FIRST EDUCATION

Engineering & Robotics II | Course Overview

Year-Long Course Outline with CTE Competencies

Pre-requisites – Intro to Engineering and Robotics

Equipment Requirements – *FIRST* Tech Challenge Robotics Kit, *FIRST* Robotics Competition Robot, Design and Fabrication Equipment (3D Printers, CNC, or other Metal Fabrication)

Course Description

Engineering & Robotics II is an advanced, project-based course that builds on engineering design, robotics, programming, and documentation foundations established in Engineering & Robotics I. Students engage in deeper engineering challenges that require integration of mechanical design, advanced electronics, automation, sensors, control theory, and software development.

Learners apply industry-relevant engineering practices, including systems engineering, advanced CAD modeling, rapid prototyping, and data-driven optimization. The course culminates in a semester-long team engineering project or competition-style challenge using *FIRST* platforms such as *FIRST* Tech Challenge or *FIRST* Robotics Competition. This course prepares students for advanced CTE pathways in Engineering, Manufacturing, Information Technology, and Mechatronics.

Course Outcomes

COMPETENCY	STUDENT OUTCOMES
Apply Advanced Engineering Design and Systems Engineering Processes	Students will use advanced problem-solving strategies to evaluate multiple solution pathways and apply systems-engineering methods when designing integrated robotic systems, while managing project requirements, constraints, risks, and trade-offs inherent in complex engineering challenges.
Develop and Optimize Advanced Mechanical Systems	Students will design and model multi-component mechanisms in CAD, apply force and torque calculations to guide design choices, prototype, test, and refine mechanisms through iterative engineering.
Implement Advanced Programming for Robotics Control Systems	Students will develop modular robot code, integrate advanced controls such as PID, state machines, and sensor fusion, and use communication protocols like CAN, serial, I2C, and wireless telemetry to create reliable robotic systems.
Integrate Sensors, Automation, and Electronics into Functional Systems	Students will build and troubleshoot complex electrical systems, apply principles like Ohm's law and circuit protection, and integrate microcontrollers to automate sensing, movement, and decision-making.
Use Data Acquisition and Analysis to Drive Engineering Optimization	Students will collect and interpret performance data to refine mechanical, electrical, and control systems, using statistical tools and spreadsheets to support evidence-based design decisions.
Advanced Project Management & Engineering Documentation	Students will manage projects using engineering notebooks, design reviews, revision tracking, and documentation tools, producing clear technical artifacts that support effective collaboration.
Team Leadership in Engineering Projects	Students will lead engineering teams by coordinating tasks, mentoring peers, resolving conflicts, and clearly communicating progress and decisions throughout complex projects.
Capstone Engineering Project	Students will design, build, test, and refine a fully integrated robotic or automated system, documenting their work and presenting evidence-based engineering decisions in a final demonstration.

Industry Certifications

- Certified Onshape Associate or Fusion 360 Associate
- OSHA 10 Hour Safety Training

FIRST Training learning content that can be used to implement this course.

Engineering Explorations Course	*FIRST* Robotics Competition Trainings		UL Safety Trainings	
Unit 1: Welcome to *FIRST*	Module 1: Intro to *FIRST* Robotics Competition	Module 7: Kickoff	Robotics Safety	Personal Protective Equipment
Unit 2: Build a Bot	Module 2: How does *FIRST* Robotics Competitions Work?	Module 8: Design and Mechanical	Giving and Receiving Feedback	Lockout/Tagout/Tryout
Unit 3: Make it Move	Module 3: Intro to CAD and 3D Printing	Module 9: Programming & Electrical	Cybersecurity	Hazard Communication-Safety Data Sheets
Unit 4: Programming Autonomous Robots	Module 4: Fabrication Tools and Safety	Module 10: Business and Media	Recognizing Electrical Hazards	Hand and Power Tool Safety
Unit 5: Build & Program Manipulators	Module 5: Rapid Prototyping	Module 11: Preparing for Competition	Fire Extinguisher Safety	
Unit 6: The Ball Game	Module 6: Preparing for Build Season	Module 12: Season Wrap-up		
	Java Programming I	Java Programming II		

Standards Alignment

Organization	Aligned Standards
NGSS	HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4, HS-PS2-1, HS-PS2-2, HS-PS3-1, HS-PS3-3, HS-PS4-5
ISTE	1.1.a, 1.1.c, 1.2.a, 1.2.b, 1.4.a, 1.4.b, 1.5.a, 1.5.b, 1.5.c, 1.6.a, 1.6.b, 1.7.a, 1.7.b
ITEEA (STEL)	1M, 2P, 3J, 4I, 5H, 6F, 7J, 8J, 9K, 10L
NIMS	Measurement Materials & Safety (MMS), Job Planning Benchwork & Layout, Quality & Continuous Improvement, Industrial Technology Maintenance Awareness, CNC Operations (Intro), Electrical Systems (Fundamentals), Workforce Readiness
NBEA	Information Technology II.A, Information Technology III.A, Communication III.A, Management III.A, Career Development I.B
ACTE-CRP	CRP1, CRP2, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP10, CRP11, CRP12