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**  

   a. **other supplemental materials**  
      ARM Architecture Reference Manual

5. **Specific course information**  
   a. **brief description of the content of the course (catalog description)**  

   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.