

**COLLEGE OF INFORMATION TECHNOLOGY**

**DEPARTMENT OF INFORMATION TECHNOLOGY**

**COURSE SYLLABUS/SPECIFICATION**

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| **CODE & TITLE:** | **ITCS 303 – Design and Analysis of Algorithms** | |
| **WEIGHT:** | **(2 - 2 - 3)** |  |
| **PREREQUISITE:** | **ITCS 224 & ITCS 203** |  |
| **DESCRIPTION:** | The course covers classical techniques and paradigms used in the design and analysis of algorithms. Some of the covered techniques are induction and recursion, divide and conquer, dynamic programming, and greedy approach. Techniques like backtracking and randomization are also introduced to deal with NP-Complete problems. Students will be able to practice their skills on many well-known algorithms and data structures designed to solve practical problems. | |
| **OBJECTIVES:** | 1. To introduce the specialist theories, concepts and principles of problems and algorithms design.  2. To design efficient algorithms for solving different kinds of problems using various classical techniques and paradigms.  3. To analyze the time and space complexities of algorithms.  4. To introduce computability and complexity theories, and study a number of techniques for solving hard problems. | |
| **SEMESTER:** |  | **ACADEMIC YEAR:** |
| **INSTRUCTOR:** | | |
| **OFFICE TEL.:** | | |
| **EMAIL:** | | |

**INTENDED LEARNING OUTCOMES (ILOS)**

Upon successful completion of the course, students should be able to:

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| **A. Knowledge and Understanding** | |
| **A1** | Concepts and Theories: Demonstrate advanced knowledge and understanding of the concepts and  specialist theories of algorithmic design and analysis, algorithm design paradigms, optimal algorithms, complexity theory, P and NP problems, etc. |
| **A2** | Contemporary Trends, Problems and Research: NA |
| **A3** | Professional Responsibility: NA |

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| **B. Subject-Specific Skills** | |
| **B1** | Problem Solving: Identify real world problems and solve them by designing efficient algorithms. |
| **B2** | Modeling and Design: Develop formal definitions of real world problems, and design their efficient  algorithmic solutions using different techniques, such as, divide and conquer, dynamic programming, and the greedy approach. |
| **B3** | Application of Methods and Tools: Apply a computer programming language to implement algorithms designed for solving real world problems. |

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| **C. Thinking Skills** | |
| **C1** | Analytic: Critically analyze and evaluate the asymptotic performance of different algorithms, and find  the best and optimal solution for a problem. |
| **C2** | Synthetic: NA |
| **C3** | Creative: Demonstrate ability to analyze and design efficient algorithm for solving new problems  using different algorithmic techniques. |

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| **D. General and Transferable Skills (Other Skills Relevant to Employability and Personal**  **Development)** | |
| **D1** | Communication: Show ability to convey ideas and describe processes of designing efficient  algorithms in appropriate oral and written forms. |
| **D2** | Teamwork and Leadership: Work effectively as a member/leader of a team who may plan, design, and  implement an algorithm for solving real world problem. |
| **D3** | Organizational and Developmental Skills: Demonstrate ability to utilize ideas of classical algorithms  to develop procedures and processes to solve real world problems and effectively allocate time in given assignment. |
| **D4** | Ethical and Social Responsibility: NA |

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| **Course Structure (Outline)** | | | | | | |
| **Week** | **Hours** | | **ILOs** | **Unit/Module or Topic Title** | **Teaching**  **Method** | **Assessment**  **Method** |
| **Lec.** | **Lab** |
| 1 | 2 | 2 | A1 | **Introduction to problems:**  Types and sizes of problems, problem search space and instances. | Lecture/ In-  Class Supervised Work |  |
| 2 | 2 | 2 | A1, B2 | **Problem Formulation and**  **Modeling** | Lecture/ Lab  Demonstration/ In-Class Supervised Work | In-Class  Exercises |
| 3 | 2 | 2 | A1 | **Algorithm Analysis:**  Best, worst and average cases, asymptotic analysis. | Lecture/ Lab  Demonstration |  |
| 4 | 2 | 2 | A1, C1 | **Algorithm Analysis:**  Asymptotic notations. | Lecture/  In-Class Supervised Work/ Lab Demonstration (program execution time) | In-Class Exercises/ Quiz 1 |
| 5-6 | 4 | 4 | A1, B1, B2, B3, C1 | **Divide and Conquer:**  Problem solving such as sorting problems. | Lecture/  In-Class Supervised Work / In-Lab Supervised Work | In-Lab Exercises/ In- Class Exercises/ Quiz 2 |
| 7-8 | 4 | 4 | A1, B1, B2, B3, C1 | **Data Structures:**  Heaps, operations on heaps and  Heap Sort. | Lecture/  In-Class Supervised Work/ In-Lab Supervised Work | Test 1/ In-Lab Exercises/ In- Class Exercises |
| 9-10 | 4 | 4 | A1, B1, B2, B3, C1 | **Greedy Approach:**  Problem solving such as MST, Prim’s and Kruskal’s Algorithms. | Lecture/  In-Class Supervised Work/ In-Lab Supervised Work | Quiz 2/ In-Lab Exercises/ In- Class Exercises |
| 11-12 | 4 | 4 | A1, B1, B2, B3, C1 | **Dynamic Programming:**  Problem solving, such as shortest paths problem and | Lecture/  In-Class  Supervised | Quiz 3/ In-Lab  Exercises/ In- Class Exercises |

