DIPLOMA IN

INFORMATION TECHNOLOGY

MODULE LEARNING GUIDE

DISCRETE MATHEMATICS

Version 1: May 2007
INTRODUCTION

This module provides an accessible introduction to discrete mathematics through an algorithmic approach that focuses on problem-solving techniques.

AIMS

The main aim of the module is to provide students with fundamental mathematical principles and techniques, which are widely used in computer science applications, and to introduce students to the ideas of proof and algorithm in the context of discrete mathematics.

LEARNING OUTCOMES

At the completion of this module, lecturers must ensure that students will be able to:

- Introduce logic as the study of reasoning.
- Introduce the quantifiers in the propositions and proof of arguments.
- Use the fundamental concepts of mathematics in computer science.
- Introduce the concept of relations and functions in data base management.
- Write algorithms for simple mathematical problems.
- Understand the different types of counting techniques and the concept of pigeonhole principle in computer science.
- Solve recurrence relations
- Solve problems with use of graphs
- Gain knowledge in trees and tree traversals.

AUDIENCE AND PRE-REQUISITES

This module is intended for students who are in the advanced stages of the Diploma program. Ideally this module should run after successful completion of the Business Mathematics & Data Structures module.

OVERVIEW OF THE MODULE

The module is divided into 7 sections dealing with:

- Logic and Proofs
- The language of Mathematics
- Algorithms
- Counting Methods & The pigeonhole principle
- Recurrence relations
- Graph Theory
- Trees

INSTRUCTIONAL PLAN AND RESOURCES

The base source of material to be used in the design of the teaching-learning schedule will be the set text. Each topic must be taught with reference to Algorithm, problem solving and solution.

Candidates must be guided diligently in application of concepts in writing Algorithms via tutorials.

Where ever possible computer simulation should be used to demonstrate the concepts.

CLASS LEARNING SCHEDULE

<table>
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<tr>
<th>Week</th>
<th>Lecture</th>
<th>Tutorial/ Activities</th>
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</thead>
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<tr>
<td>1</td>
<td>Logic &amp; Proofs 1.1, 1.2, 1.3</td>
<td>Pg. 6, 7, 13, 14, 27 to 29</td>
</tr>
<tr>
<td>2</td>
<td>Logic &amp; Proofs 1.4, 1.5, 1.6</td>
<td>Pg. 36, 37, 40, 46 to 51 Test Question–Pg 53 &amp; 54</td>
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<tr>
<td>3</td>
<td>The Language of Mathematics 2.1, 2.2, 2.3, 2.4</td>
<td>Pg. 62, 63, 69 to 71, 76, 83 to 85</td>
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<td>4</td>
<td>The Language of Mathematics 2.5, 2.6, 2.7, 2.8</td>
<td>Pg. 89 to 92, 96, 97, 100, 101, 111 to 113 Test Question–Pg 116 to 119</td>
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<tr>
<td>5</td>
<td>Algorithms 3.1, 3.2, 3.3, 3.4</td>
<td>Pg. 122, 127, 128, 131, 137, 138</td>
</tr>
<tr>
<td>6</td>
<td>Algorithms 3.5, 3.6, 3.7</td>
<td>Pg. 149 to 154, 157, 160 Test Question–Pg 162 to 164</td>
</tr>
<tr>
<td>7</td>
<td>Counting Methods &amp; The Pigeon Hole Principle 4.1, 4.2, 4.3</td>
<td>Pg. 171 to 174, 182 to 186, 191, 192</td>
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</table>
### ASSESSMENT REQUIREMENTS

**AIM**

The aim of the assessment is to identify formal practices and procedures for assessing and appraising the performance of participants in order those judgments and decisions can be reached concerning:

- The progression of participants through the program
- How well participants have met the program learning outcomes through the combination of the individual module learning outcomes.
- The provision of feedback information to participants concerning their performance and how they adhered to the generic assessment criteria and the module-specific assessment criteria.

**ASSESSMENT INSTRUMENTS:**

The following is an outline of the various assessment instruments for this module:

**Examinations (60%)**

Final Examination is included in this module. It seeks to determine participants’ individual effectiveness in responding to specific questions under time-constrained invigilated conditions.

