**University of Asia Pacific (UAP)**

**Department of Computer Science and Engineering (CSE)**

**Course Outline**

**Program:** Computer Science and Engineering (CSE)

**Course Title:** Compiler Design

**Course Code:** CSE 429

**Semester:** Spring-2020

**Level: 4**th Semester

**Credit Hour:** 3.0

**Name & Designation of Teacher:** Laboni Sarker, Lecturer

**Office/Room:** 7th Floor (Office)

**Class Hours:** 12:30 PM – 1: 50 PM (Saturday, Tuesday) Sec B  
2:00 PM – 3: 20 PM (Tuesday) Sec A  
11:00 AM – 12:20 PM (Saturday) Sec A

**Consultation Hours:** 2:00 PM – 3:30PM (Wednesday, Thursday) Sec B, A

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**Rationale:** Compiler Design is a required course in the CSE program.

**Pre-requisite** (if any)**:** CSE 103, CSE 205, CSE 311

**Course Synopsis: Introduction to compilers**: Introductory concepts, types of compilers, applications, phases of a compiler. **Lexical analysis**: Role of the lexical analyzer, regular expressions, regular languages. **Parsing**: Parser and its role, context 73 free grammars, bottom-up parsing; LR (O) parsing, SLR parsing, LR (I) parsing, LALR (1) parsing, classification of context-free grammars and language. **Syntax-directed translation**: syntax directed definitions, attributes evaluation, Abstract syntax trees. **Type checking**: symbol Tables type checking, syntactic error recovery, Semantic checks for Inheritance, Sub typing and for overloading Generation of intermediate code. **Run-time organization**: runtime structures, storage strategies. **Intermediate code generation**: Intermediate languages, declarations, assignment statements. generation of inter mediate code-translation of Boolean expression, switch/case statements. Code optimization: Basic concepts of code optimization, principal sources of optimization, Generation of optimized target code. **Advanced Topic**: control flow graphs, live-variable analysis allocation optimization register allocation by graph coloring Available expression analysis, Global common expression elimination, Dominators, Loops in control flow graphs, Defuse & use-def chains, Loop invariant, code-notion, Partial redundancy elimination, constant propagation, optimizing Object-oriented programs, copy propagation, phase ordering of optimization, Instruction Scheduling optimizations for memory hierarchies.

**Course Objectives:** The objectives of this course are to:

1. **Introduce** the key concepts in the areas of compiler design and different phases of compiler.
2. **Demonstrate** the design and implementation of phases of compiler and its use, optimization techniques.
3. **Enable** students to gain skills on regular expressions, parsing and various parsers like LL parser, LR parser.
4. **Provide** knowledge on practical programming skills necessary for construction of a compiler and also various tools for it.

**Course Outcomes (CO) and their mapping with Program outcomes (PO) and Teaching-Learning Assessment methods:**

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| --- | --- | --- | --- | --- | --- |
| **CO**  **No.** | **CO Statements:**  Upon successful completion of the course, students should be able to: | **Corresponding**  **POs**  **(Appendix-1)** | **Bloom’s taxonomy domain/level**  **(Appendix-2)** | **Delivery methods and activities** | **Assessment**  **Tools** |
| CO1 | **Explain** terms related to important compiler and its phases, grammars of parsers, objective of the design & design techniques. | 1 | 1/Remember | Live Lecture, PPT Presentation | Quiz,  Written exam |
| CO2 | **Analyze** various phases of a compiler. | 2 | 1/Analyze | Live Lecture, PPT Presentation | Assignment and viva, Written Online Quiz |
| CO3 | **Apply** grammars, regular expressions for parsing. | 3 | 1/Apply | Live Lecture, PPT Presentation | Online written exam, Short MCQ |
| CO4 | **Apply** knowledge and optimization techniques to design a compiler model with its phases. | 3 | 1/Apply | Live Lecture, PPT Presentation | Quiz, Written exam |

**Weighting COs with Assessment methods:**

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| --- | --- | --- | --- | --- | --- |
| **Assessment Type** | **% weight** | **CO1** | **CO2** | **CO3** | **CO4** |
| Final Exam(Online written exam) | 50% | 10 | 10 | 10 | 20 |
| Mid Term(Short MCQ, Online written exam) | 20% | 5 | 5 | 10 |  |
| Class performance, Quizzes, Assignment with viva | 30% |  | 10 | 10 | 10 |
| Total | 100% | 15 | 27 | 28 | 30 |

**Course Content Outline and mapping with COs**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Weeks** | **Topics / Content** | | **Course Outcome** | **Delivery methods and activities** | | **Reading Materials** | |
| 1-2 | **Introductory concepts**, types of compilers, applications, phases of a compiler. | | CO1 | Lecture, multimedia | | Book Reference, Slides, Class Notes | |
| 2-3 | **Lexical analysis:** Role of the lexical analyzer, regular expressions, regular languages | | CO1, CO2 | Lecture, multimedia | | Book Reference, Slides, Class Notes | |
| 4-5 | **Parsing:** Parser and its role, context free grammars, bottom-up parsing; LR (O) parsing, SLR parsing, LR (I) parsing, LALR (1) parsing, classification of context-free grammars and language. | | CO1, CO2, CO3 | Lecture, Problem Solving | | Book Reference, Slides, Class Notes | |
| 6-7 | **Syntax-directed translation:** syntax directed definitions, attributes evaluation, Abstract syntax trees | | CO1, CO2, CO3 | Lecture, Problem Solving, Group discussion | | Book Reference, Slides, Class Notes | |
| **Mid** | | | | | | | |
| 8-9 | **Type checking:** symbol Tables type checking, syntactic error recovery, Semantic checks for Inheritance, Sub typing and for overloading Generation of intermediate code. | CO4 | | | Lecture, multimedia | | Book Reference, Slides, Class Notes |
| 10 | **Run-time organization:** runtime structures, storage strategies. | CO1,  CO4 | | | Lecture, multimedia | | Book Reference, Slides, Class Notes |
| 11-12 | **Intermediate code generation:** Intermediate languages, declarations,assignment statements, generation ofinter mediate code-translation ofBoolean expression, switch/casestatements. | CO4 | | | Lecture, multimedia | | Book Reference, Slides, Class Notes |
| 13 | **Code optimization:** Basic concepts of code optimization, principal sources of optimization, Generation of optimized target code. | CO4 | | | Lecture, multimedia | | Book Reference, Slides, Class Notes |
| 13-14 | **Advanced Topic:** control flow graphs, live-variable analysis allocation optimization register allocation by graph coloring Available expression analysis, Global common expression elimination, Dominators, Loops in control flow graphs, Defuse & use-def chains, Loop invariant, code-notion, Partial redundancy elimination, constant propagation, optimizing Object-oriented programs, copy propagation, phase ordering of optimization, Instruction Scheduling optimizations for memory hierarchies. | CO1,  CO4 | | | Lecture, multimedia | | Book Reference, Slides, Class Notes |
| **Final Exam** | | | | | | | |

