Eastern Illinois University
New Course Proposal
MAT 3870, Data Structures

1. Catalog Description
   a. Course number: MAT 3870
   b. Title: Data Structures
   c. Meeting times and credit: 3-0-3
   d. Terms to be offered: Fall
   e. Short title: Data Structures
   f. Course description: Introduction to the design and analysis of data structures and their related algorithms; lists, stacks, queues, trees, heaps and graphs; sorting and searching. C++ or another object-oriented language will be used for any implementations.
   g. Prerequisite: MAT 2345 and MAT 2670 or permission of instructor
   h. Initial term: Fall 2006

2. Student Learning Objectives and Evaluation
   a. Objectives
      Students will:
      1. apply of a broad range of data structures available to designers;
      2. evaluate the trade-offs associated with data structure choices;
      3. compare the relative effects of data structure choices on algorithm efficiency;
      4. implement various data structures in a specific programming language such as C++.

   b. Assessment
      Course assessment will consist of evaluation of student work in the following areas:
      1. Textbook exercises (15%)
      2. Computer projects involving implementation of data structures (15%)
      3. 2 in-class exams (40%)
      4. Final exam (30%)
      Student achievement of the stated goals will be assessed in the following manner:

      |                        | Homework | Programming | Tests | Final Exam |
      |------------------------|----------|-------------|-------|------------|
      | Range of Data Structures | X        | X           | X     | X          |
      | Implications of Data Structure Choices | X        | X           | X     | X          |
      | Algorithm Efficiency   | X        | X           | X     | X          |
      | Implementation         | X        | X           | X     | X          |

   c. Technology
      This course is not technology-delivered.

   d. Graduate Student Assessment
      Not applicable.

   a. Writing Designation
      Not applicable.

3. Outline of the Course
   a. Units of Time

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Object and classes; templates.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>Inheritance. Exercise set 1 due.</td>
</tr>
</tbody>
</table>
| Week 3 | Static searching: sequential and binary search.  
|        | Program correctness and efficiency. |
| Week 4 | The Standard Template Library.  
|        | Lists, Stacks, and Queues.  
|        | Exercise set 2 due. |
| Week 5 | Applications of Stacks and Queues.  
|        | Expression parsing. |
| Week 6 | Sets, Maps, and Priority Queues.  
|        | Implementation issues.  
|        | Applications of sets, maps, and priority queues.  
|        | Exam 1. |
| Week 7 | Recursion.  
|        | Mathematical Induction and Recursion.  
|        | Example: modular exponentiation.  
|        | Exercise set 3 due. |
| Week 8 | Sorting.  
|        | Shell sort, merge sort, quick sort. |
| Week 9 | Ramdomization: generators, random permutations.  
|        | Exercise set 4 due. |
| Week 10 | Graphs and Paths.  
|         | Mathematical properties; topological sorting.  
|         | Dijkstra’s algorithm for shortest path.  
|         | Exercise set 5 due. |
| Week 11 | Trees.  
|         | Mathematical properties; applications, traversals.  
|         | Exam 2. |
| Week 12 | Binary Search Trees.  
|         | Basic operations and implementation.  
|         | Exercise set 6 due. |
| Week 13 | Hash Tables.  
|         | Collisions and probing. |
| Week 14 | The Priority Queue.  
|         | The binary heap and associated algorithms.  
|         | Exercise set 7 due. |
| Week 15 | The Disjoint Set Problem.  
|         | Dynamic equivalence; union/find algorithm. |

b. **Technology-delivered**
   1. Not applicable
   2.

4. **Rationale**
   a. **Purpose and need**
      The study of data structures is a fundamental topic of computer science. Data structures are an essential part of any program, as such, understanding their individual capabilities and limitations is important. Having a course that is devoted to the study of data structures allows for the examination of some of the more complex data structures that are used in practice but might otherwise be overlooked. Furthermore, the analysis of data structures is mathematically rigorous and reinforces the fact that computer science is more than coding.

b. **Justification for course level and prerequisites**
   A junior-level course in data structures is quite common. Placing the course at this level allows for Discrete Mathematics (MAT 2345) and Computer Science II (MAT 2670) to be prerequisites. This ensures that students have had two semesters of experience with programming and that they have had exposure to mathematical proof techniques. These combine to allow for a more sophisticated discussion of program correctness and algorithmic efficiency. It
also enables the students to perform the coding required to implement the data structures.

c. **Similarity to existing courses**
   MAT 4870 currently examines the design, implementation, and analysis of data structures. This proposal goes along with concurrent requests to add a new course, MAT 4880, and to drop (by executive action) MAT 4870. The core of this course will be drawn from the design and implementation material formerly included in MAT 4870. The material on algorithm analysis currently done in that MAT 4870 will be moved into MAT 4880, providing more focus on data structures and programming language support for these structures.

d. **Impact on program**
   The proposed course will be a requirement for the Mathematics and Computer Science major. It could also be included as an elective in some of the options in the Mathematics degree and could be considered as an elective in CIS.

5. **Implementation**
   a. **Faculty members to whom this course may be assigned**
      Andrews, Mertz, Slough, Van Cleave, or other qualified faculty in the Department of Mathematics and Computer Science.
   
   b. **Additional cost to students**
      None.
   
   c. **Text and supplementary materials**

6. **Community College Transfer**
   Not applicable

7. **Date approved by the department:** October 24, 2005

8. **Date approved by the college curriculum committee:** November 11, 2005

9. **Date approved by CAA** _________________________ **CGS** _________________________