Mehran University of Engineering and Technology, Jamshoro Department of

Title of Subject	**:**	**Advanced Formal Methods (SE616)**
Discipline	**:**	Software Engineering (2nd Semester)
Effective	**:**	24MESE & onwards
Pre-requisite	**:**	--
Assessment	**:**	Theory**:** 10% Sessional, 30% Mid, 60% Final
Credit Hours	**:**	3 + 0 **Marks:** 100
Minimum Contact Hours:		42

Objectives of course:

- Identify what can and what cannot be expressed by certain specification/modeling formalisms.
- Transform formal specifications of object-oriented system units, using the concepts of method contracts and class invariants.
- Formulate connection between programs and formal specifications that can be represented in a program logic.

Course outline:

Introduction to Formal Methods

- Overview of Formal Methods and Specification
- State-Based Formal Methods: Fundamentals and Concepts
- Transformational Systems: Traditional Approaches and Z Specification
- Formal Development Cycle: Techniques and Best Practices
- Temporal Specification: Syntax and Semantics of Temporal Logic
- Temporal Specification of Reactive Systems: Safety, Aliveness, and Fairness
- Model Checking: Techniques and Applications

Model Checking Analysis

- Evaluating Well-Formedness: Completeness, Consistency, and Robustness
- Analyzing Correctness: Static Analysis, Simulation, and Model Checking

Formal Languages for Specification

- Comparative Formal Methods: Alloy and Alloy Analyzer Introduction
- Sets, Sequences, and Composite Objects in Formal Analysis
- Proofs in Formal Methods: Techniques and Applications
- Introduction to Object Constraint Language (OCL) for Model Verification

Formal Verification Methods for Java Programs

- Unit Level Specification Language for Java Programs
- Logic for Verification of Java Programs
- Verification of Java Programs: Ensuring Implementation Fulfillment of Specifications

Advanced Topics in Formal Methods Research

- Current Research Trends and Developments in Formal Methods
- Symbolic Model Checking: Techniques and Overview of Reduction Methods
- Spin and Promela: Case Study and Practical Verification of Properties
- Practical Application of Formal Methods in Real-World Systems

BOOKS RECOMMENDED

1. Antoni Diller, Z: An Introduction to Formal Methods, John Wiley & Sons, Inc. Latest Edition

2. Hossam A. Gabbar, Modern Formal Methods and Applications, Springer-Verlag, Latest Edition
3. Charatan, Quentin, and Aaron Kans, Formal Software Development: From VDM to Java, Palgrave Macmillan, Latest Edition
4. Tony Clark, Jos Warmer, Object Modeling with the OCL: The Rationale behind the Object Constraint Language, Springer, Latest Edition

Approval:

Board of Studies:	**Resolution No. 2.3**	**Dated: 21-07-2023**
Board of Faculty:	**Resolution No. 21.9**	**Dated: 07-12-2023**
AS&RB	**Resolution No.**	
Academic Council:	**Resolution No.**	