**Minimum attendance:** 70% class attendance is mandatory for a student in order to appear at the final examination.

**Textbook:** 1. Compilers: Principles, Techniques, and Tools – Alfred V. Aho, Ravi

Sethi, Jeffrey D. Ullman. Second Edition.

2. Compiler Design and Construction (Electrical/computer science and

engineering series) by Arthur B. Pyster.

3. Modern Compiler Design by D. Grune, H. Bal, C. Jacobs and K.

Langendoen**.**

**Grading System:** As per the approved grading scale of University of Asia Pacific (Appendix-3).

**Special Instructions:**  **Assignment**: Assignment will be given throughout the semester. Copied assignments will be graded as zero. Late submission will result a 50% deduction in score.

**Class Test:** There will be no make-up quizzes.

**Student’s responsibilities:** Students must come to the class prepared for the course material covered in the previous class (es).

They must submit their assignments on time.

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| **Prepared by**  **(**Course Teacher**)** | **Checked by**  **(**Chairman, PSAC committee**)** | **Approved by**  **(**Head of the Department**)** |
| Laboni Sarker |  |  |

**Appendix-1:**

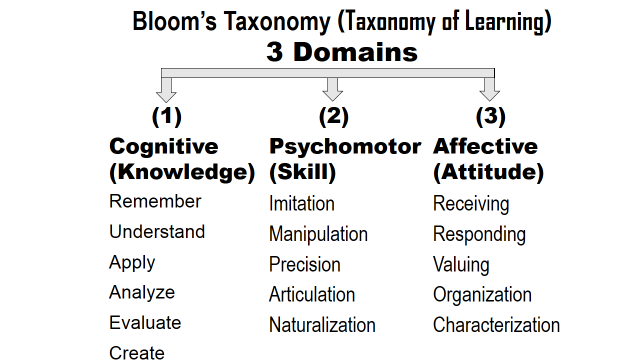
**Washington Accord Program Outcomes (PO) for engineering programs:**

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| --- | --- | --- |
| **No.** | **PO** | **Differentiating Characteristic** |
| 1 | Engineering Knowledge | Breadth and depth of education and type of knowledge, both theoretical and practical |
| 2 | Problem Analysis | Complexity of analysis |
| 3 | Design/ development of solutions | Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified |
| 4 | Investigation | Breadth and depth of investigation and experimentation |
| 5 | Modern Tool Usage | Level of understanding of the appropriateness of the tool |
| 6 | The Engineer and Society | Level of knowledge and responsibility |
| 7 | Environment and Sustainability | Type of solutions. |
| 8 | Ethics | Understanding and level of practice |
| 9 | Individual and Team work | Role in and diversity of team |
| 10 | Communication | Level of communication according to type of activities performed |
| 11 | Project Management and Finance | Level of management required  for differing types of activity |
| 12 | Lifelong learning | Preparation for and depth of Continuing learning. |

**Generic Skills (Detailed):**

1. **Engineering Knowledge (T)** -Apply knowledge of mathematics, sciences, engineering fundamentals and manufacturing engineering to the solution of complex engineering problems;
2. **Problem Analysis (T)** – Identify, formulate, research relevant literature and analyze complex engineering problems, and reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences;
3. **Design/Development of Solutions (A)** –Design solutions, exhibiting innovativeness, for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, economical, ethical, environmental and sustainability issues.
4. **Investigation (D)** Conduct investigation into complex problems, displaying creativeness, using research-based knowledge, and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions;
5. **Modern Tool Usage (A & D)** -Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations;
6. **The Engineer and Society (ESSE)** -Apply reasoning based on contextual knowledge to assess societal, health, safety, legal, cultural, contemporary issues, and the consequent responsibilities relevant to professional engineering practices.
7. **Environment and Sustainability (ESSE)** -Understand the impact of professional engineering solutions in societal, global, and environmental contexts and demonstrate knowledge of and need for sustainable development;
8. **Ethics (ESSE)** –Apply professional ethics with Islamic values and commit to responsibilities and norms of professional engineering code of practices.
9. **Communication (S)** -Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;
10. **Individual and Team Work (S)** -Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
11. **Life Long Learning (S)** -Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
12. **Project Management and Finance (S)** -Demonstrate knowledge and understanding of engineering management and financial principles and apply these to one’s own work, as a member and/or leader in a team, to manage projects in multidisciplinary settings, and identify opportunities of entrepreneurship.

**Appendix-2**



**Appendix-3**

**UAP Grading Policy:**

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