Examinations test retained knowledge and understanding and the student's ability to address questions and problems under examination conditions and time constraints. This process simulates conditions under which managers invariably have to work - assessing what is needed, identifying options, establishing priorities, making decisions and communicating - all under pressure. Examinations also ensure that the student has to produce original work, which cannot benefit from outside help. Employers value the examination process as it assures them that students on the program are thoroughly assessed on their own merits and cannot achieve a pass based largely on the work of others.

**MID TERM (40%)**

Students will be given a mid-term focusing on content on the first five weeks of classes.

**ASSESSMENT TIMELINES**

The coursework assignment is to be distributed to students by the end of Week 1 and its submission deadline is on week 8.

Final examinations are held at the end of the semester which will be in week 14.

**ASSESSMENT CRITERIA**

Refer to assignment and final examination marking guide.
## ASSESSMENT DESCRIPTOR

The following general principles should be used when marking and awarding grade:

<table>
<thead>
<tr>
<th>GRADE</th>
<th>CHARACTERISTICS</th>
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</table>
| **Above 70%** | • Excellent work which demonstrates that the student:  
• Possesses an authoritative grasp of the concepts, methodology and content appropriate to the subject and to the assessment  
• Selects and organises material with consistent success at an exceptionally high stage  
• Is able to display originality and personal insight and is capable of expressing their argument clearly, concisely and accurately. |
| **60-69%** | The student demonstrates:  
• An above average stage of understanding, organising, interpretation and a clear grasp of methodology suitable focused on the topic  
• An ability to synthesise material and to construct responses which reveal insight and may offer originality  
• A grasp of material that enables a coherent response to the assessment task to emerge  
• An ability to generate work that is accurate and appropriately organised. |
| **50-59%** | • The student is able to cover basic subject matter but in a relatively unimaginative and pedestrian manner.  
• Organisation and presentation of material is acceptable but may display some weakness.  
• Limitations in understanding and interpretation and difficulty in linking to relevant material may be evident. |
| **40-49%** | • The student’s performance is only just acceptable in most respects revealing some inadequacies in the grasp of material, weak organising ability and limited communication skills. |
| < **40%** | • The student’s performance is deficient revealing inadequate grasp of material, poor organising ability and poorly developed communication skills. |
LEARNING SUGGESTIONS AND GUIDELINES

WEEK 1 & 2

Over the week of lecture and tutorial, the focus will be to undertake the following:

- To understand the concept of Propositions and compound propositions
- To understand the concept of Conditional propositions and logical equivalence
- To understand the concept of Quantifiers.
- To understand the concept of Proofs and Resolution Proofs
- To understand the concept of Mathematical Induction.

Learning outcomes to attain:

- Able to solve problems relating to Propositions
- Able to solve problems relating to Conditional Propositions
- Able to solve problems relating to De Morgan’s law of logic
- Able to solve problems relating to Propositional functions
- Able to solve problems relating to Proofs & resolution proofs
- Able to solve problems relating to Mathematical induction

Readings and preparation to be undertaken by the student:

a. Chapter 1 from the Set text, page number 1 – 51
d. Conduct all activities as found in the set text, page 6, 7, 13, 14, 27 to 29, 36, 37, 40, 46 to 51. Conduct the chapter test on the completion of the 2nd week of classes as on page 53 & 54.

WEEK 3 & 4

Over the week of lecture and tutorial, the focus will be to undertake the following:

- To define Set, types of set, draw venn diagrams and to state laws
- To define Sequences and strings and its types
- To understand different types of Number systems and their conversions
- To understand the concept of Relations and its types.
- To understand the concept of Equivalence relations and equivalence class
- To understand the concept of Matrices of relations
- To understand the concept of Relational Databases
- To understand the concept of Functions and its types

Learning outcomes to attain:

- Able to solve problems relating to Sets
- Able to solve problems relating to Sequences and strings
- Able to solve problems relating to Number systems and their conversions
- Able to solve problems relating to Relations
- Able to solve problems relating to Equivalence relations and equivalence class
- Able to solve problems relating to Matrices of relations
- Able to solve problems relating to Relational Databases
- Able to solve problems relating to Functions and its types

