FIRST® Robotics Engineering Explorations Course Outline

The *FIRST*® Robotics Engineering Explorations course provides students with experiences in engineering, robotics, programming, and game-based learning. *FIRST* revolves around a defined set of Core Values and gives students authentic, real-world learning experiences. Working as part of a team, students use what they learn through *FIRST* to research and design an innovative solution to a real-world problem. At the same time, students will work in teams to build their own game-ready robot to showcase at an event at the end of the course. Students practice 21st century skills like technical writing, presentation skills, communication, project management, collaboration, and teamwork.

Unit 1: Welcome to *FIRST* (12 hours)

OBJECTIVES

- Explore what it means to be a part of *FIRST*.
- Research and think about ways robots can improve people's lives.
- Explore a variety of career options and the varying levels of education needed for them.
- Use basic materials to solve engineering challenges.
- Design a game for the teams to compete in.

ACTIVITY	DRIVING QUESTIONS	TIMING
Robotics Engineering Explorations	• How do we prepare for *FIRST* competitions using robots? • What are the Core Values and philosophies of *FIRST*? • Why are we working in teams?	1 hour
Engineers Rock	• What are engineers? What do they do? How do they do it? Why are they important? • What is the purpose of an Engineering Notebook? • How can we use the Engineering Design Process to solve a problem?	1 hour
Problems and Innovation	• Why is identifying a problem an important part of the Engineering Design Process? • What are some problems our community has faced in the past, and how were they solved? • What is a problem our community is currently facing?	2 hours
Solve Your Own Problem	• Are there robots in our community right now? • Can we use a robot to solve the community problem we identified? • What would a robot need to do to solve our community problem?	1.5 hours
Help Wanted, Positions Available	• How do we know if we've successfully used the Engineering Design Process? • What sorts of skills do we need for big design and engineering projects? • What professions are needed for big engineering design projects?	1.5 hours
Safety and the Kit	• What do we need to know so we can stay safe while working with our robot? • What will we use to build the robot? • What is in the robotics kit?	2 hours
Ball Game	• How can we design our own ball game? • How can we work with another team as an alliance to win a game? • How can we use *FIRST* Core Values, *Gracious Professionalism*®, and *Coopertition*® while we work to win a game?	3 hours

Unit 2: Build a Bot (12 hours)

OBJECTIVES

- Design and build a robot chassis that can complete a game-based challenge while researching ways in which robotics is used in your community.
- Get to know your kit of parts.
- Explore real-world chassis designs.
- Introduce movement, control, and power.

ACTIVITY	DRIVING QUESTIONS	TIMING
A Robot Skeleton	• What is a frame? • What is a chassis? • How do we build a frame from the parts in our robotics kit? • How will the chassis design help our team compete in the ball game?	3 hours
Get Those Chassis Moving	• Why are different wheels used for different jobs? • How do we mount wheels to our chassis using the robotics kit? • What sorts of wheel configurations can you create from the robotics kit?	3 hours
Mounting Motors	• How will the robot move? • How do we mount motors onto the chassis? • Where should we mount motors on the chassis?	2.5 hours
Power and Control	• How do we power our robot? • What is a control system and what does it do? • How do we connect all the electronic components of my robot?	1.5 hours
Fine Tuning	• How can we improve the design of our robot? • Are all the parts of our robot secure? • Is our robot ready for programming?	2 hours

Unit 3: Make It Move (24 hours)

OBJECTIVES

- Configure and program a robot to perform driver-controlled movements.
- Develop and troubleshoot driver-controlled programs.
- Collect data about your robot using telemetry.

