Objective: The term project consists of a design which is based on knowledge the student gained throughout the semester in the lecture and lab sessions. The term project is meant to challenge the student’s ability in applying their understanding and knowledge of logical design to a practical problem.

Task: Design a simple calculator that accepts two numbers (where numbers are more than -32 but less than 32) and allows the user to select one of the three operations (addition, subtraction and multiplication). The calculator displays the output of the operation in 5 seven-segment displays.

Design Criteria:
1. Use addition, subtraction and multiplication designs/algorithms that use a minimum number of additions and shifts.
2. Design a circuit that uses a minimum number of registers (Flip-Flops).
3. Only use a maximum of 16 input data switches and a clock.
4. Provide two modes of operation:
   a. A single step clock mode for testing and demonstration with control to step the clock one pulse and pause until stepped again.
   b. A run clock mode that will perform the operations at full clock speed and then stop to display the result.

Design Task:
1. Research binary subtraction methods and multiplication algorithms, and register configurations. Describe the alternative approaches giving references. Compare the different approaches and select the best solution to meet the design criteria above and give the reasons for the selection.
2. Design a control unit (a synchronous sequential circuit) for the calculator and simulate your calculator in LogicWorks.
3. The inputs to the control unit are:
   - Start button - resets registers as needed and starts the operation
   - Two 7-bit inputs as operands A and B
   - Selection code for selecting the operation (00 – addition, 01 – subtraction and 10 - multiplication)
   - Switch with Clock mode control for step or run.
   - Switch for step mode
4. The Outputs of the Calculator are:
   - Operands A and B
   - The result of the operation in 5 seven-segment displays.
   - One of the seven segment displays must be used for showing the negative sign if the output of the operation is negative.

Deliverables:
1. Soft- and hard-copy of the term project report (written in a word processing program on a computer)
   a. Describe the algorithms using a flowchart or equivalent. Give the alternatives considered and reasons for selection.
   b. Describe the hardware using a block diagram. Give the alternatives considered and reasons for selection.
   c. Describe the calculator using a state table or state diagram. Give the design options considered (such as, state assignments, kinds of flip-flops, etc.) and reasons for your selection.
   d. Describe the test plan for the calculator including specific inputs and results from the LogicWorks simulation.
   e. Give your self-assessment of your ABET Outcome c) assessment as described below, including your assessment of each point, EDP1 through EDP12, and your overall assessment using the percentage contribution given.

2. Softcopy of the LogicWorks design of the Calculator.

_Presentation Requirements:_
Each student is given 10 minutes to present their work. Describe the algorithm using a flowchart or equivalent and hardware using a block diagram. Describe the calculator using a state table or state diagram. Demonstrate selected **test plan inputs** using the Logicworks simulation of the Control Unit using both single clock step mode and run mode.

**Important Notice:** The term project is an INDIVIDUAL project so NO GROUP design and submission is acceptable.

**Important Statement of Ethics Compliance:** The UTA statement of ethics is completely followed and implemented in project review and grading. A copy of the statement of ethics can be found at: [http://ranger.uta.edu/~tiernan/completed/CSE2320/Ethics_pol.htm](http://ranger.uta.edu/~tiernan/completed/CSE2320/Ethics_pol.htm)

**Due Date:**
Term Project Report and LogicWorks design are **due April 30, 2012**. Email the LogicWorks file and the softcopy of your report to: tummalapalli.reddy@mavs.uta.edu

**Subject:** CSE 2441 ABET-Project

Presentation Time: presentations will be done on Tuesday May 1 and Thursday May 3 during class time.

**Grading:**
The Lab Final Exam/ABET Outcome task will be the Term Project for CSE 2441 and it will be graded two ways.

1) **As the lab final exam,** it will be graded by the point scoring below and will be 10% of the final CSE 2441 lab grade.
   a) 60% Design complete and control unit operates as specified
   b) 15% Term project report
2) As the ABET outcome task, to assess the ability to design a component to meet desired needs, the Term Project will be graded based on how well it demonstrates the steps of the Engineering Design Process (Appendix A) using the point scoring as given below.

Undergraduate students achieving a semester grade of C or better, but failing the ABET Outcome task experimentation assessment (below 60%) and documenting their circumstances will be assigned a semester grade of I (incomplete) and may re-attempt the assessment in the next semester. If the assessment is then passed, the semester grade will be changed from I to the achieved grade.

ABET outcome c) assessment rubric for Final Exam/ABET Outcome task to assess use of the Engineering Design Process: “Student term project documentation” is the Term Project report plus a self-assessment of the report based on the rubric presented below. In the assessment rubric point (EDP1 – EDP12) below, the 5, 3, and 1; levels indicate level of success in achieving the particular assessment criteria. The percentage given in braces after each rubric point indicates the percentage, which that rubric point contributes to the overall assessment.

