WSU CySER Curriculum and Research

Assefaw Gebremedhin
School of EECS, WSU
Outline

- Background on EECS Programs
- CySER Curriculum and Research
- New BS in Cybersecurity Degree
About Me

- Joined WSU in Fall 2014

- Research interests
  - AI and data science
  - High-performance computing
  - Cybersecurity

- Teaching at WSU
  - Automata and Formal Languages (CptS 317)
  - Data Science (CptS 475)
  - Network Science (CptS 591)

- Lab: Scalable Algorithms for Data Science Laboratory (SCADS)

assefaw.gebremedhin@wsu.edu

www.eecs.wsu.edu/~assefaw

https://scads.eecs.wsu.edu
Current BS Programs @ EECS

- Electrical Engineering (BS EE)
- Computer Engineering (BS CptE)
- Computer Science (BS CptS)
- Software Engineering (BS SE)
- Data Analytics (BS DA)
Computer Science (CS) @EECS

• Learn about different subdomains of CS and gain additional breath/depth in:
  - Machine Learning (ML)
  - Artificial Intelligence (AI)
  - Data Science and Big Data
  - Cybersecurity
  - ...

• WSU offers:
  - B.S. in CS (Major and Minor), and
  - M.S. and Ph.D. in CS

Technical Areas
• Software
• Data and Information Management
• Cybersecurity
• AI and ML
• Systems
• Scientific and Visual Computing
Software Engineering (SE) @EECS

- SE is the application of engineering practices to software
- Learn to develop and maintain large and complex software
- Learn about methods and tools on topics such as software requirements analysis, design principles, testing, and maintenance
- WSU offers:
  - B.S. in SE (Major and Minor), and
  - Online M.S. in SE
Computer Engineering (CptE) at WSU

- **Microelectronics**
  - Analog and mixed-signal (analog+digital) circuits
  - RF/wireless communication circuits and systems
  - Bio and optical circuits and systems

- **Computer Engineering**
  - Digital circuits and VLSI (design with billions of transistors)
  - High-performance microprocessor and memory architecture
  - Emerging technologies and systems

- **WSU Offers**
  - B.S., M.S., and Ph.D. in EE and CptE
Electrical Engineering (EE) at WSU

• **Energy and Power Systems Engineering**
  - Smart Grid and efficient and reliable electric power systems
  - Power systems dynamics, control, and optimization
  - Power electronics, integration of renewable energy resources
  - Power system economics, electricity markets

• **Systems Engineering (Communications, Controls, Signal processing)**
  - Signal processing: Audio/image/video signal processing, array processing, speech/image recognition, data compression
  - Control engineering: Aircraft flight control system, epidemiology, unmanned vehicles
  - Communication systems: Underwater sensor networks, near-shore surveillance, channel estimation, modulation
Student Clubs

- Examples of School of EECS Student Organizations
  - Association for Computing Machinery (ACM)
  - ACM Women in Computing (ACM-W)
  - Institute of Electrical and Electronic Engineers (IEEE)
  - Cybersecurity Group
  - Robotics Club
  - Society for Women Engineers (SWE)
  - National Society of Black Engineers (NSBE)
  - Society of Latinx Engineers & Scientists (SOLES)
Undergraduate Research at WSU
  - NSF Research Experience for Undergraduates (REU)
  - DOE Science Undergraduate Laboratory Internship (SULI)
  - NIH Training Opportunities
  - CySER Program

Internships
  - Schweitzer Engineering Laboratories (SEL)
  - Pacific Northwest National Laboratory (PNNL)
  - GI and related CySER Internships
Examples of companies hiring EECS graduates

Google, Amazon, Intel, Dell, Microsoft, Boeing, Oracle, Expedia, FAST, ALASKA, SEL, TATA, APPTIO, General Motors, CapitalOne, Micron, Tableau, PNNL, Meter
VICEROY Institute for Cybersecurity Education and Research
CySER Vision

- Directly respond to the **VICEROY program**
  - Training ROTC and DoD-aligned civilians in cybersecurity at the undergraduate and graduate level, with emphasis on undergraduate

- **Integrate cybersecurity research and education with professional skills in teamwork, communication, leadership and lifelong learning**
  - Merge theoretical knowledge with experiential learning

- **Build a strong consortium in the Pacific Northwest for cybersecurity education and research**
  - CySER brings together 5 institutions with complementary strengths and diversity of populations served

- **Position WSU to attain Center of Academic Excellence in Cyber Operations (CAE-CO) designation**
  - Designation conferred by National Security Agency
  - Requirements: 10 Mandatory and 10 (out of 17) Optional Knowledge Units (KUs)
CySER Curriculum: Encapsulated via 3 Certificate Offerings