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|  |  |  |  | knapsack problem. | Work/ In-Lab  Supervised  Work |  |
| 13 | 2 | 2 | A1, B1, B2, B3, C1 | **Complexity Theory:**  P, NP, NP-complete problems and Exhaustive search. | Lecture/ Lab  Demonstration | In-Lab Exercises |
| 14 | 2 | 2 | A1, B1, B2, B3, C1 | **Coping with NP-complete:**  Backtracking, branch, bound and randomization, parallelization. | Lecture/ In-Lab Supervised Work | In-Lab Exercises |
| 15 | 2 | 2 | B1, B2, B3, C1, C3, D1, D2, D3 | Student Projects | Project  Supervision | Evaluation of  Project Presentations and Reports |
| 16 | 2 | - | A1, B1, B2,  C1, C3 | All Topics |  | Final Exam |

**TEACHING MATERIALS:**

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| **TEXTBOOK(S):** | 1. Levitin A. (2014) *Introduction to the Design & Analysis of Algorithms*, 3rd  Edition, Pearson Education.  2. Morhan I. C. (2012) *Design and analysis of algorithms*, 2nd Edition, PHI Learning  Pvt. Ltd. |
| **HANDOUT(S):** | PowerPoint slides available on Moodle i.e. <http://www.ahlia.edu.bh/moodle> |
| **REFERENCE(S):** | 1. [Puntambekar](https://www.google.com.bh/search?tbo=p&amp;tbm=bks&amp;q=inauthor%3A%22A.A.Puntambekar%22) A.A. (2010) *Design and Analysis of Algorithms*, Technical  Publications.  2. Dormehl L. (2015) *The Formula: How Algorithms Solve All Our Problems-And*  *Create More*, WH Allen.  3. Weiss M. A. (2012) *Data Structures and Algorithm Analysis in Java*, 3rd Edition, Pearson Education.  4. Wayne K. and Sedgewick R. (2014) *Algorithms*, 4th Edition, Addison-Wesley  Professional.  5. Sedgewick R. and Flajolet P. (2013) *An Introduction to the Analysis of Algorithms*,  2nd Edition, Addison-Wesley. |

**ASSESSMENTS:**

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| **Type of**  **Assessment** | **Description** | **ILOs** | **Weighting** |
| Quizzes | Three written quizzes to be  conducted. The quizzes consist mainly of problem solving and analysis questions. Average of best two will be considered. | A1, B1, B2, C1 | 10% |
| Project | Student will work as groups of 2-4 | B1, B2, B3, C1, | 20% |

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|  | members; they will choose a real  world problem, analyze it, design an algorithm, implement it and evaluate the performance. | C3, D1, D2, D3 |  |
| In-Class Exercises | Exercises cover problem solving and  analysis questions to help the students in differentiating between the various algorithm designs. | B1, B2, C1 | Formative |
| In-Lab Exercises | Implement the algorithms for solving  problems. | B3 | Formative |
| Tests | In-class One test that will consist of  short-answer, essay, problem solving, and algorithm analysis and design questions. | A1, B1, B2, C1 | 30 % |
| Final Exam | The final exam is comprehensive and  will be of two hours duration. It will consist of short-answer, essay, problem-solving, algorithm analysis and design questions. | A1, B1, B2, C1, C3 | 40% |
| **Overall** |  |  | **100%** |

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