

Setting the Stage for CE2016

A Revised Body of Knowledge

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Abstract— The audience will discuss the current state of the effort to update the 2004 document titled “Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering,” also known as CE2004. The presenters represent the ACM and the IEEE Computer Society (IEEE-CS), which are leading the effort. They will engage participants on ways of improving the body of knowledge so that the document reflects the state-of-the-art of computer engineering education and practice that is relevant for the coming decade.

Keywords—Computer engineering; curriculum guidelines; CE2004; CE2016; ACM; IEEE Computer Society

I. BACKGROUND

This is the fourth conference presentation [1–3] supporting a process began in 2011 by the ACM and the IEEE Computer Society to update the CE2004 report, known formally as “Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering” [4]. Based on 289 survey responses in 2011 and discussions with the computer engineering education community, the authors are leading a significant update of the document with a targeted release date in 2016 and to be known as CE2016.

While many areas are being restructured to reflect current and emerging education practice, seven are receiving new or significantly enhanced coverage: (1) system on a chip (SoC), (2) field-programmable gate arrays (FPGAs), (3) multicore computing, (4) security, (5) mobile, power-aware systems, (6) software, including modern processes and tools, and (7) validation and verification of hardware/software systems.

In shared areas of interest, the authors are also consulting the related document “Computer Science Curricula 2013”

(informally CS2013) and the draft produced by the parallel effort to update the software engineering guidelines (SE2004).

II. SPEICAL SESSION FORMAT

This special session will engage the computer engineering education community in evaluating the current draft for changes and in planning further revisions to the guidelines.

The authors will present the current state of the revisions focusing on the structural and content changes to the body of knowledge (BOK). Upcoming milestones including additional opportunities for in-person feedback at various conferences will also be discussed. About half of the special session will be dedicated to small group discussions on specific knowledge areas (KAs) of the BOK and whether the proposed changes are reflective of current and emerging practice appropriate for a document expected to be in use for the coming decade.

REFERENCES

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III. Appendix: Draft (June 8, 2014, Version 1.00) Computer Engineering Body of Knowledge

This draft outline is changing regularly as feedback is received and reviewed by the steering committee. Please contact one of the authors for the latest version.