- **CySER CAE-CO Fundamentals** *(approved by Faculty Senate)*
  - BS in Computer Science, Software Engineering
  - Lead by EECS

- **CySER Basics** *(approved by Faculty Senate)*
  - For non-CS majors (typically ROTC cadets)
  - Primarily affiliated with the MISE program in the college of business

- **CySER CAE-CO Advanced** *(Senate approval expected by Spring 2023)*
  - MS/PhD students in CS, CE, EE, ME, ChE, MISE or similar field
  - Lead by EECS
CySER: New Courses

- **CptS 327: Introduction to Cybersecurity**
  - Focus: Computer, Web, and Application Security
  - KUs targeted: M7, M8, M9, 04, 013, C4

- **CptS 427: Applied Cybersecurity**
  - Focus: Software, Network, and Cloud Security
  - KUs targeted: M4, M9, 02, 03, 04, 013, C4

- **CptS 428/528: Advanced Cybersecurity**
  - Focus: Reverse Engineering and Forensics
  - KUs targeted: M2, 08, 011, C1, C2, C5, S1, S2, S7
Certificate Requirements (targeted for BS in CS students)

a) Take required CS courses in Theory, Algorithms, Systems Prog and Discrete Structures (CptS 317, 350, 360; Math 216)
b) Take the following 3 required cybersecurity courses (9 credits)
   - CptS 327 Intro to Cybersecurity
   - CptS 427 Applied cybersecurity
   - CptS 428 Advanced Cybersecurity
c) Take at least 4 elective courses out of the following courses
   - CptS 455 Introduction to Computer Architecture
   - CptS 460 Operating Systems and Computer Architecture
   - CptS 475 Data Science
   - CptS 415 Big Data
   - CptS 443 Human-Computer Interaction
   - CptS 466 Embedded Systems
   - CptS 464 Distributed Systems Concepts and Programming
   - CptS 478 Software Process and Management
   - EE 334 Computer Architecture
   - EE 434 ASIC & Digital Systems Design
   - EE 489 Introduction to Control Systems
   - MIS 374 IT Infrastructure & Security
d) Take CptS 421 and CptS 423 Capstone Senior Design Project with a Cybersecurity emphasis
e) Engage in a cybersecurity related internship experience
f) Engage in CySER research
g) Attend cybersecurity seminars
h) Attend CySER summer workshop
# WSU CySER Basics Certificate: targeted for ROTC and Civilian non-CS majors

<table>
<thead>
<tr>
<th>Requirement (credits)</th>
<th>Description</th>
</tr>
</thead>
</table>
| **MIS 372† (3) [or UI's CYB 110 (3)]** | Data Management – Management of data in business environments  
Cybersecurity & Privacy – Intro on cybersecurity & privacy, case studies, threats, laws |
| **CptS 111 (Python) (3)** | Intro to Computer Programming – Python-based problem solving, computational models, operations |
| **MIS 374† (3) [or UI's CYB 310 (3)]** | IT Infrastructure & Security – Designing, managing, securing info technical infrastructures  
Cybersecurity Technical Foundations – Threats, architectural mitigation strategies, cryptography |
| **CySER Summer Workshop** | CySER Workshop – 2-week CySER summer Workshop on practical aspects of cybersecurity |
| **Cybersecurity internship CptS 490 (3)** | In a company, national lab or military installation with a cybersecurity related emphasis; the undergraduate advisor will obtain verification from the institution about cybersecurity relevance. |
| **CySER sem. CptS 498 (1)** | CySER Seminar Series – Invited speakers on cybersecurity practice, communications, leadership. |
| **CySER Capstone Project: CptS 421/423 or Sp. Prob. 499 – any major (3)** | Capstone: Interdisciplinary team focusing on a cybersecurity problem comprised of 1 or 2 non-Computer Sci. plus 2 or 3 Computer Sci. majors. Alternatively, students may take a Management or Entrepreneur Capstone or Special Problems 499 elective, and the undergraduate advisor will obtain verification from the instructor about cybersecurity relevance. |

†MIS courses required for MIS majors
CySER Research Areas

- Cyber-Physical Systems
- Networks & Information Security
- Machine Learning & AI
- Software Security & Quality Assurance
- Cyber Education
CySER Major Accomplishments