Readings and preparation to be undertaken by the student:

a. Chapter 2 from the Set text, page number 56 – 114
d. Conduct all activities as found in the set text, page 62, 63, 69 to 71, 76, 83 to 85, 89 to 92, 96, 97, 100, 101, 111 to 113. Conduct the chapter test on the completion of the 4th week of classes as on page 116 to 119.
WEEK 5 & 6

Over the week of lecture and tutorial, the focus will be to undertake the following:
- To understand what is Algorithm and its characteristics
- To understand the structure, control statements, Syntax of procedures
- To understand the concept of Euclidean Algorithm
- To understand the concept of Recursive Algorithm
- To understand the Complexity of Algorithms
- To understand the concept of RSA Public-Key cryptosystem.

Learning outcomes to attain:
- Able to write Algorithms
- Able to write procedures using the control statements
- Able to solve problems relating to the Euclidean Algorithm
- Able to solve problems relating to the Recursive Algorithm
- Able to identify the Complexity of Algorithms
- Able to solve problems relating to the RSA Public-Key cryptosystem.

Readings and preparation to be undertaken by the student:
- Chapter 3 from the Set text, page number 121 - 161
- Conduct all activities as found in the set text, page 6122,127,128,131,137,138, 149 to 154,157,160. Conduct the chapter test on the completion of the 6th week of classes as on page 162 to 164.

WEEK 7 & 8

Over the week of lecture and tutorial, the focus will be to undertake the following:
- To understand the concept of Multiplication Principle & Addition Principle
- To understand the concept of Permutations and Combinations
- To understand how to write Algorithms for generating Permutations and Combinations.
- To understand what is probability, conditional probability and event types
- To understand the concept of Baye’s Theorem
- To understand the concept of Binomial Theorem and Pascal’s Triangle.
- To understand the concept of the forms of Pigeonhole principle.

Learning outcomes to attain:
- Able to solve problems relating to Multiplication Principle & Addition Principle
- Able to solve problems relating to Permutations and Combinations
- Able to write Algorithms for generating Permutations and Combinations.
- Able to solve problems relating to probability and its types
- Able to solve problems relating to Baye’s Theorem
- Able to solve problems relating to Binomial Theorem and Pascal’s Triangle
- Able to solve problems relating to the three forms of Pigeonhole principle

Readings and preparation to be undertaken by the student:
- Chapter 4 from the Set text, page number 165 - 220
- Conduct all activities as found in the set text, page 171 to 174,182 to 186, 191, 192, 194,195, 204 to 206,210, 211, 215, 219, and 220. Conduct the chapter test on the completion of the 8th week of classes as on page 221 to 223.
WEEK 9 & 10

Over the week of lecture and tutorial, the focus will be to undertake the following:

• To understand the concept of recurrence Relations, Tower of hanoi puzzle, Ackermann’s function
• To understand the two methods of Solving recurrence Relations.
• To understand how to use recurrence relations for the analysis of Algorithms.

Learning outcomes to attain:

• Able to solve problems relating to recurrence Relations
• Able to solve Tower of hanoi puzzle,
• Able to solve problems relating to Ackermann’s function
• Able to solve problems relating to the two methods of Solving recurrence Relations.
• Able to know how to use recurrence relations for the analysis of Algorithms.

Readings and preparation to be undertaken by the student:

a. Chapter 5 from the Set text, page number 224 - 260
d. Conduct all activities as found in the set text, page 232 to 235, 244 to 249, 244 to 249, 256 to 259. Conduct the chapter test on the completion of the 10th week of classes as on page 260 to 262.

WEEK 11 & 12

Over the week of lecture and tutorial, the focus will be to undertake the following:

• To understand the basics of Graphs and its types
• To understand the basics of Path and Cycles
• To understand the concept of Hamiltonian Cycles and The Traveling Salesperson Problem
• To understand the concept of Dijkstra’s Shortest-Path Algorithm.
• To understand the Representation of Graphs
• To understand the concept of Isomorphism of Graphs
• To understand the concept of Planar Graphs, Euler’s equation, homeomorphic graphs and kuratowski’s theorem
• To understand the concept of Instant Insanity puzzle

Learning outcomes to attain:

