SCOPE STATEMENT of ECE QUALIFYING EXAM 1 (QE 1)

The examination problems will be designed such that the math skills as well as the technical Electrical Engineering (EE) and Computer Engineering (CE) subjects can be tested. The examination problems will be given in 7 subject areas. There will be a total of 18 problems and each student will be given 6 hours to answer any 7 of the 18 problems. Of the 18 problems, 9 will be in the context of EE undergraduate program and the other 9 will be in the context of CE undergraduate program. (Note that the examination problems will be designed for students to complete the answers in four hours. The above-mentioned six-hour time is to provide students with additional time.)

ELECTROMAGNETICS (3 problems):

Vector calculus, 3D coordinate systems, complex algebra;
Electrostatics, dielectric materials, conductors;
Magnetostatics, magnetic materials;
Faraday's law, Maxwell's equations;
Plane waves, reflection and transmission of waves;
Basics of transmission lines, waveguides and antennas.

CIRCUITS & DEVICES (3 problems):

Physics of semiconductor devices;
Mathematical and circuit models for electronic devices;
Digital & analog circuits and systems using diodes and transistors;
Basic amplifier configurations, differential amplifiers;
Transient and frequency responses, feedback;
Differential equations and solution methods.

COMMUNICATIONS (3 problems):

Signal and system analysis in continuous-time, discrete-time and frequency domains, feedback, stability;
Fourier series, Fourier transform, z-transform, Laplace transform;
Analog communication systems, modulation and demodulation;
Random signals and noise; basic digital communication system;
Probability and random variables, matrix algebra.

DIGITAL LOGIC CIRCUIT DESIGN (2 problems):

Basic logic design concepts, flip-flops, storage devices, register, counters, design and minimization of combinational and sequential circuits.

COMPUTER ORGANIZATION (2 problems):

Data and control flow, microprocessors, instruction sets, memory ierarchy, arithmetic operations, pipelining.

DATA STRUCTURE (2 problems):

Basic program/algorithm analyses, concepts of arrays/pointers/linked lists, stacks/queues, sorting/search, hashing and hash tables, trees and tree traversals, special-purpose trees and applications (such as balanced trees, binary tress, etc.).

MATHEMATICS FOR DISCRETE STRUCTURES (3 problems):

The contents of these 3 problems may include, but are not limited to, concepts in discrete math such as combinatorial, permutation, sets, relations, graphs, properties of trees, and Boolean algebra.

Suggested sample textbooks:

(Notice that no examination problems will be designed based specifically on any of the suggested textbooks. Any textbook covering similar materials will also be appropriate.)

- Electromagnetics:
  - A. T. Adams and J. K. Lee, *Electromagnetics*, University Readers, 2012.
  - D. K. Cheng, *Field and Wave Electromagnetics*, Addison-Wesley, 1989, 2nd Ed.

- Circuits & Devices:
  - R. C. Jaeger and T. N. Blalock, *Microelectronic Circuit Design*, McGraw Hill, 2004, 2nd Ed.

- Communications:
  - B.P. Lathi, *Modern Digital and Analog Communication Systems*, Oxford, 1998, 3rd Edition.

- Digital Logic Circuit Design:
  - John F. Wakerly, *Digital Design Principles and Practices,* Prentice Hall 2005, 4th Ed.

- Computer Organization:
  - David A. Patterson and John L. Hennessy, *Computer Organization and Design,* Morgan Kaufmann, 2004, 3rd Ed. (Note that this is different from the graduate-level textbook *Computer Architecture -A Quantitative Approach* written by the same authors.)

- Data Structure:
  - Robert Sedgewick, *Algorithms in C++, Parts 1-.4: Fundamentals, Data Structure, Sorting. Searching,* Addison-Wesley Professional, 1998, 3rd Ed.

- Mathematics for Discrete Structures:
  - C. L. Liu, *Elements of Discrete Mathematics,* McGraw Hill, 1985, d 2nd Ed.