



Course Information

Program	: B.Sc Engg in CSE
Course Title	: Compiler Design
Course Code	: CSE 323
Semester	: Fall 2020-21
Credit Hour	: 3.0
Intake	: 39 [Shift: Day]
Section	: 01 and 02
Prerequisites	: CSE 213 - Theory of Computing & Automata Theory

Course Objectives

The objectives of this course is to teach the fundamental concepts of compiler design. This course focuses on various types of translators, linkers, loaders and phases of compilation. This course includes various types of parsers especially the top down and bottom up parsers. Students also learn syntax and semantic analysis, intermediate code generation, type checking, the role of symbol table and its organization, code generation, machine independent code optimization and instruction scheduling etc.

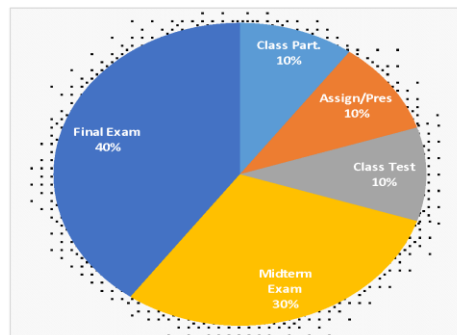
Course Synopsis

Introduction to Compilers, Language processing system, Compiler structure, Impacts on compiler in developing higher level programming language, Applications of compiler, Symbol table management, Context free grammar, Parse tree, Ambiguous grammar, Lexical analyzer, lexical error detection and recovery, Regular expression, Non-deterministic and deterministic finite automata, Syntax Analysis, Parsing error detection and recovery, Top Down parsing, Recursive Descent Parser, Predictive parser, Elimination of left recursion, FIRST and FOLLOW, Construction of predictive Parsing table, LL(1) Grammar, Bottom up parsing, Shift reduce parsing, handle pruning, LR Parser, LR parser algorithm, Syntax directed definition, Annotated parse tree, Dependency graph, Construction of syntax trees, S-attributed and L-attributed definitions, Top down translation, Intermediate code generation, DAG, Quadruple, Triple, Translation of Assignment, Boolean Expression and Control statements, Principal sources of Optimization, Optimization of basic blocks, Final Code generation.



Assessment Schema

Class Participation	:	10%
Assignment/Presentation	:	10%
Class Test	:	10%
Midterm Examination	:	30%
Final Examination	:	40%



Course Outcomes (COs)

After completion of this course students will be able to:

- CO1:** **Understand** basic concepts of a typical compiler including the front-end (analysis) and back-end (synthesis).
- CO2:** **Implement** different analysis techniques and design solutions of different parsers (Top-Down and Bottom-Up parsers) problems in compiler design.
- CO3:** **Apply** different code representation techniques in compiler construction.
- CO4:** **Analyze** the errors, type checking and code optimization in compilation.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√											
CO2			√									
CO3			√									
CO4		√										



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Sl. No.	CO's	Corresponding POs	Bloom's taxonomy domain/level	Delivery methods and activities	Assessment tools
CO1	Understand basic concepts of a typical compiler including the front-end (analysis) and back-end (synthesis).	PO1	Understand	Class Lecture and Discussion	Midterm Examination
CO2	Implement different analysis techniques and design solutions of different parsers (Top-Down and Bottom-Up parsers) problems in compiler design.	PO3	Apply	Class Lecture and Discussion	Midterm and Final Examination
CO3	Apply different code representation techniques in compiler construction.	PO3	Apply	Class Lecture and Discussion	Final Examination
CO4	Analyze the errors, type checking and code optimization in compilation.	PO2	Analyze	Class Lecture and Discussion	Final Examination



Descriptions of Program Outcomes (POs)

PO1	Engineering Knowledge (Cognitive): Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis (Cognitive): Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.
PO3	Design/Development of Solutions (Cognitive, Affective): Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.
PO4	Investigation (Cognitive, Psychomotor): Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
PO5	Modern Tool Usage (Psychomotor, Cognitive): Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The Engineer and Society (Affective): Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO7	Environment and Sustainability (Affective, Cognitive): Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics (Affective): Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.
PO9	Individual Work and Teamwork (Psychomotor, Affective): Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.
PO10	Communication (Psychomotor, Affective): Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.
PO11	Project Management and Finance (Cognitive, Psychomotor): Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.
PO12	Life-Long Learning (Affective, Psychomotor): Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.