• Able to solve problems relating to Graphs and its types
• Able to solve problems relating to Path and Cycles
• Able to solve problems relating to Hamiltonian Cycles and The Traveling Salesperson Problem
• Able to solve problems relating to Dijkstra’s Shortest-Path Algorithm.
• Able to solve problems relating to Representation of Graphs
• Able to solve problems relating to Isomorphism of Graphs
• Able to solve problems relating to Planar Graphs, Euler’s equation, homeomorphic graphs and kuratowski’s theorem
• Able to solve problems relating to Instant Insanity puzzle

Readings and preparation to be undertaken by the student:

a. Chapter 6 from the Set text, page number 263 - 317
d. Conduct all activities as found in the set text, page 271 to 273, 281 to 285, 290, 291, 296, 300, 301, 305 to 307, 311 to 313, 316, 317. Conduct the chapter test on the completion of the 12th week of classes as on page 319 to 322.

WEEK 13 & 14

Over the week of lecture and tutorial, the focus will be to undertake the following:

• To understand the basics of trees
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- To understand the Terminology and Characterizations of Trees
- To understand the concept of Spanning Trees
- To understand the concept of Minimal Spanning Trees
- To understand the concept of Binary Trees.
- To understand the concept of Tree Traversals and its types
- To understand the concept of Decision Trees and the Minimum Time for Sorting
- To understand the concept of isomorphism of Trees
- To understand the concept of Game Trees.

Learning outcomes to attain:
- Able to solve problems relating to trees
- Able to solve problems relating to Spanning Trees
- Able to solve problems relating to Minimal Spanning Trees
- Able to solve problems relating to Binary Trees.
- Able to solve problems relating to Tree Traversals
- Able to solve problems relating to Decision Trees and to find the Minimum Time for Sorting
- Able to solve problems relating to isomorphism of Trees
- Able to solve problems relating to Game Trees.

Readings and preparation to be undertaken by the student:

a. Chapter 7 from the Set text, page number 323 - 384
d. Conduct all activities as found in the set text, page 330, 331, 335, 336, 342, 343, 347 to 349, 354, 355, 360, 361, 366, 367, 375, 376, 381 to 383. Conduct the chapter test on the completion of the 14th week of classes as on page 385 to 389.

WEEK 15

FINAL EXAMINATION
<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Resources required</th>
</tr>
</thead>
</table>
| 1    | Logic & Proofs
      1.1, 1.2, 1.3 | Discrete Mathematics by Richard Johnsonbaugh |
| 2    | Logic & Proofs
      1.4, 1.5, 1.6 | Discrete Mathematics by Richard Johnsonbaugh |
| 3    | The Language of Mathematics
      2.1, 2.2, 2.3, 2.4 | Discrete Mathematics by Richard Johnsonbaugh |
| 4    | The Language of Mathematics
      2.5, 2.6, 2.7, 2.8 | Discrete Mathematics by Richard Johnsonbaugh |
| 5    | Algorithms
      3.1, 3.2, 3.3, 3.4 | Discrete Mathematics by Richard Johnsonbaugh |
| 6    | Algorithms
      3.5, 3.6, 3.7 | Discrete Mathematics by Richard Johnsonbaugh |
| 7    | Counting Methods & The PigeonHole Principle
      4.1, 4.2, 4.3 | Discrete Mathematics by Richard Johnsonbaugh |
| 8    | Counting Methods & The PigeonHole Principle
      4.4, 4.5, 4.6, 4.7, 4.8 | Discrete Mathematics by Richard Johnsonbaugh |
| 9    | Recurrence Relations
      5.1, 5.2 | Discrete Mathematics by Richard Johnsonbaugh |
| 10   | Recurrence Relations
      5.2, 5.3 | Discrete Mathematics by Richard Johnsonbaugh |
| 11   | Graph Theory
      6.1, 6.2, 6.3, 6.4 | Discrete Mathematics by Richard Johnsonbaugh |
| 12   | Graph Theory
      6.5, 6.6, 6.7, 6.8 | Discrete Mathematics by Richard Johnsonbaugh |
| 13   | Trees
      7.1, 7.2, 7.3, 7.4, 7.5 | Discrete Mathematics by Richard Johnsonbaugh |
| 14   | Trees
      7.6, 7.7, 7.8, 7.9 | Discrete Mathematics by Richard Johnsonbaugh |