The Fu Foundation School of Engineering and Applied Science
Computer Engineering Program
COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Computer Engineering: Incoming MS Student Orientation

Requirements & Course Overview

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MS Requirements: Overview *(see bulletin for details)*

- Total: at least 30 points (at or above 4000-level)
- "Core" requirement: at least 15 points from listed core
- Distribution requirement: at least 6 points each: CS, EE
  - "CSEE", "EECS": count for either CS or EE
- 6000-level requirement: at least 15 points (CS, EE, joint included)
- Research credits *(optional)*: at most 9 points *(towards requirements)*
- Non-tech electives *(optional)*: at most 3 points *(towards requirements)*
- Min GPA: at least 2.7/Time period: at most 5 years

Core Comp Eng Course List - 42

- COMS W4113 Fund. Large-Scale Dist. Sys.
- **COMS W4115 Prog. Lang. & Translators**
- **COMS W4118 Operating Systems, I**
- **CSEE W4119 Computer Networks**
- COMS W4130 Parallel Programming
- **CSEE W4140 Computer Networking Lab**
- COMS W4180 Network Security
- **EECS E4321 Digital VLSI Circuits**
- EECS E4340 Computer Hardware Design
- ELEN E4350 VLSI Design lab
- **ELEN E4702 Digital Communications**
- **ELEN E4750 GPU for Sig. Proc. & Comm.**
- **ELEN E4810 Digital Signal Processing**
- **CSEE W4823 Adv. Logic Design**
- CSEE W4824 Computer Architecture
- ELEN E4830 Digital Image Processing
- CSEE W4840 Embedded Systems
- ELEN E4896 Music Signal Processing
- COMS W6118 Operating Systems, II
- CSEE W6180 Modeling & Perf. Evaluation
- COMS W6181 Adv. Internet Services
- EECS E6321 Adv. Digital Elec. Circuits
- ELEN E6350 VLSI Design Lab
- ELEN E6488 Optical Interconnects
- **ELEN E6761 Computer Comm. Net., I**
- ELEN E6762 Computer Comm. Net., II
- EECS E6765 Internet of Things
- **ELEN E6770 Topic: Next Gen. Networks**
- CSEE E6824 Parallel Computer Architecture
- CSEE E6831 Sequential Logic Circuits
- CSEE E6832 Topics in Logic Design
- CSEE E6847 Distributed Embedded Systems
- ELEN E6850 Visual Information Systems
- **ELEN E6860 Advanced Digital Sig. Proc.**
- CSEE E6861 CAD of Digital Systems
- **CSEE E6868 System-on-chip Platforms**
- **ELEN E6950 Wireless & Mobile Net., I**
- ELEN E6951 Wireless & Mobile Net., II
- **COMS E6998 (Adv. Dist. Sys.)**
- COMS E6998 (Resilient Hardware Sys.)
- **COMS E6998 (Formal Verif. HW/SW)**

Overview of 4000-/6000-Level Comp Eng Courses

- Selective survey of some key computer engineering courses
- Focus: COMS (i.e. CS), CSEE, EECS courses
  - EE comp eng courses: covered in EE presentations
- … incomplete list!: MS degree allows other courses too

Digital/VLSI Design

CSEE W4823 Advanced Logic Design [Fall]

Instructor: Prof. Steve Nowick

Description:

- 2nd-level course in digital system design
- **Topics include:**
  - designing/optimizing large complex subsystems = RTL design
  - VHDL (industrial hardware description language)
  - advanced arithmetic circuits (Kogge-Stone prefix adders, array multipliers)
  - low-power design: bus encoding, "precomputation", gated clocking
  - controller design (Mealy/Moore)
  - fault-tolerance, error correction/detection, soft errors, Hamming & CRC codes
  - design projects: custom floating point units, Huffman conversion

Digital/VLSI Design (cont.)

EECS E4321 Digital VLSI Circuits [Fall]

Instructor: Prof. Ken Shepard

Description:

- Design and analysis of high speed VLSI logic, arithmetic and memory circuits.

