Joint Task Force (JTF) on Cybersecurity Education

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CAE Community
Nov 8, 2018
Miami, FL
Curriculum Guidelines for Post-Secondary Degree Programs in Cybersecurity

A Report in the Computing Curricula Series
Joint Task Force on Cybersecurity Education

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• US National Science Foundation (Award 1623104)
• Intel
• US National Security Agency (Grant H98230-17-1-0219)
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Developed with the assistance of > 325 contributors across 35 countries, CSEC2017 is the first set of global cybersecurity curricular guidelines and we envision that it will be the leading resource of comprehensive curricular content for global institutions seeking to develop a broad range of cybersecurity offerings.
CSEC2017 Mission

• To develop comprehensive and flexible undergraduate curricular guidance in cybersecurity education that will support future program development and associated educational efforts at the post-secondary level.

• To produce a curricular volume that structures the cybersecurity discipline and provides guidance to institutions seeking to develop or modify a broad range of programs rather than a prescriptive document to support a single program type.
CSEC2017 Goals

• To describe a vision of proficiency in cybersecurity;

• To define a structure for the cybersecurity discipline by developing a thought model that defines the boundaries of the discipline and outlines key dimensions of the curricular structure;

• To support the alignment of academic programs and industry needs in cybersecurity;

• To involve broad global audience of stakeholders through continuous community engagement during the development process;

• To develop curricular guidance that is comprehensive enough to support a wide range of program types; and

• To develop curricular guidance that is grounded in fundamental principles that provide stability, yet is structured to provide flexibility to support evolving program needs.
CSEC2017 Purpose

WHAT

• To develop course roadmaps that link the forthcoming CSEC2017 Curricular Guidance to the National Cybersecurity Workforce Framework (NCWF).

WHY

• To aid program developers bridge the academic program to workforce gap

HOW

• By linking CSEC2017 learning outcomes with NCWF specialty area competencies through roadmap exemplars that identify and describe relevant courses and course modules; outline knowledge acquisition strategies when specific courses are not available within the institution; and highlight challenges (and associated strategies to overcome them) to linking the CSEC2017 and the NCWF for the specialty area.
CSEC2017 Guiding Principles

Cybersecurity education programs should:

• Be based on core knowledge and skills
• Have a computing-based foundation
• Teach concepts applicable to a broad range of cybersecurity expertise
• Emphasize ethical obligations and responsibilities
• Be flexible so programs can tailor their curriculum to any specialized needs
Cybersecurity is defined as a computing-based discipline involving technology, people, information, and processes to enable assured operations in the context of adversaries. It involves the creation, operation, analysis, and testing of secure computer systems. It is an interdisciplinary course of study, including aspects of law, policy, human factors, ethics, and risk management.
Cybersecurity
(A computing-based, inter-disciplinary course of study)
Disciplinary Lens

- The depth of coverage across KUs, topics, and learning outcomes will be determined by the combination of Disciplinary Lens and Institution Type

- ACM/IEEE Disciplines
  - Computer Science
  - Information Technology
  - Computer Engineering
  - Software Engineering
  - Information Systems
  - (Plus) Other Disciplines
CSEC2017 Thought Model

BODY OF KNOWLEDGE

8 Knowledge Areas:
- Data
- Software
- Component
- Connection
- System
- Human
- Organization
- Societal

Cross-cutting Concepts:
- Confidentiality
- Integrity
- Availability
- Risk
- Adversarial Thinking
- Systems Thinking

Other Disciplines

Disciplinary Lenses

Information Systems

Computer Science

Computer Engineering

Software Engineering
CSEC2017 Knowledge Areas

1. Data Security
2. Software Security
3. Component
4. Connection Security
5. System Security
6. Human Security
7. Organizational Security
8. Societal Security
Knowledge Area Organization
Knowledge Area Descriptions

- **Data Security**: focuses on the protection of data at rest, during processing, and in transit.

- **Software Security**: focuses on the development and use of software that reliably preserves the security properties of the information and systems it protects.

- **Component Security**: focuses on the design, procurement, testing, analysis and maintenance of components integrated into larger systems.

- **Connection Security**: focuses on the security of the connections between components including both physical and logical connections.
• **System Security**: focuses on the security aspects of systems that are composed of components and connections, and use software.

• **Human Security**: focuses on protecting individuals’ data and privacy in the context of organizations (i.e., as employees) and personal life, in addition to the study of human behavior as it relates to cybersecurity.

• **Organizational Security**: focuses on protecting organizations from cybersecurity threats and managing risk to support the successful accomplishment of the organization’s mission.

• **Societal Security**: focuses on aspects of cybersecurity that broadly impact society as a whole for better or for worse.
Knowledge Area Essentials

• The essential concepts of each knowledge area capture the cybersecurity proficiency that every student needs to achieve regardless of program focus.

• Essentials should be introduced early and reinforced throughout every cybersecurity program.

• These concepts may also appear as specific knowledge units, as topics within knowledge units, or as aggregates of topics across knowledge units. Taken together, the essential concepts in all of the knowledge areas should be covered in every cybersecurity program.

• In the curricular volume, the essential concepts are explicitly identified for each knowledge area along with learning outcomes.
Essentials

Data Security Essentials

• Basic cryptography concepts
• End-to-end secure communications
• Digital forensics
• Data integrity and authentication
• Data erasure

Software Security Essentials

• Fundamental design principles; least privilege, open design, and abstraction
• Security requirements and the roles they play in design
• Implementation issues
• Static, dynamic analysis
• Configuring, patching
• Ethics, especially in development, testing, and vulnerability disclosure
Essentials (continued)

**Component Security Essentials**
- Vulnerabilities of system components
- Component lifecycle
- Secure component design principles
- Supply chain management
- Security testing
- Reverse engineering

**Connection Security Essentials**
- Systems, architecture, models, and standards
- Physical component interfaces
- Software component interfaces
- Connection attacks
- Transmission attacks
Essentials (continued)

System Security Essentials
• Holistic approach
• Security policy
• Authentication
• Access control
• Monitoring
• Recovery
• Testing
• Documentation

Human Security Essentials
• Identity management
• Social engineering
• Awareness and understanding
• Social behavioral privacy and security
• Personal data privacy and security
Essentials (continued)

**Organizational Security Essentials**
- Risk management
- Governance and policy
- Laws, ethics, and compliance
- Strategy and planning

**Societal Security Essentials**
- Cybercrime
- Cyber law
- Cyber ethics
- Cyber policy
- Privacy
Linking Learning Outcomes & Competencies

CSEC2017

Knowledge Area

Essentials Knowledge Unit

Topic

Learning Outcomes

Knowledge Unit(s) ...

Topic

Learning Outcomes

Content influenced by disciplinary lens and institution type

National Cybersecurity Workforce Framework (NCWF)

Roadmaps link LOs to Specialty Area Competencies
Roadmap Components

CSEC 2017 Curricular Guidance
Disciplinary Lens + Institution Type LOs

Overview
Relevant Courses
Knowledge Acquisition Strategies
Challenges

National Cybersecurity Workforce Framework
Specialty Area Competencies
STEP 1: Identify type of program (Disciplinary Lens + Institution Type) and desired student outcome (NCWF Specialty Area)
Roadmap Development Process

STEP 2: Link 8 KA Essential Knowledge Unit LOs to NCWF Specialty Area Competencies
STEP 3: identify knowledge acquisition strategies (courses, informal learning opportunities at the institution)
STEP 4: Outline institutional challenges (e.g. gaps in courses) to meeting competency requirements
Exemplars

• The CSEC2017 Body of Knowledge affords the flexibility to support many different types of programs. The exemplars will demonstrate how a variety of institutions cover the knowledge area essentials and some subset of the knowledge units.

• Appendix C of the curricular volume contains the Curricular, Workforce, and Course exemplar templates

• The exemplars will be provided on the cybered.acm.org community engagement website to demonstrate the ways that the Body of Knowledge may be organized into a complete curriculum.
Curricular Exemplar Requirements

- Institution information
- Disciplinary Lens of program
- Curricular overview
- Possible curricular revisions (based on CSEC2017)
- Course summaries
- Knowledge Unit Table with course outcomes (spreadsheet)
- Essentials and Knowledge Unit Coverage Table (spreadsheet)
## Disciplinary Lens + Institution Type

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<tr>
<th>Disciplinary Lens</th>
<th>Institution Type</th>
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<td>Computer Science</td>
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<td>Other Disciplines</td>
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Program exemplars in each category will provide details on depth of coverage and learning outcomes.

Contact the JTF if you are interested in developing an exemplar.
# Example: Knowledge Unit Table w/Outcomes

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<td><strong>Data Security</strong></td>
<td>Essentials</td>
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<td>Description of the purpose of cryptography and list ways it is used in data communications; Explain how public key infrastructure supports digital signing and encryption and discuss the limitations/vulnerabilities. Describe which cryptographic protocols, tools and techniques are appropriate for a given situation; Explain the goals of end-to-end data security;</td>
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<td>Basic cryptography concepts; Digital forensics; End to end secure communication; Data integrity and authentication; Information storage security;</td>
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<td>Basic concepts; Mathematical background; Symmetric ciphers; Asymmetric ciphers;</td>
<td>Basic concepts; Advanced concepts; Mathematical background; Historical ciphers; Symmetric (private key) ciphers; Asymmetric (public-key) ciphers;</td>
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Continued Community Engagement

• Community website: [cybered.acm.org](http://cybered.acm.org)
  • Downloadable CSEC2017 document
  • Information about the Task Force and its process
  • Curriculum, Course, and Workforce exemplars (solicitation)
  • Exemplar templates and submission information
  • List of past and upcoming community engagement events
Thank YOU!

Questions?
Comments?
Feedback?