<i>Proposed Computer Engineering</i>		<i>Knowledge Areas and Units</i>	
CE-CAE	Circuits and Electronics [50 core hours]	CE-CAO	Computer Architecture and Organization [60 core hours]
CE-CAE-1	History and overview [1]	CE-CAO-1	History and overview [1]
CE-CAE-2	Relevant tools, standards, and/or engineering constraints [4]	CE-CAO-2	Relevant tools, standards and/or engineering constraints [1]
CE-CAE-3	Electrical quantities [3]	CE-CAO-3	Instruction set architecture [10]
CE-CAE-4	Electrical circuits [9]	CE-CAO-4	Performance [3]
CE-CAE-5	Power concepts [2]	CE-CAO-5	Computer arithmetic [3]
CE-CAE-6	Semiconductor properties [3]	CE-CAO-6	Central processing unit (CPU) organization [10]
CE-CAE-7	Diodes and diode circuits [3]	CE-CAO-7	Memory system organization and architecture [9]
CE-CAE-8	Metal-oxide semiconductor (MOS) transistor circuits [10]	CE-CAO-8	Input/output interfacing and communication [6]
CE-CAE-9	Bipolar transistors and logic families [2]	CE-CAO-9	Component interconnect architectures [6]
CE-CAE-10	MOS CIRCUIT TIMING AND POWER [4]	CE-CAO-10	Peripheral subsystems [5]
CE-CAE-11	Storage cell architecture [3]	CE-CAO-11	Many-core and multicore architectures [3]
CE-CAE-12	Interfacing logic families [3]	CE-CAO-12	Distributed system architectures [3]
CE-CAE-13	Mixed-signal circuit design [3]	CE-CAO-13	Performance enhancements
CE-CAL	Algorithms [30 core hours]	CE-CSE	Computing Systems Engineering [30 core hours]
CE-CAL-1	History and overview [1]	CE-CSE-1	History and overview [1]
CE-CAL-2	Relevant tools, standards and/or engineering constraints [1]	CE-CSE-2	Relevant tools, standards and/or engineering constraints [3]
CE-CAL-3	Basic algorithmic analysis [4]	CE-CSE-3	Hardware and software processes [3]
CE-CAL-4	Algorithmic strategies [6]	CE-CSE-4	Requirements analyses and elicitation [2]
CE-CAL-5	Searching and sorting algorithms [6]	CE-CSE-5	System specifications [2]
CE-CAL-6	Parallel algorithms and multi-threading [8]	CE-CSE-6	System architectural design and evaluation [4]
CE-CAL-7	Computer arithmetic algorithms [2]	CE-CSE-7	Concurrent hardware and software design [2]
CE-CAL-8	Algorithmic complexity [2]	CE-CSE-8	System integration, testing and validation [2]
CE-CAL-9	Scheduling algorithms	CE-CSE-9	Maintainability, sustainability, manufacturability [3]
CE-CAL-10	Basic computability theory	CE-CSE-10	Project management [2]
		CE-CSE-11	Human-computer interaction (HCI) [3]
		CE-CSE-12	Risk, reliability and fault tolerance [3]
CE-DIG	Digital Design [50 core hours]	CE-ESY	Embedded Systems [40 core hours]
CE-DIG-1	History and overview [1]	CE-ESY-1	History and overview [1]
CE-DIG-2	Relevant tools, standards, and/or engineering constraints [4]	CE-ESY-2	Relevant tools, standards, and/or engineering constraints [2]
CE-DIG-3	Number systems and data encoding [4]	CE-ESY-3	Characteristics of embedded systems [2]
CE-DIG-4	Boolean algebra applications [4]	CE-ESY-4	Basic software techniques for embedded applications [3]
CE-DIG-5	Basic logic circuits [4]	CE-ESY-5	Parallel input and output [3]
CE-DIG-6	Hardware description language modeling and simulation [3]	CE-ESY-6	Asynchronous and synchronous serial communication [6]
CE-DIG-7	Design with programmable logic [4]	CE-ESY-7	Periodic interrupts, waveform generation, time measurement [3]
CE-DIG-8	Modular design of combinational circuits [6]	CE-ESY-8	Data acquisition, control, sensors, actuators [4]
CE-DIG-9	Sequential logic circuits [7]	CE-ESY-9	State machines and RTOS implementation strategies [7]
CE-DIG-10	Memory elements [4]	CE-ESY-10	Techniques for low-power operation [2]
CE-DIG-11	Control and datapath design [5]	CE-ESY-11	Mobile and networked embedded systems [2]
CE-DIG-12	System design constraints [4]	CE-ESY-12	System-on-Chip (SoC) architectures [3]
CE-DIG-13	Fault models, testing, and design for testability	CE-ESY-13	High performance embedded systems [2]
CE-DIG-14	Formal verification	CE-ESY-14	Advanced I/O topics
		CE-ESY-15	Embedded systems applications
CE-HST	Hardware-software and Systems-level Tradeoffs [10 core hours]	CE-NWK	Networks [20 core hours]
CE-HST-1	History and overview [1]	CE-NWK-1	History and overview [1]
CE-HST-2	Relevant tools, standards, and/or engineering constraints [2]	CE-NWK-2	Relevant tools, standards, and/or engineering constraints [1]
CE-HST-3	Commercial off-the-shelf (COTS) strategies [1]	CE-NWK-3	Communications network architecture and protocols [7]
CE-HST-4	Field programmable gate array (FPGA) [2]	CE-NWK-4	Local and wide area networks [4]
CE-HST-5	Standard cell [1]	CE-NWK-5	Network applications [3]
CE-HST-6	Very-large-scale integration custom design and fabrication [1]	CE-NWK-6	Mobile computing and wireless networks [2]
CE-HST-7	System-on-Chip applications [2]	CE-NWK-7	Performance evaluation [2]
CE-HST-8	Mixed-signal	CE-NWK-8	Data communications
CE-HST-9	Hardware Accelerators	CE-NWK-9	Network management
CE-HST-10	Optical radio frequency (RF) interfaces	CE-NWK-10	Compression and decompression
		CE-NWK-11	Smart power grids