[see EE course presentation]

Digital/VLSI Design (cont.)

EECS 6321 Advanced Digital Electronic Circuits [Spring]

Instructor: Prof. Mingoo Seok

Description:

- Advanced techniques: VLSI logic, arithmetic and memory circuits.

➡ *new: recently added to "core"*

[see EE course presentation]

Computer Architecture/Parallel Systems

CSEE W4824 Computer Architecture [Spring]

Instructor: Prof. Luca Carloni

Description:

- Advanced topics in modern computer architecture, illustrated by recent case studies.
- **Topics include:**
  - quantitative analysis
  - pipelining, out-of-order execution, speculation
  - superscalar, VLIW and vector processors
  - parallel processors and thread-level parallelism
  - memory hierarchy design
  - synchronization and cache coherence protocols
  - interconnection networks

Computer Architecture/Parallel Systems (cont.)

CSEE E6824 Parallel Computer Architecture

Instructor: Prof. Simha Sethumadhavan

Description:

- Fundamentals of parallel computer systems
- **Topics include:**
  - recent parallel architectures (industrial/research)
  - shared memory and distributed memory systems
  - synchronization and coherence models
  - recent case studies

Computer Architecture/Parallel Systems (cont.)

COMS W4130 Parallel Programming [Fall]

Instructor: Prof. Kim

Description:

- Programming parallel processors, concurrency foundations.
- **Topics include:**
  - basics of parallel programming
  - principles of concurency: data parallelism, deadlock, determinacy
  - pgmg. assignments: incl. game playing, high-performance cptg., machine learning
  - modern parallel programming languages

Embedded Systems

CSEE W4840 Embedded Systems [Spring]

Instructor: Prof. Stephen Edwards

Description:

- Embedded system design and implementation combining hardware and software.
- **Topics include:**
  - hardware/software interfacing
  - bus protocols and device drivers
  - custom peripherals
  - microprocessor-based system design
  - team project target: a substantial embedded system
    - hardware/software design employing FPGA's
    - e.g. digital tone control, speech synthesizer, internet radio, interfacing and peripherals

SOC Platforms

CSEE E6868 System-on-Chip Platforms [Fall]

Instructor: Prof. Luca Carloni

Description:

- Design & programming of system-on-chip platforms.
- **Topics include:**
  - overview of technology & trends
  - methodologies & CAD tools
  - software simulation
  - system-C language
  - hardware-software partitioning
  - communication, power, applications

Special Offerings:

COMS E6998-10 Formal Verification of Hardware/Software Systems [Fall 15]

Instructor: Drs. Theobald (D.E. Shaw Research)/Ivancic (NEC Research)

COMS E6998-11 Advanced Distributed Systems [Fall 15]

Networking and Communications

CSEE W4119 Computer Networks [Fall, Spring]

Instructor: G. Zussman and others

Description:

- Introduction to modern computer networks.
- **Topics include:**
  - Technical foundations of the Internet
  - Applications, protocols
  - Local area networks (LANs)
  - Algorithms for routing and congestion control
  - Security
  - Basics of performance evaluation

Networking and Communications (cont.)

CSEE W4140 Networking Laboratory [Fall, Spring]

Description:

- Hands-on networking lab course.
- **Topics include:**
  - technologies and protocols of the Internet
  - CISCO routers
  - wide area networks
  - networking protocol foundations:
    - IP, ARP, ICMP, UDP, TCP, DNS, RIP, FTP, TELNET, SMTP
  - Substantial projects: putting “principles into practice”

Networking and Communications (cont.)

COMS W4180 Network Security *(sometimes)*

Description:

- Introduction to network security concepts and mechanisms.

CSEE E6180 Modeling and Performance Analysis *(sometimes)*

Description:

- Introduction to queuing analysis and simulation techniques.

COMS E6181 Advanced Internet Services *(sometimes)*

Description:

- In-depth survey of protocols and algorithms to transport multimedia info across the Internet.