ACTIVITY	DRIVING QUESTIONS	TIMING
Configure It Out	• Now that the robot is built and wired, how do we drive it around? • How can we communicate with the robot so it can do its job?	3 hours
Programming is Everywhere	• How can we use a gamepad to move our robot? • How and why should we use a similar strategy with our ball game robot?	3 hours
Troubleshooting is Everywhere	• How can we troubleshoot a program? • Why is troubleshooting important?	3 hours
Think Like a Robot	• How can we write directions for a person to do exactly what we want and nothing else? • How can we get our robot to do exactly what we want and nothing else? • Why is this important?	3 hours
Let's Get Moving	• Can we program our motors to change the way the robot moves? • What role will the programming of the motor play in their robot design?	3 hours
Information Exchange	• How do we retrieve data from our robot? • What sort of data can we get from our robot? • How can we use data feedback to improve our robot?	3 hours

I'm in Complete Control	• What sort of tasks can we make our robot do? • Can we create a set of instructions based on what we want our robot to do? • How do we translate a set of instructions for completing a job into a program for our robot?	3 hours
The Big Race	• Can we control our robot well enough to drive it in a relay race against another team? • Can we use the Engineering Design Process to create the best possible program for winning a relay race? • Why is the level of control we have over a robot important, and how does it apply to our ball game?	3 hours

Unit 4: Programming Autonomous Robots (12 hours)

OBJECTIVES

- Develop and troubleshoot autonomous programs and sensors.
- Explore the differences between driver-controlled and autonomous modes.
- Explore sensor configuration and functions.

ACTIVITY	DRIVING QUESTIONS	TIMING
Autonomous Functionality	• How can we control a robot when it is not driver controlled? • What do we need to know to make our robot move autonomously? • How do we write instructions that will make our robot complete a task autonomously?	3 hours
Better Control Through Encoders	• What are encoders? • How can we use the encoders built into our motors to gain better control of our robot's movement? • What algorithms do we need to use to take advantage of our encoders?	3 hours
Robot Senses	• What are sensors, and how can we use them to improve our robot? • What sensors are available in our kit of parts? • What additional sensors will be most useful in the ball game challenge?	3 hours
Collision Avoidance	• How can we store data in our program? • How can we reuse and call stored data? • What are variables and how do we use them in our program?	3 hours

Unit 5: Build and Program Manipulators (20 hours)

OBJECTIVES

- Build and program an arm and manipulator that works in autonomous and driver-controlled modes.
- Research basic arm and manipulator designs.
- Program and test a robotic manipulator in autonomous and driver-controlled modes.

ACTIVITY	DRIVING QUESTIONS	TIMING
Ball Grabber	• What is an actuator? • How do we use the actuators in our kit?	4 hours
Iterate, Feedback, and Improve	• How do we improve the robot mechanically and through programming? • How can we improve our designs to perform better? • How can programming enable our robot to have more control? • How can sensors improve the automation process?	4 hours
Robot Arms	• How can we do more complex actions with our ball game robot? • What is a robotic arm? • Where are robotic arms used in manufacturing? • How do we choose the correct motors for the robot arm?	4 hours

Actuating Your Manipulator	• How are the motors in our robotics kit different? • How do we ensure we choose the correct motor to make our manipulator work? • How can we integrate the proof of concept into our robot?	4 hours
Project Sprints	• How can a project sprint help to improve iteration cycles? • How does a project sprint help us keep track of tasks that need to be completed? • How can project sprints help us improve teamwork and innovation?	4 hours

Unit 6: The Ball Game (10 hours)

OBJECTIVES

- Build and program a robotic arm and manipulator that works in autonomous and driver-controlled modes.
- Research basic arm and manipulator designs.
- Program and test a robotic manipulator in autonomous and driver-controlled modes.
- As a team, present the final innovative solution and your innovative robotics solution.

ACTIVITY	DRIVING QUESTIONS	TIMING
Preparing for the Game	• How can we involve the team during the competition? • How do we plan our competition day? • How do we know if we are prepared for the game?	3 hours
More Than Robots	• What are our next steps for the community event? • What needs to be done to our robot for the ball game challenge? • How will we market the community event? • How will we present our robot and our design in our community?	2 hours
Welcome to the Game	• Are we ready to have fun competing? • Are we ready to share our knowledge and what we have learned? • How does *Coopertition* impact our approach to competing?	5 hours