Electrical and Electronic Engineering, Information Engineering

(Information for the entrance examinations held in August 2019)

- Examinees are requested to choose and answer four problems out of the following 10 problems. Please note that examinees have to choose
  - two problems out of Problems 1 to 4, and
  - two problems out of Problems A to F.

- The keywords for each problem are listed below. Note that they represent significant concepts in each area, and that they DO NOT necessarily indicate the range of possible questions.

1. Electromagnetism
   - Electric charges and electrostatics
   - Dielectrics
   - Currents
   - Magnetic fields
   - Magnetic substances
   - Faraday's law (electromagnetic induction)
   - Ampère's law
   - Maxwell's equations
   - Electromagnetic wave

2. Circuits
   - Linear circuits:
     - Direct-current and alternating-current circuits
     - Transient response and Laplace transform
     - Frequency response and Fourier transform
     - Transmission line
   - Electronic circuits and transistor circuits:
     - Small-signal equivalent circuits
     - Amplifiers and oscillators
     - Transfer function and feedback
     - Operational amplifier
3. **Information Theory**
   - Models of information sources
   - Amount of information, entropy
   - Source coding
   - Models of communication channels
   - Channel capacity
   - Channel coding
   - Error detection and correction
   - Cryptography

4. **Algorithm and Programming**
   - Algorithms (lookup, sorting, string search, tree search, optimization, etc.)
   - Analysis of algorithms (correctness proof, complexity, classes of complexity, etc.)
   - Control and data structures of programs (array, list, tree, etc.)
   - Random numbers and simulations
   - Recursion (recursive data structures, recursive functions)

A. **Computer Architecture and Digital Circuits**
   - Computer architecture:
     - Data flow and control flow
     - Instruction set architecture
     - Instruction execution (pipeline, instruction level parallelism, in-order/out-of-order execution, etc.)
     - Memory hierarchy (cache, virtual memory)
     - I/O and peripherals
   - Digital circuits:
     - Boolean algebra, combinational circuits, and sequential circuits
     - Functional circuits (ALU, registers, counters, FIFO memories, etc.)

B. **Communication Technology and Signal Processing**
   - Communication technology:
     - Network architectures
     - Protocols
     - Modulation and demodulation
   - Signal processing:
     - Analog signal/digital signal
C. **Solid-State Physics**
- Basics of quantum mechanics and statistical mechanics
- Schrödinger equation
- Eigenenergy, eigenstate (eigenfunction)
- Fermi-Dirac statistics, Bose-Einstein statistics
- Crystal structures, lattice and reciprocal lattice
- Lattice vibration and thermal properties
- Band structures and electron transport in solids
- Electrical properties of solids
- Optical properties of solids

D. **Semiconductor Devices**
- pn junction
- Schottky junction and ohmic contact
- Transistors (MOS transistors, bipolar transistors, etc.)
- Photonic devices (semiconductor lasers, photodiodes, etc.)

E. **Control Engineering and Electric Machinery**
- Control Engineering:
  - Transfer function
  - Stability margin and criteria
  - Time and frequency responses
  - Design of feedback controller
  - Root locus method
  - PID control
  - State space method
- Electric Machinery
  - Electromechanical and energy conversion
  - Transformers and rectifiers
  - Induction machines, synchronous machines, and DC machines
  - Control of electric drives
F. Electric Power and Energy System

- Electric energy
- Active power and reactive power
- Three-phase AC power transmission
- Power generators, transformers, and transmission facilities
- High voltage and electrical insulation
- Electrical discharge phenomena