- **Website** providing information to current and prospective students developed
  - [https://www.cyser.wsu.edu](https://www.cyser.wsu.edu)
- Three new **cybersecurity courses** developed and offered
- Three **certificate programs** developed
- **Bi-weekly virtual seminar series** featuring cybersecurity experts from industry and academia
  - Fall 2022: 5 seminars (planned)
  - Spring 2022: 7 seminars
  - Fall 2021: 5 seminars
- A **two-weeks intensive summer workshop** held in 2022; a similar one planned for 2023
  - Featured research presentations, tutorials, hands-on learning experiences, field trips
- Currently **27 undergraduate students and 7 graduate mentors at WSU** are involved in CySER
  - 14 new students in Year 2 (Fall 2022/Spring 2023)
  - 13 continuing students from Year 1
  - Research and experiential learning opportunities provided
- A new **Cybersecurity Student Club** at WSU established
- Student club members participated in two **cyber competitions**
  - Cyber Force (Nov 4-5, 2022)
  - NICCDC (Nov 11-12, 2022)
Examples of research CySER students I mentor are involved in

- **Observability of network security monitoring**
  - Undergraduate students: Zachary Werle and William Heinecke
  - Graduate mentor: James Halvorsen
- **Polymorphic virus detection**
  - Undergraduate students: Nathan Waltz and Kaitlin White
  - Graduate mentor: James Halvorsen
- **Automation of feature extraction using Control Flow Graphs**
  - Undergraduate students: Jose Sainz, Cai Haught, and Andrew Fritz
  - Peer mentor: Nathan Waltz
- **Cybersecurity education**
  - Undergraduate students: James Minteer and Fish Guinevere
  - Graduate mentor: James Crabb
CySER Summer Workshop 2022

- Held May 23 to June 3, 2022, at WSU-Pullman with option for virtual participation

- Involved presentations, tutorials, hands-on and experiential learning activities

- Field trips to
  - SEL, Pullman (half-day)
  - Fairchild Air Force Base (full day)
  - Keyport Naval Undersea Warfare Center (2 days)

- Student poster presentations

- Slides and recordings made available on CySER website

Topics:

- Cybersecurity in industrial control systems (ICS)
- Digital forensics
- Cybersecurity and behavioral threats
- Cyber education
- Team building and leadership
- Virtualization
- Software assurance and trusted software bills
- Cybersecurity competitions
- Cybersecurity in power systems
- Adversary emulation, purple teaming, and ICS
- Applications of machine learning in cybersecurity
- Human-in-the loop learning for anomaly detection
- Clustering software vulnerabilities using self-organizing maps
- On-chip communication in the age of heterogeneity
- Cybersecurity in biomanufacturing
- Smart phone technology security
- Binary analysis
- US Army Cybercommand
- Being a lifelong learner
New BS in Cybersecurity Degree at WSU
New BS in Cybersecurity: key features

- Independent degree program (major)
- Focuses on cyber operations
- Emphasizes hands-on coursework, experiential learning
- Credits Required: 120 (4-year)
  - 67 Comp Sci/Cyber; 33 Math/Stat/Physics; 20 General
- First two years very similar to BS in Comp Sci; last two years heavy on cyber courses
- Feedback from industry sought and incorporated
  - Microsoft, Boeing, Deloitte and others
Cybersecurity courses in the new BS program

**Required**
- CptS 327: Fundamentals of Cybersecurity and Cryptography
- CptS 427: Cybersecurity of Wireless and Distributed Systems
- CptS 428: Software Security and Software Reverse Engineering
- CptS 455: Introduction to Computer Networks and Security
- CptS 426: Hardware Security and Hardware Reverse Engineering
- CptS 432: Cybersecurity Capstone Project

**Electives**
- CptS 424: Cyber Law, Ethics, Rights, and Policies
- CptS 425: Cyber Forensics
- CptS 429: Virtulization and Offensive Cyber Operations
- CptS 431: Security Analytics and DevSecOps
- CptS 439: Cybersecurity of Critical Infrastructure Systems

CySER developed new courses
Existing courses with minor updates
Brand new courses being developed
Summary

- CySER is contributing to the VICEROY vision of training the next generation of military and defense-aligned civilian workforce in cybersecurity.
- CySER students are receiving wide-ranging training that integrates cybersecurity research and education with professional skills in teamwork, communication, leadership, and lifelong learning.
  - Merging theoretical knowledge with experiential learning.
- CySER is fostering a strong collaborative consortium in the Pacific Northwest for cybersecurity education and research.
  - Bringing together 5 institutions with complementary strengths and diversity of populations served.
- CySER support has contributed to WSU launching a new BS in cybersecurity degree program.
- CySER is enabling WSU attain Center of Academic Excellence in Cyber Operations status.