Weekly Schedule

We ek	Lec ture	Course Topics	Remark s	CO	Exam (Mark
1	1	Introduction to Compilers: Compilers, Translators, Compilation and Interpretation, Language processing system	Ch-01	CO1	Mid-Term Exam (30)
	2	The phases of Compiler, The grouping of phases, Errors encountered in different phases, Compiler construction tools, The Grouping of Phases into Passes	”	CO2	
2	3	Higher level languages, science of code optimization, Scope of blocks	”	CO1	
	4	Lexical Analysis: Need and role of lexical analyzer, Lexical errors-Error Recovery, Buffer pairs, Regular Expression, Expressing tokens by Regular Expression	Ch-03	CO1	
3	5	Finite Automata, Transition Diagram, Failure Function	”	CO2	
	6	Syntax Analysis: Need and role of the parser, Syntactic Errors in Programs, Error Detection and Recovery Approaches	Ch-04	CO1	
4	7	Context free grammar, Derivations, Parse trees, Ambiguous grammar, Writing a Grammar: Eliminating Ambiguity	”	CO2	
	8	Elimination of Left Recursion, Left Factoring [Class Test-1]	”	CO2	
5	9	Top Down parsing: Strategy and Approaches, Recursive Descent Parser, Calculating FIRST and FOLLOW sets	”	CO2	
	10	LL(1) Grammars, Generating Predictive parsing table	”	CO2	
6	11	Non-recursive Table Driven Predictive Parsing	”	CO2	
	12	Error Recovery in Predictive Parsing: Panic mode error recovery <i>Review class for Mid-Term Examination</i>	”	CO2	
7		Mid Term Examination			
8	13	Bottom Up Parsing: Concepts of Bottom up parsing, Shift-reduce parsing, conflicts During Shift-Reduce Parsing	Ch-04	CO2	
	14	LR Parsers: Grammar Augmentation, Canonical LR(0) items, Transition Diagram (DFA) of GotoFunction, Constructing LR-Parsing Table, LR Parsing	”	CO2	



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9	15	Conflicts in LR Parser, Error Recovery in LR Parsing, Construction of SLR Parser and comparison	”	CO2	Final Exam (40)
	16	LALR(1) Parsing methodology, Error analysis and comparison among LR, SLR and LALR parsers [Class Test-2]	”	CO2	
10	17	Syntax Directed Translation: Syntax-Directed Definition, Inherited and Synthesized Attributes, Semantic Rules, Construction of Annotated Parse Tree	Ch-05	CO2	
	18	Dependency Graph, Bottom-up evaluation of S-attributed and L-attributed definitions	”	CO2	
11	19	Intermediate-Code Generation: Graphical IRs: DAG, AST, Control Flow Graphs	Ch-06	CO3	
	20	Linear IRs: Stack based (postfix), Three-address code: Quadruples, Triples, Indirect Triples	”	CO3	
12	21	Boolean Expression and Control statements, Forms of intermediate code, Type construction design, Back patching [Class Test-3]	”	CO3	
	22	Code Generation: Instruction Scheduling, Efficient Cost Model,	Ch-08	CO3	
13	23	Code generation Algorithm1: Next Use Information	”	CO3	
	24	Code generation Algorithm2: Register & Variable Descriptor, Register Allocation (Graph Coloring)	”	CO3	
14	25	Code Optimizing: Control Flow graph, Code optimization techniques	Ch-09	CO4	
	26	Local & Global Common-Sub-expression elimination, copy propagation, dead code elimination	”	CO4	
15	27	Code Optimizing: constant-folding, Code Motion, induction variable and Reduction in Strength	”	CO4	
	28	Code Optimizing: iteratively solving the dataflow equations for reaching definitions, Live-Variable Analysis <i>Review class for Semester Final Examination</i>	”	CO4	
16		Final Examination			



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Descriptions of Cognitive Domain (Anderson and Krathwohl's Taxonomy 2001):

The **cognitive domain** involves the development of our mental skills and the acquisition of knowledge.

Level	Category	Meaning	Keywords
C1	Remembering	Recognizing or recalling knowledge from memory. Remembering is when memory is used to produce or retrieve definitions, facts, or lists, or to recite previously learned information.	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write
C2	Understanding	Constructing meaning from different types of functions be they written or graphic messages or activities like interpreting, exemplifying, classifying, summarizing, inferring, comparing, or explaining.	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report
C3	Applying	Carrying out or using a procedure through executing, or implementing. Applying relates to or refers to situations where learned material is used through products like models, presentations, interviews or simulations.	Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer, use
C4	Analyzing	Breaking materials or concepts into parts, determining how the parts relate to one another or how they interrelate, or how the parts relate to an overall structure or purpose. Mental actions included in this function are differentiating, organizing, and attributing, as well as being able to distinguish between the components or parts. When one is analyzing, he/she can illustrate this mental function by creating spreadsheets, surveys, charts, or diagrams, or graphic representations.	Analyze, characterize, classify, compare, contrast, debate, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, structure
C5	Evaluating	Making judgments based on criteria and standards through checking and critiquing. Critiques, recommendations, and reports are some of the products that can be created to demonstrate the processes of evaluation.	Appraise, argue, assess, choose, conclude, critique, decide, evaluate, judge, justify, predict, prioritize, prove, rank, rate, select, monitor
C6	Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing. Creating requires users to put parts together in a new way, or synthesize parts into something new and different creating a new form or product. This process is the most difficult mental function.	Construct, design, develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce



Teaching Materials/Equipment

Required References: 1. Compilers – *Principles, Techniques and Tools* (Third Edition)
- Alfred V Aho, Ravi Sethi and Jeffrey D Ullman

Recommended References: 2. Modern Compiler Implementation in C
- Andrew W. Appel

Other materials: Lecture Notes

Overall CO Assessment Scheme

Assessment Area	CO				Assessment Area Mark
	CO1	CO2	CO3	CO4	
Class Participation					
Assignment/Presentation					
Class Test					
Midterm Exam	10	20			30
Final Exam		20	10	10	40
Total Mark	10	40	10	10	70



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Overall CO Assessment Rubrics

COs (Bloom's Level)	Excellent (80%-100%)	Good (70%-79%)	Satisfactory (60%-69%)	Poor (40%-59%)	Unsatisfactory (0-39%)	Marks (70)
CO1 (Understanding)	Answer is complete and sufficient detail provided to support issues related to the question. And also deals fully with the entire question.	Answer is brief with sufficient detail provided to support issues were introduced. And most of the basic details are included but some are missing.	Answer is brief with insufficient detail provided to support issues were introduced.	Answer is incomplete and excessive discussion of unrelated issues. And serious gaps in the basic details.	None of the relevant details were included or didn't answer.	
CO2, CO3 (Applying)	The question is answered appropriately by applying the suggested method in the question.	The question is answered briefly by applying the suggested method in the question.	The question is answered correctly by applying the suggested method in the question but some steps are missing.	The question is answered incompletely by applying the suggested method in the question but some steps are correct.	No attempt to implement the suggested method.	
CO4 (Analyzing)	A clear, complete, and properly ordered chain of analyzing steps (i.e. proper explanation of the procedure) is followed to answer the question.	The chain of analyzing steps is complete and correctly ordered but lack of expected explanation.	One or more intermediate analyzing steps are missing or unclear, but the correctness of the analysis is not compromised.	One or more intermediate analyzing steps are missing or unclear to answer the question.	The stated chain of analysis does not lead to the stated question.	



Grading System

Numerical Grade	Letter Grade		Grade Point
80% and above	A+	(A Plus)	4.00
75% to less than 80%	A	(A Regular)	3.75
70% to less than 75%	A-	(A Minus)	3.50
65% to less than 70%	B+	(B Plus)	3.25
60% to less than 65%	B	(B Regular)	3.00
55% to less than 60%	B-	(B Minus)	2.75
50% to less than 55%	C+	(C Plus)	2.50
45% to less than 50%	C	(C Regular)	2.25
40% to less than 45%	D		2.00
Less than 40%	F		0.00

Instructor Information

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Class Schedule

Day	Time	Room No
Monday	11:30 A.M. – 12:50 P.M.	B3/506
Tuesday	11:30 A.M. – 12:50 P.M.	B2/319



Counselling Hour

Day/Time	08:30 A.M. – 09:50 A.M.	10:00 A.M. – 11:20 A.M.	11:30 A.M. – 12:50 P.M.	01:20 P.M. – 02:40 P.M.	02:50 P.M. – 04:10 P.M.	04:20 P.M. – 05:40 P.M.
Sunday					C.H.	C.H.
Monday				C.H.	C.H.	
Tuesday				C.H.	C.H.	
Wednesday		C.H.	C.H.			
Thursday			C.H.	C.H.		
Friday	Day Off					
Saturday	Day Off					

*CH – Counselling Hour

Special Instructions

- Students are expected to attend all classes and examinations. A student must have at least 70% class attendance to sit for the final exam.
- Students will not be allowed to enter into the classroom after 20 minutes of the starting time.
- For plagiarism, the grade will automatically become zero for that exam/assignment.
- All mobile phones MUST be turned to silent mode during class and exam period.
- There is zero tolerance for cheating in exams. The only penalty for cheating is expulsion for several semesters as decided by the Disciplinary Committee of the university.

Prepared by:

Checked by:

Approved by: