WASHINGTON STATE UNIVERSITY
School of
Electrical Engineering and Computer Science
VOILAND COLLEGE OF ENGINEERING AND ARCHITECTURE

# 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

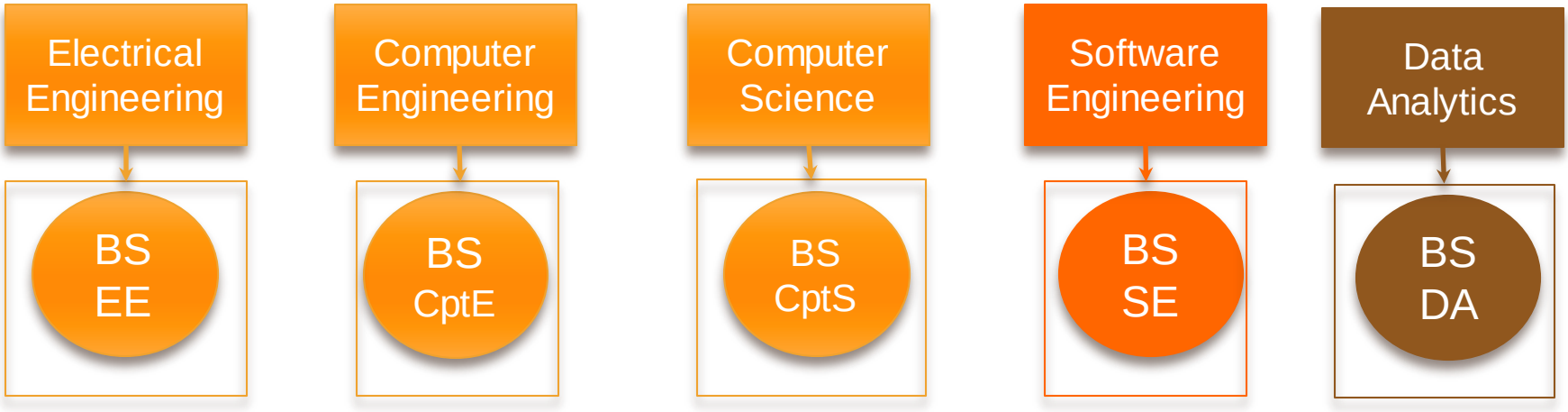
- Joined WSU in Fall 2014
- Research interests
  - AI and data science
  - High-performance computing
  - Cybersecurity
- Teaching at WSU
  - Automata and Formal Languages (CptS 317)
  - Data Science (CptS 475)
  - Network Science (CptS 591)
- Lab: Scalable Algorithms for Data Science Laboratory (SCADS)

assefaw.gebremedhin@wsu.edu

www.eecs.wsu.edu/~assefaw

https://scads.eecs.wsu.edu

# Current BS Programs @ EECS



# 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

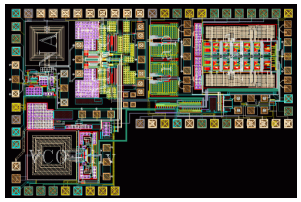
- Software
- Data and Information Management
- Cybersecurity
- AI and ML
- Systems
- Scientific and Visual Computing

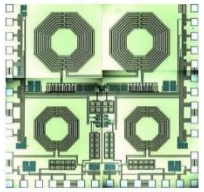
# Software Engineering (SE) @EECS

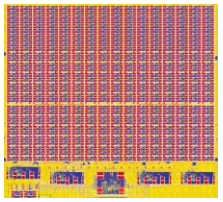
- SE is the application of engineering practices to software
- Learn to develop and maintain large and complex software
- Learn about methods and tools on topics such as software requirements analysis, design principles, testing, and maintenance
- WSU offers:
  - B.S. in SE (Major and Minor), and
  -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

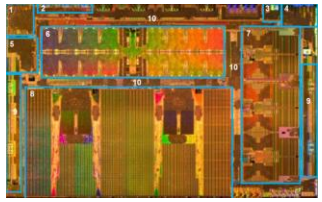
# Computer Engineering (CptE) at WSU

- **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


RF transceiver


Phase-locked loop


Many-core architecture


ASIC design

# Electrical Engineering (EE) at WSU

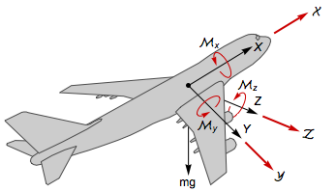
- **Energy and Power Systems Engineering**
  - Smart Grid and efficient and reliable electric power systems
  - Power systems dynamics, control, and optimization
  - Power electronics, integration of renewable energy resources
  - Power system economics, electricity markets