<i>Proposed Computer Engineering</i>		<i>Knowledge Areas and Units</i>	
CE-PFP	Professional Practice [20 core hours] CE-PFP-1 History and overview [1] CE-PFP-2 Relevant tools, standards, and/or engineering constraints [1] CE-PFP-3 Effective communication strategies [1] CE-PFP-4 Multidisciplinary team approaches [1] CE-PFP-5 Engineering solutions and societal effects [2] CE-PFP-6 Professional and ethical responsibilities [4] CE-PFP-7 Intellectual property and legal issues [3] CE-PFP-8 Contemporary issues and lifelong learning strategies [2] CE-PFP-9 Philosophical frameworks and cultural issues [2] CE-PFP-10 Elements of project management [3]	CE-SEC	Security [20 core hours] CE-SEC-1 History and overview [1] CE-SEC-2 Relevant tools, standards, and/or engineering constraints [2] CE-SEC-3 Security principles [1] CE-SEC-4 Data security and integrity [1] CE-SEC-5 Exploitation and vulnerabilities [1] CE-SEC-6 Resource protection models [1] CE-SEC-7 Buffer overflows and defenses [1] CE-SEC-8 Secret and public key cryptography [2] CE-SEC-9 Modes of operation [1] CE-SEC-10 Message authentication codes (MACs) [1] CE-SEC-11 Network security [1] CE-SEC-12 Authentication [1] CE-SEC-13 Web and mobile platforms security [2] CE-SEC-14 Trusted computing [1] CE-SEC-15 Malware: Hardware and software [2] CE-SEC-16 Side-channel attacks [1]
CE-SET	Strategies for Emerging Technologies [10 core hours] CE-SET-1 History and overview [1] CE-SET-2 Relevant tools, standards, and/or engineering constraints [1] CE-SET-3 Quantum computing [2] CE-SET-4 Three-dimension integrated circuit architecture and design [1] CE-SET-5 Other emerging technologies [5]	CE-SGP	Signal Processing [30 core hours] CE-SGP-1 History and overview [1] CE-SGP-2 Relevant tools, standards, and/or engineering constraints [3] CE-SGP-3 Sinusoidal and Transient Analysis [4] CE-SGP-4 Convolution [2] CE-SGP-5 Transform analysis [5] CE-SGP-6 Frequency response [3] CE-SGP-7 Sampling and aliasing [3] CE-SGP-8 Digital spectra and discrete transforms [6] CE-SGP-9 Finite and infinite impulse response (FIR and IIR) filter design [3] CE-SGP-10 Window functions CE-SGP-11 Multimedia processing
CE-SRM	Systems Resource Management [20 core hours] CE-SRM-1 History and overview of operating systems [1] CE-SRM-2 Relevant tools, standards, and/or engineering constraints [1] CE-SRM-3 Managing system resources [8] CE-SRM-4 Real-time operating system design [4] CE-SRM-5 Operating systems for mobile devices [3] CE-SRM-6 Multithreading support [3] CE-SRM-7 System performance evaluation	CE-SWD	Software Design [40 core hours] CE-SWD-1 History and overview [1] CE-SWD-2 Relevant tools, standards, and/or engineering constraints [3] CE-SWD-3 Programming paradigms [3] CE-SWD-4 Programming constructs [11] CE-SWD-5 Problem-solving strategies [9] CE-SWD-6 Data structures [4] CE-SWD-7 Recursion [2] CE-SWD-8 Object-oriented design [4] CE-SWD-9 Database systems [2] CE-SWD-10 Data modeling [1] CE-SWD-11 Power-aware software engineering CE-SWD-12 Event-driven and concurrent programming CE-SWD-13 Using application programming interfaces (APIs) CE-SWD-14 Data mining CE-SWD-15 Data visualization

Proposed CE Core Hours: 430

CE2004 CE Core Hours: 420

<i>Proposed Mathematics Knowledge</i>		<i>Areas and Units</i>	
CE-CAN	Analysis of Continuous Functions [30 core hours]	CE-DSC	Discrete Structures [30 core hours]
CE-CAN-1	History and overview [1]	CE-DSC-1	History and overview [1]
CE-CAN-2	Relevant tools, standards, and/or engineering constraints [3]	CE-DSC-2	Relevant tools, standards, and/or engineering constraints [1]
CE-CAN-3	Differentiation methods [4]	CE-DSC-3	Functions, relations, and sets [6]
CE-CAN-4	Integration methods [6]	CE-DSC-4	Boolean algebra principles [4]
CE-CAN-5	Linear differential equations [8]	CE-DSC-5	First-order logic [6]
CE-CAN-6	Other essential topics and applications [8]	CE-DSC-6	Proof techniques [6]
		CE-DSC-7	Basics of counting [2]
		CE-DSC-8	Graphs and trees [2]
		CE-DSC-9	Iteration and recursion [2]
CE-LAL	Linear Algebra [20 core hours]	CE-PRS	Probability and Statistics [30 core hours]
CE-LAL-1	History and overview [1]	CE-PRS-1	History and overview [1]
CE-LAL-2	Relevant tools, standards, and/or engineering constraints [1]	CE-PRS-2	Relevant tools, standards, and/or engineering constraints [4]
CE-LAL-3	Bases and vector spaces [2]	CE-PRS-3	Discrete probability [5]
CE-LAL-4	Matrix representations of linear systems [2]	CE-PRS-4	Continuous probability [4]
CE-LAL-5	Matrix inversion [2]	CE-PRS-5	Expectation [2]
CE-LAL-6	Eigensystems [2]	CE-PRS-6	Stochastic Processes [4]
CE-LAL-7	Other topics [10]	CE-PRS-7	Sampling distributions [4]
		CE-PRS-8	Estimation [4]
		CE-PRS-9	Hypothesis tests [2]
		CE-PRS-10	Correlation and regression

Proposed Math Core Hours: 110

CE2004 Math Core Hours: 66