Course Specification

(Bachelor)

Course Title:	Engineering Compiler Construction
Course Code:	SE3611
Program:	BSc in Software Engineering
Department:	Software Engineering
College:	College of Computing
Institution:	Umm Al Qura University
Version:	1.0
Last Revision Date:	22/04/2025

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track	☐Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (3rd year/ 5th or 6th level) or (4th year/8th level)					
4. Course General Description:					
This class examines the design and implementation and optimizing of a compiler. Students will learn about common optimizations, intermediate languages, and design choices in lectures. Students will learn about the software engineering challenges of implementing a compiler for an imperative, object-oriented language in machine problems.					
5. Pre-requirements for this course (if any)**:**					
CS2105 - Data Structures and Algorithms with Java					
6. Co-requisites for this course (if any)**:**					
N/A					
7. Course Main Objective(s):					
By the end of the course, students will: 1. Understand the theoretical foundations and practical techniques for designing and implementing compilers. 2. Be proficient in using intermediate representations for program translation and optimization. 3. Gain the ability to optimize program performance through advanced techniques like dataflow analysis and register allocation. 4. Appreciate the role of compilers in modern technologies, including their intersection with machine learning. 5. Be equipped to design, test, and optimize compilers for diverse programming paradigms.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%

No	Mode of Instruction	Contact Hours	Percentage
2	E-learning	0	0
3	Hybrid • Traditional classroom • E-learning	0	0
4	Distance learning	0	0

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	30
3.	**Field**	0
4.	**Tutorial**	0
5.	**Others (specify)**	0
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Understand the principles of lexical analysis, parsing, and intermediate representations (AST, CFG, SSA).	K1	Lecture, Exercise	Quiz, Exams
1.2	Learn about runtime environments, including memory management and calling conventions.	K2	Lecture, Exercise	Quiz, Exams
1.3	Explore optimization techniques, such as dataflow analysis, register allocation, and instruction scheduling.	K3	Lecture, Exercise	Quiz, Exams
2.0	**Skills**			

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.1	Design and test lexers, parsers, and intermediate code generators.	S1	Lecture, Exercise	Quiz, Exams
2.2	Implement and transform intermediate representations, including ASTs and CFGs.	S2	Lecture, Exercise	Quiz, Exams
2.3	Perform dataflow analysis and apply optimizations like dead code elimination and loop unrolling.	S3	Lecture, Exercise	Quiz, Exams
3.0	**Values, autonomy, and responsibility**			
3.1	Appreciate the importance of efficient and secure compiler designs in modern computing.	V1	Lecture, Exercise	Quiz, Exams
3.2	Embrace ethical considerations in software optimization to ensure security and correctness.	V1	Lecture, Exercise	Quiz, Exams
3.3	Value interdisciplinary approaches to compiler design, particularly for machine learning and high-performance computing.	V2	Lecture, Exercise	Quiz, Exams

C. Course Content

No	List of Topics	Contact Hours
1.	Introduction	**4**
2.	Lexing and Parsing	**4**
3.	Parsing	**4**
4.	Parsing, Testing, and Intermediate Representations	**8**
5.	Intermediate Representations (AST and CFG)	**4**
6.	Intermediate Representations (CFG and SSA)	**4**
7.	Intermediate Code Generation	**4**
8.	Runtime Environments	**4**
9.	Optimization Basics	**8**
10.	Dataflow Analysis	**4**

11.	Register Allocation	4
12.	Instruction Scheduling	4
13.	Procedure-level Optimization	4
14.	Compilers in the World of Machine Learning	8
Total		60

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Assignments and Quizzes	2-14	15
2.	Projects	2-14	15
3.	Practicals	2-14	10
4.	Mid Term	7	20
5.	Final Exam	16-17	40

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	• Cooper, K. D., & Torczon, L. (2022). *Engineering a compiler* (3rd ed.). Morgan Kaufmann. ISBN 978-0128154120.
Supportive References	• Aho, A. V., Lam, M. S., Sethi, R., & Ullman, J. D. (2006). *Compilers: Principles, techniques, and tools* (2nd ed.). Addison-Wesley. ISBN 978-0321486813. • Muchnick, S. S. (1997). *Advanced compiler design and implementation*. Morgan Kaufmann. ISBN 978-1558603202.
Electronic Materials	
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Traditional Classroom

Items	Resources
Technology equipment (projector, smart board, software)	Multimedia Projector
Other equipment (depending on the nature of the specialty)	N/A

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Direct, Indirect
Effectiveness of Students' assessment	Faculty, Peer reviewer	Direct, Indirect
Quality of learning resources	Faculty, Course coordinator	Direct, Indirect
The extent to which CLOs have been achieved	Course coordinator, Program management committee	Direct
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**SOFTWARE ENGINEERING DEPARTMENT COUNCIL**
REFERENCE NO.	**THE 17TH MEETING FOR THE ACADEMIC YEAR 1446H**
DATE	**22/04/2025**