- **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


Power systems

Smart grid

Face recognition



Dynamic control


Satellite communication

# Student Clubs

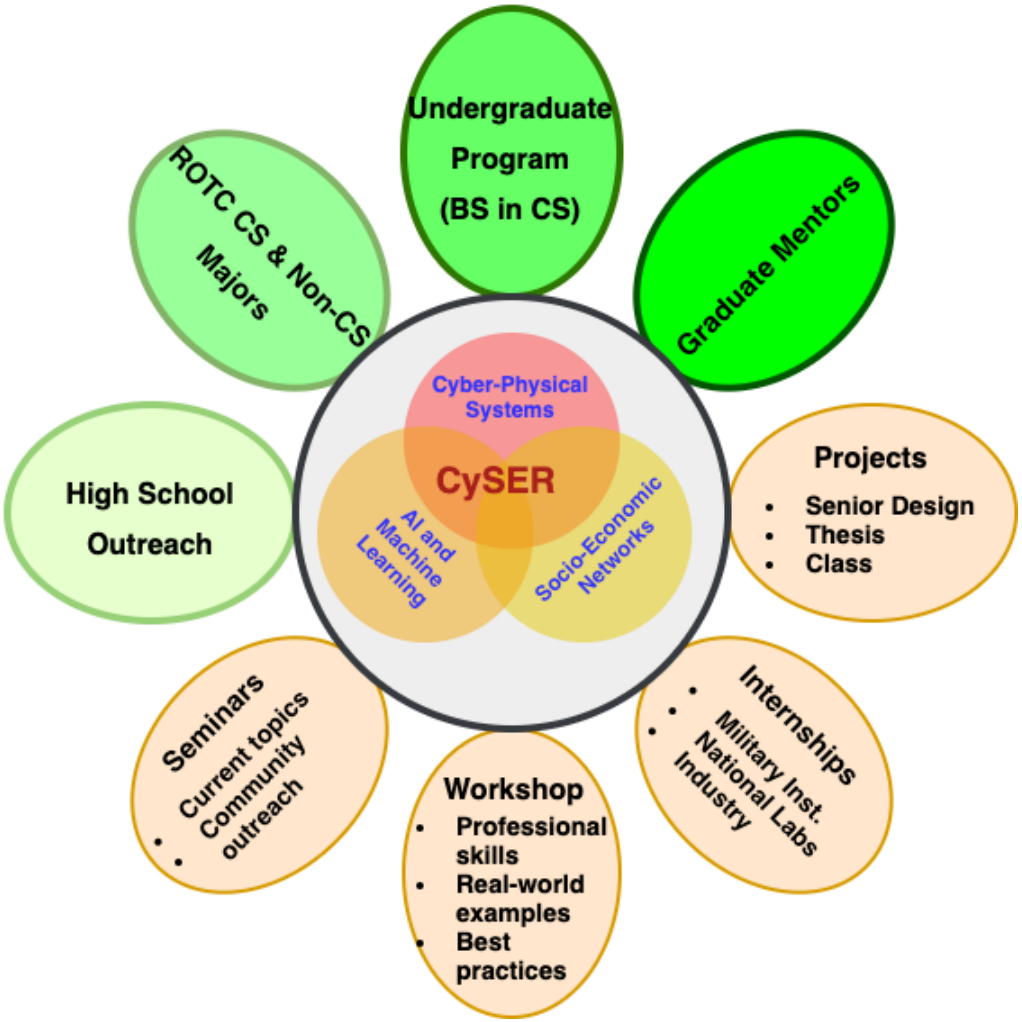
- Examples of School of EECS Student Organizations
  - Association for Computing Machinery (ACM)
  - ACM Women in Computing (ACM-W)
  - Institute of Electrical and Electronic Engineers (IEEE)
  - Cybersecurity Group
  - Robotics Club
  - Society for Women Engineers (SWE)
  - National Society of Black Engineers (NSBE)
  - Society of Latinx Engineers & Scientists (SOLES)

# WSU Undergraduate Research & Internships

- 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

# 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

CySER
CAE-CO
Fundamental
Certificate

## Certificate Requirements (targeted for BS in CS students)

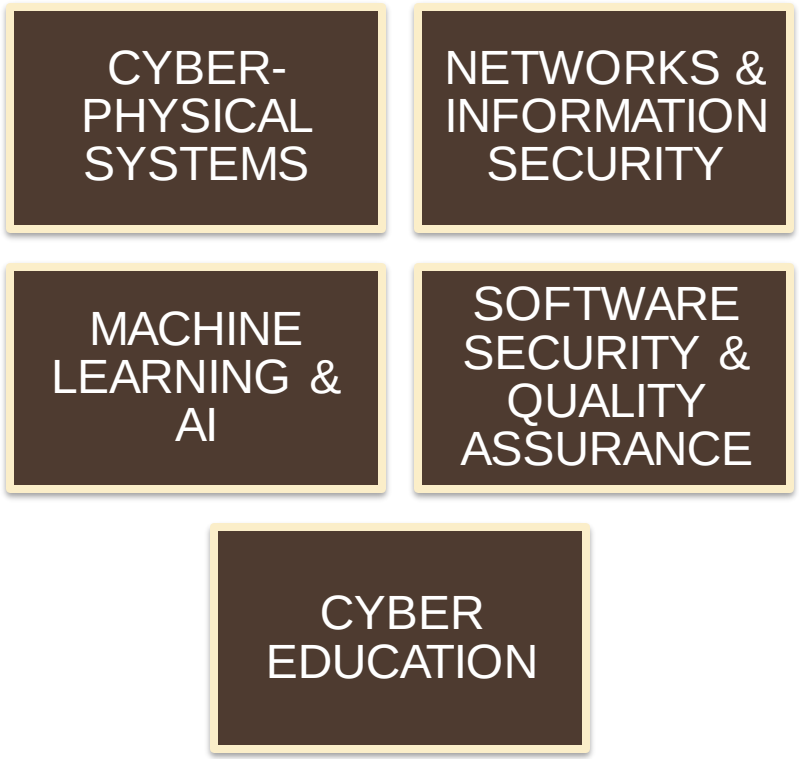
a) Take required CS courses in Theory, Algorithms, Systems Prog and Discrete Structures (CptS 317, 350, 360; Math 216)
b) Take the following 3 required cybersecurity courses (9 credits)
   - CptS 327 Intro to Cybersecurity
   - CptS 427 Applied cybersecurity
   - CptS 428 Advanced Cybersecurity
c) Take 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

| Requirement (credits) | Description |
|---|---|
| **MIS 372† (3) [or UI's CYB 110 (3)]** | Data Management – Management of data in business environments<br>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<br>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



# CySER Major Accomplishments

- **Website** providing information to current and prospective students developed
  - 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