EE-3175
Computer Architecture with Modeling and Simulation

Curricular Designation: CpE: required, EE: elective

Catalog Description: Covers the theory and practice of using computer-aided modeling and simulation as tools for digital system design. Topics are drawn from both discrete event simulation and stochastic modeling of system performance and reliability, including Monte Carlo approaches, queuing models, and Markov models. Includes system modeling programming assignments. Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered: Fall Spring Pre-requisites: (CS 2911 or CS 3911) and CS 2141 and CS 3421 and (MA 3710 or MA 3720) and (EE 2170 or EE 2171)

Textbooks(s) and/or Other Required Materials:
3. Relevant manuals for software tools used in the course.

Prerequisites by Topic:
1. Familiarity with conditional probability, random variables, expected (mean) values, probability density functions, cumulative distribution functions.
2. Familiarity with computer programming, C/C++, and introductory numerical methods, including solutions to systems of linear equations.
3. Familiarity with combinatorial and sequential logic, computer architecture, RISC, pipelining, memory system hierarchies, and one assembler language.

Course Objectives:
1. Mastery of hierarchical memory system architectural options, management policies, performance analysis, modeling, and simulation,
2. Architectural options, performance analysis, modeling and simulation of processor architectures, including: Mastery of RISC scalar processors and introduction to superscalar processors,
3. Application of graphical models for visualizing and evaluating system components and processes for performance and reliability, including:
   a. Mastery of common Petri Net models, and familiarity with Markov models and fault trees,
   b. Familiarity with a representative set of tools for stochastic model evaluation and discrete event simulation, including their application to computer system design problems.
Topics Covered:

1. Memory Hierarchies consisting of caches, main mem, and disk drives, incl:
   a. technologies, architectures, impacts of locality and inclusion,
   b. analytical and statistical models, parameters, derivation of access times for \( N \geq 3 \) levels,
   c. discrete event simulation for performance and parameter estimation,

2. Processor pipelining incl: scalar and superscalar RISC pipelines,
   a. pipeline production equation, branch delays, data hazards, and other latencies,
   b. models, simulation methods, and tools for performance and parameter estimation,

3. Stochastic modeling of performance and dependability in Computer System Processes, incl:
   a. Discrete Time Markov Chains (DTMCs) and Continuous Time Markov Chains (CTMCs), Timed Transition Petri Nets (TTPNs) and Generalized Stochastic Petri Nets (GSPNs), and Fault-Trees.
   b. Applications drawn from: communication, fault-tolerance and reliability, RAID.

Relationship of Course to Program Objectives (See UPAC SOP, Tables 1 and 2):

- **EE:**
  - Outcome: a via topic(s): (all)
  - Outcome: k via topic(s): 1c, 2b, 3
  - Outcome: l via topic(s): 3

- **CpE:**
  - Outcome: a, n, r via topic(s): (all)
  - Outcome: k via topic(s): 1c, 2b, 3
  - Outcome: p via topic(s): 1b, 2b, 3
  - Outcome: s via topic(s) 1a, 1b, 2a

Contribution of Course to Meeting the Professional Component (See UPAC SOP, Tables 1 and 2):

- **EE:** Engineering Topics
- **CpE:** Engineering Topics

Class/Laboratory Schedule (note: 1 hour = 50 minutes):
Lecture: 45 hours = 3 hours/week for 15 weeks

Prepared by:
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