Problem Specification - rubric points {total of 17%}

EDP1: Student term project documentation includes term project description, which contains the given problem to solve.
   Level 5: Term project description included
   Level 3: Term project description talked about but not included
   Level 1: Student documentation does not include problem description

EDP2: Student term project documentation shows evidence of research related to understanding the given problem.
   5: Notes and references are recorded in the engineering notebook and/or properly cited references are used in the term project report
   3: Notes are recorded without attribution in the engineering notebook and/or references are used in the term project report without proper citation
   1: No evidence of research

EDP3: Student term project documentation identifies problem criteria and constraints
   5: Criteria and constraints above and beyond those given in the term project description are documented and clearly identified in the engineering notebook and/or term project report
   3: Criteria and constraints given in the term project description are clearly identified in the engineering notebook and/or term project report
   1: Criteria and constraints are not addressed in term project documentation

Solution Determination - rubric points {total of 30%}

EDP4: Student term project documentation shows evidence of solution development
   5: The engineering notebook and/or term project report document at least three approaches (or three places where multiple solutions are considered) to solving all
or part of the term project problem. (E.g., using counters or using primitive logic to implement part of the date mechanism would be two different approaches.)

3: The engineering notebook and/or term project report document(s) at least two choices for solving some part of the term project problem.
1: The engineering notebook and/or term project report document that only one solution was ever considered or no documentation exists.

EDP5: Student term project documentation shows consideration of each solution approach in terms of cost/benefit, pros/cons, risks/rewards or other analysis {5%}

5: The engineering notebook and/or term project report document(s) meaningful analysis of each solution decision point.
3: The engineering notebook and/or term project report document(s) meaningful analysis of at least two solution decision points.
1: No analysis of solution decision points is documented.

EDP6: Student term project documentation shows evaluation of each solution approach in terms of the problem criteria and constraints {5%}

5: The engineering notebook and/or term project report document(s) meaningful evaluation of each solution decision point.
3: The engineering notebook and/or term project report document(s) meaningful evaluation of at least two solution decision points.
1: No evaluation of solution decision points is documented.

EDP7: Student term project documentation shows choice of optimum solution approach in terms of the analysis and evaluation {2%}

5: The engineering notebook and/or term project report document(s) choices clearly with reasons and additional notations about tradeoffs or other issues.
3: The engineering notebook and/or term project report document(s) choices with some reasons recorded.
1: No choice rationale of solution is documented.

Implementation - rubric points {total of 10%}
EDP8: Student term project LogicWorks design demonstrates model for solution {10%}

5: The LogicWorks design includes all required functionality
3: The LogicWorks design includes half of the required functionality
1: The LogicWorks design does not implement required functionality

Evaluation - rubric points {total of 15%}
EDP9: Student term project documentation shows testing and evaluation results for LogicWorks design model for solution {15%}

5: The engineering notebook and/or term project report describes tests that exercise all functions of the design done during implementation of LogicWorks design and results
3: The engineering notebook and/or term project report describes tests that exercise half of the functions of the design done during implementation of LogicWorks design and results
1: The engineering notebook and/or term project report has no description of tests done during implementation of LogicWorks design and/or no results

Solution Refinement and Completion - rubric points {total of 28%}
EDP10: Student term project documentation shows changes made to LogicWorks design model for solution based on results of testing and evaluation {10%}
5: The engineering notebook and/or term project report document(s) all errors found and the corrections made to the implementation as a result of test evaluation during implementation of LogicWorks design
3: The engineering notebook and/or term project report document(s) some of the errors found and the corrections made to the implementation as a result of test evaluation during implementation of LogicWorks design
1: The engineering notebook and/or term project report does not document(s) changes made as a result of test evaluation

EDP11: Student term project documentation and LogicWorks design provide a working and correct solution for the given problem {8%}
5: The LogicWorks design successfully accomplishes all required functionality
3: The LogicWorks design correctly accomplishes half of the required functionality
1: The LogicWorks design accomplishes no correct functionality

EDP12: Student term project documentation and in-class presentation describes LogicWorks design model for solution {10%}
5: The LogicWorks design is clearly and completely described
3: Parts of the LogicWorks design are described but not all or all is described but not clearly.
1: The LogicWorks design is not described.
Appendix A: Engineering Design Process

Problem Specification
1. Identify and specifically define the problem.
2. Research the need or problem
3. Identify criteria and constraints

Solution Determination
4. Develop a list of possible solutions.
5. Explore possible solutions (cost/benefit, pros/cons)
6. Evaluate the options using criteria identified by the problem specification.
7. Choose the optimum solution.

Implementation
8. Build a model or prototype

Evaluation
9. Test and evaluate the solution

Solution Refinement and Completion
10. Refine the design based on evaluation
11. Repeat engineering design process with new design until acceptable solution for original problem is completed.
12. Communicate the solution