > 5 ∧ y ≠ 0).

Answer: _____

- Q3. Prove by mathematical induction that 1+2+3+...+n = n(n+1)/2.

Answer: _____

- Q4. Translate to predicate logic: "Every user has at least one active session."

Answer: _____

SENG 11232 Engineering Foundation · Lecture 03: Mathematical Foundations for Software Engineering