

**UNIVERSITY OF MALAWI-THE POLYTECHNIC**

**FACULTY OF ENGINEERING**

**ELECTRICAL ENGINEERING DEPARTMENT**

1. **Programmes: BECE**
2. **Module Title:**  Algorithm analysis and Design
3. **Module Code:** ELE-ADA-5-1
4. **Level:** 4
5. **Credit:** 10
6. **Presented to:**  Senate
7. **Presented by:** Faculty of Engineering
8. **Lectures (Hrs/Wk):** 3
9. **Tutorials:** 1
10. **Prerequisites:** ELE-OOP-3-1, ELE-SWE-4-2
11. **Co-requisites:** None
12. **Module Aim**

To provide students with techniques for the design of efficient algorithms

1. **Intended Learning Outcomes**

On completion of this module, the student should be able to:

1. Demonstrate an understanding of methods for showing lower bounds on computational complexity.
2. Demonstrate knowledge on particular algorithms for sorting, searching, set manipulation, arithmetic, graph problems, pattern matching.
3. Solve algorithm problems
4. **Indicative Content**
5. **Introduction: *Some Representative Problems***
   1. A First Problem: Stable Matching
   2. Five Representative Problems
6. **Basics of Algorithms Analysis**
   1. Computational Tractability
   2. Asymptotic Order of Growth Notation
   3. Implementing the Stable Matching Algorithm using Lists and Arrays
   4. A Survey of Common Running Times
   5. A More Complex Data Structure: Priority Queues
7. **Graphs**
   1. Basic Definitions and Applications
   2. Graph Connectivity and Graph Traversal
   3. Implementing Graph Traversal using Queues and Stacks
   4. Testing Bipartiteness: An Application of Breadth-First Search
   5. Connectivity in Directed Graphs
   6. Directed Acyclic Graphs and Topological Ordering
8. **Greedy Algorithms**
   1. Interval Scheduling: The Greedy Algorithm Stays Ahead
   2. Scheduling to Minimize Lateness: An Exchange Argument
   3. Optimal Caching: A More Complex Exchange Argument
   4. Shortest Paths in a Graph
   5. The Minimum Spanning Tree Problem
   6. Implementing Kruskal's Algorithm: The Union-Find Data Structure
   7. Clustering
   8. Huffman Codes and the Problem of Data Compression
   9. (\*) Minimum-Cost Arborescences: A Multi-Phase Greedy Algorithm
9. **Divide and Conquer**
   1. A First Recurrence: The Mergesort Algorithm
   2. Further Recurrence Relations
   3. Counting Inversions
   4. Finding the Closest Pair of Points
   5. Integer Multiplication
   6. Convolutions and The Fast Fourier Transform
10. **Dynamic Programming**
    1. Weighted Interval Scheduling: A Recursive Procedure
    2. Weighted Interval Scheduling: Iterating over Sub-Problems
    3. Segmented Least Squares: Multi-way Choices
    4. Subset Sums and Knapsacks: Adding a Variable
    5. RNA Secondary Structure: Dynamic Programming Over Intervals
    6. Sequence Alignment
    7. Sequence Alignment in Linear Space
    8. Shortest Paths in a Graph
    9. Shortest Paths and Distance Vector Protocols
    10. Negative Cycles in a Graph
11. **Network Flow**
    1. The Maximum Flow Problem and the Ford-Fulkerson Algorithm
    2. Maximum Flows and Minimum Cuts in a Network
    3. Choosing Good Augmenting Paths
    4. The Preflow-Push Maximum Flow Algorithm
    5. A First Application: The Bipartite Matching Problem
    6. Disjoint Paths in Directed and Undirected Graphs
    7. Extensions to the Maximum Flow Problem
    8. Survey Design
    9. Airline Scheduling
    10. Image Segmentation
    11. Project Selection
    12. Baseball Elimination
    13. A Further Direction: Adding Costs to the Matching Problem
12. **NP and Computability Intractability**
    1. Polynomial-time Reductions
    2. Efficient Certification and the Definition of NP
    3. NP-Complete Problems
    4. Sequencing Problems
    5. Partitioning Problems
    6. Graph Coloring
    7. Numerical Problems
    8. co-NP and the Asymmetry of NP
    9. A Partial Taxonomy of Hard Problems
13. **Assessment**

Examination 70%

Coursework 30%

1. **Teaching and Learning Methods**

Lectures, tutorials and group discussions

1. **Prescribed text**

# Goodrich M. (2001), Algorithm Design: Foundations, Analysis, and Internet Examples, Wiley; ISBN-13: 978-0471383659

1. **Recommended text**
2. Kleinberg J. Tardos E. (2006), Algorithm Design, Addison Wesley, ISBN-13:9780321295354

# Lee R.C.T., chang R.C. (2005), Introduction to the Design and Analysis of Algorithms, McGraw-Hill Education; ISBN-13: 978-0071243469