1. *Course number and name*
   ENGR 456 Computer Systems

2. *Credits and contact hours*
   3 credits
   Contact hours; two 75-minute lecture sessions/week

3. *Instructor's or course coordinator's name*
   Instructor: Xiaorong Zhang, Assistant Professor of Computer Engineering
   Course coordinator: Xiaorong Zhang, Assistant Professor of Computer Engineering

4. *Text book, title, author, and year*
   "Computer Organization and Embedded Systems, Sixth Edition", Carl Hamacher, Zvonko Vranesic, Safwat Zaky, and Naraig Manjikian, published in 2011

   a. *other supplemental materials*
      ARM Architecture Reference Manual

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Basic structures of computers. Computer performance measurements. Assembly language programming and basic processor organization. Addressing methods and program sequencing. Various machine instruction sets. Simple and pipelined data paths. Hardwired and micro programmed control. Memory system configuration.

   b. *prerequisites or co-requisites*
      ENGR 356 with a grade of C- or better; ENGR 213 with a grade of C- or better or CSC 210 with a grade of C or better

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required for Computer Engineering, Elective for Electrical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

   - The student will demonstrate knowledge of the overall structure of a computing system.

   - The student will demonstrate an ability to design arithmetic circuits.

   - The student will demonstrate knowledge of simple and pipelined datapaths

   - The student will demonstrate knowledge of hardwired and microprogrammed control.

   - The student will demonstrate knowledge of memory hierarchy and its operations.

- The student will demonstrate a good understanding of the ARM processor.

- The student will demonstrate an ability to compare performance measurements.

- The student will demonstrate knowledge of instruction formats and addressing modes.

- The student will demonstrate knowledge of the basic concepts in assembly language programming.

b. *explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*
Course addresses ABET Student Outcome(s): a,c,e.

7. *Brief list of topics to be covered*
- ***System Level Organization:*** CPU, memory systems (main memory, cache, virtual memory), storage technologies, I/O devices & processes, busses.
- ***Micro-Architecture Level:*** Data paths and components, micro-operations, memory interfacing, the fetch/execute cycle, processor control & sequencing, interrupts, rudimentary pipelining.
- ***Instruction Set Architecture Level:*** Instruction types and formats, opcodes, operands, immediate values, addressing modes, flow of control, branching and procedure calls.
- ***Assembler Language Level****:* Syntax, directives vs. instructions, assemblers, linkers, loaders, semantics of simple programs, stack management, procedure calls, interrupt handling.