**University of Asia Pacific (UAP)**

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

**Course Outline**

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

**Course Title:** Algorithms

**Course Code:** CSE 207

**Semester:** Fall-2021

**Level: 4**th Semester (Section – A, B)

**Credit Hour:** 3.0

**Name & Designation of Teacher:** Tanjina Helaly, Assistant Professor

Fahad Ahmed, Lecturer

**Office/Room:** 7th Floor

**Class Hours: Sec. A (Wed** 2.00-3.20PM, **Thu** 12.30-1.50PM)

**Sec. B (**Sun 11.00-12.20PM **Mon** 12.30-1.50PM**)**

**Consultation Hours:** To be announced later

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**Rationale:** Algorithm course is required for the student to be able to design, develop and analyze algorithm to solve real life problem. This is a required course and a pre-requisite to Theory of Computation (CSE 307), Mathematics for Computer Science (CSE 401), and Artificial Intelligence and Expert Systems (CSE 403) in the CSE program

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

**Course Synopsis: Introduction:** The role of algorithms in computing. **Complexity analysis**: Growth of function, asymptotic notations, orders, designing worst case and average-case. **Recurrence relations**: Substitution method, iteration method, master method. **Divide and Conquer**: Basic idea, control structure properties of D & C, applications of D & C. **Dynamic Programming**: Elements of Dynamic Programming, Comparison with D & C. Application of Dynamic programming in: Optimal binary search tree, 0/1 Knapsack problem. **Greedy Method**: Elements of greedy method, basic control structure, Application of Greedy method in: Minimum cost spanning tree, Huffman code, Job sequencing with deadline. **Backtracking:** Basic idea behind backtracking, control structure. Application of backtracking in: graph coloring problem, n -queens problems. **Branch and Bound**: Basic idea and control structure of Branch and Bound. FIFO branch and Bound, LC Branch and Bound, the l5-puzzle problem. **Graph related algorithms**: Breadth First search, Depth First search, Topological sort, Dijkstra's shortest path algorithm, The Bellman-Ford algorithm for single source shortest path, The Floyd-War shall algorithm for all pair shortest path, Johnson's algorithm for sparse graph, Flow networks, the Ford-Fulkerson method. **Number theory algorithms**: Factorization problem, discrete logarithm problem, RSA, ElGamal, Diffie-Hellman. **String Matching**: Naïve string matching algorithm, the Rabin-Karp algorithm. **Computational Geometry**: Line segment properties, finding the convex hull. **NP-Completeness**: Polynomial time, polynomial time verification, NP-completeness and reducibility, NP- completeness proofs, NP complete problems. **Approximation Algorithms:** Introduction, the vertex-cover problem, the traveling-salesman problem, the subset-sum problem.

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

1. **Provide** a thorough understanding of a variety of algorithms with real-life applications and the resource requirements.
2. **Introduce** a number of important algorithm design techniques as well as basic algorithms that are interesting both from a theoretical and also practical point of view.
3. **Demonstrate** the design and implementation of algorithms, using languages like C, C++, Java, etc.
4. **Enable** students to analyze time and space complexities of algorithms.
5. **Emphasize** on efficient algorithm designing, solving practical problems through algorithmic techniques and data structures to be used in the implementations of algorithms.
6. **Expose** the students to a variety of techniques that have practical applications, while conducting detailed analysis of the requirements required by the algorithms.

**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 algorithm analysis, design techniques, and basic algorithms. | 1 | 1/Remember | Lecture, multimedia | Quiz,  Written exam |
| CO2 | **Apply** techniques and appropriate data structures to design and implement algorithms to solve a practical problem. | 3 | 1/Apply | Lecture, Problem Solving | Problem solving Quiz, Written exam |
| CO3 | **Analyze** the performance / resource requirements of various algorithms. | 4 | 1/Analyze | Lecture,  Problem Solving | Problem Solving exam |
| CO4 | **Develop** algorithmic solutions to real-life problems. | 3 | 1/Analyze | Lecture, Problem Solving | Problem solving Quiz, Written exam |

**Weighting COs with Assessment methods:**

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| --- | --- | --- | --- | --- | --- | --- |
| **Assessment Type** | | **Marks Distribution (%)** | **CO1** | **CO2** | **CO3** | **CO4** |
| **PO1** | **PO3** | **PO4** | **PO3** |
| **Final Exam (50%)** | | **50** | 10 | 30 |  | 10 |
| **Mid Term (20%)** | | **20** | 6.67 | 6.66 | 6.66 |  |
| **Assessment (30%)** | **Assignment** | **10** |  | 5 |  | 5 |
| **Quiz** | **20** |  | 10 | 5 | 5 |
| **Total** | | **100%** | 11.67 | 48.33 | 30 | 10 |

**Course Content Outline and mapping with COs**

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| **Weeks** | **Topics / Content** | | **Course Outcome** | **Delivery methods and activities** | | **Reading Materials** | |
| 1-2 | Analyzing Algorithms: Introduction, Worst-Case and Best-Case Analysis, Asymptotic notation. | | CO1 | Lecture, multimedia | |  | |
| 3 | The Divide-and-Conquer (DC) Approach , Analyzing DC Algorithms. | | CO2-CO4 | Lecture, multimedia | | Cormen-2.3.1, 2.3.2  Slides | |
| 4-5 | Sorting(Merge) and Searching Algorithms(Binary), The Maximum-Subarray Problem Solving Recurrences | | CO2-CO4 | Lecture, Problem Solving | | Cormen-4.1, .4  Slides | |
| 5-6 | Greedy algorithm ; An Activity-Selection Problem;  Elements of the Greedy Strategy Some Legacy Greedy Problems – Coin change, fractional Knapsack, **Job-sequencing.** | | CO2-CO4 | Lecture, multimedia | | Cormen: 16.1, 16.2  Slides | |
| 7-8 | Dynamic Programming Basics, Fibonacci, Tower of Hanoi, The Rod Cutting Problem (15.1) Coin changing problem; Elements of Dynamic Programming (15.3)  0/1 Knapsack Problem, Longest Common Subsequence (15.4) | CO2-CO4 | | | Lecture, multimedia | | Cormen: Ch 15, Slides |
| 9-10 | Backtracking: The Knight’s tour problem, Rat in maze, N-Queen | CO2-CO4 | | | Lecture, multimedia | |  |
| 10-11 | Graph Theory. Applications of Graph Traversal Algorithms (DFS and BFS) (22.1, 22.2, 22.3,22.4), Graph coloring | CO2-CO4 | | | Lecture, multimedia | | Cormen: Ch 22, Slides |
| 11-12 | Disjoint-Set Operations; Disjoint-Set Forests (21.1, 21.3)  Minimum Spanning Tree (23.1)  Kruskal’s Algorithm (23.2), Prim’s Algorithm, Single-Source Shortest Path Variants, Optimal Substructure of a Shortest Path, Negative-weight Edges, Cycles, Relaxation (up-to 24.1 (exclusive))  The Bellman-Ford Algorithm (24.1)  Dijkstra’s Algorithm (24.3) | CO2-CO4 | | | Lecture, multimedia | | Cormen: Ch 21, 23, 24,  Slides |
| 13 | The Naive String-Matching Algorithm; The Rabin-Karp Algorithm(32.1, 32.2) | CO2-CO4 | | | Lecture, multimedia | | Cormen: Ch 32, Slides |
| 14 | Polynomial Time; Polynomial-Time Verification; NP- Completeness and Reducibility (34.1, 34.2, 34.3), NP-Hard, Reducibility | CO2-CO4 | | | Lecture, multimedia | | Cormen: Ch 34, Slides |
| Final Exam | | | | | | | |

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

**Textbook:** T.H. Cormen, C.E.Leiserson, R. L. Rivest, C. Stein:

*Introduction to Algorithms*, Third Edition, 2009, PHI Learning Pvt. Ltd

**Recommended References:** 1.Doanld E. Knuth : *Fundamental Algorithms (vol-1 (The Art of Computer Programming)*, 3rd edition, 1997, Addison-Wesley Professional

2. Ellis Horowitz & Sartaj Sahni*: Fundamental of Computer Algorithms*,

First Edition, 1983, Springer

3. **https://www.geeksforgeeks.org/fundamentals-of-algorithms/**

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

**Special Instructions: Late attendance:** Students who will enter the class after the attendance call will be marked as absent.

**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.

**Online Etiquettes:** Prepare yourself for the class. Remember that it is a classroom setting, consisting of all learners' classmates and teachers. Students need to follow all the etiquettes they would in a regular classroom.

Make sure your device is ready at least 10 minutes before the class starts.

Make sure all required study materials such as pen, paper, books, etc. are in your reach during the class.

Try to be alone and pay full attention to your teachers. Nobody should be around you while the class is in progress (if not possible, take extra care to keep your microphone in mute state to avoid extra noise during the class).

Follow the timetable of the class very strictly.

Keep your microphone in mute state and video in on state. If you need to communicate with your teacher raise your hands and seek permission.

Do not do anything which may disturb the class (such as passing irrelevant and negative comments etc.); you will be monitored and **disciplinary actions will be taken.**

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| **Prepared by**  **(**Course Teacher**)** | **Checked by**  **(**Chairman, PSAC committee**)** | **Approved by**  **(**Head of the Department**)** |
| Tanjina Helaly  Fahad Ahmed |  |  |

**Appendix-1:**

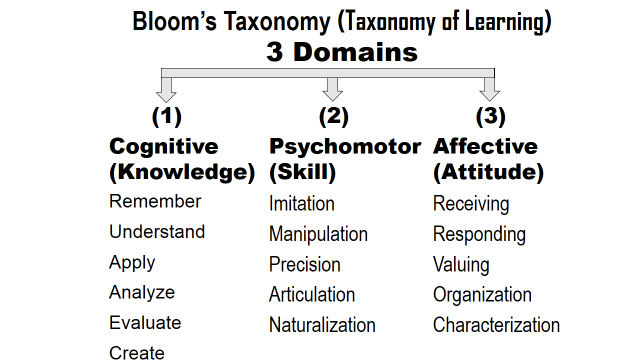
**Washington Accord Program Outcomes (PO) for engineering programs:**

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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 |