2026 - 2027 *FIRST*® Tech Challenge

FTC 101

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1 Introduction

1.1 About FIRST ®

FIRST® (For Inspiration and Recognition of Science and Technology) was founded by inventor Dean Kamen to inspire young people's interest in science and technology. As a robotics community that prepares young people for the future, FIRST is the world's leading youth-serving nonprofit advancing STEM education. For 30 years, FIRST has combined the rigor of STEM learning with the fun and excitement of traditional sports and the
inspiration that comes from community through programs that have a proven impact on learning, interest, and skill-building inside and outside of the classroom.

1.2 FIRST Ethos and Core Values

1.2.1 Core Values

The FIRST Core Values are fundamental to FIRST and unique to its programs. They emphasize friendly sportsmanship, respect for the contributions of others, teamwork, learning, and community involvement and are part of our commitment to fostering, cultivating, and preserving a culture of unity. Our community expresses the FIRST philosophies of Gracious Professionalism® and Coopertition® through the FIRST Core Values.
Discovery: We explore new skills and ideas.
Innovation: We use creativity and persistence to solve problems.
Impact: We apply what we learn to improve our world.
Inclusion: We respect each other and embrace our differences.
Teamwork: We are stronger when we work together.
Fun: We enjoy and celebrate what we do!

1.2.2 Gracious Professionalism® , a FIRST Credo Gracious Professionalism® is part of the ethos of FIRST. It's a way of doing things that encourages high quality work, emphasizes the value of others, and respects individuals and the community. Gracious Professionalism is not clearly defined for a reason. It is an aspirational ideal to always strive towards, not a goal to be achieved or a method of measuring someone, and for this reason, you can never say someone "is" or "is not" being Graciously Professional. We should each work to better embody Gracious Professionalism in all our actions. How we pursue this can and should mean different things to everyone.

Some possible meanings of Gracious Professionalism include:
− gracious attitudes and behaviors are win-win,
− gracious folks respect others and let that respect show in their actions,
− professionals possess special knowledge and are trusted by society to use that knowledge responsibly, and
− gracious professionals make a valued contribution in a manner pleasing to others and to themselves.
In the context of FIRST, this means that all teams and participants should:
− learn to be strong competitors, but also treat one another with respect and kindness in the process

and
− avoid leaving anyone feeling as if they are excluded or unappreciated.
Knowledge, pride, and empathy should be comfortably and genuinely blended.
In the end, Gracious Professionalism is part of pursuing a meaningful life. When professionals use knowledge in a gracious manner and individuals act with integrity and sensitivity, everyone wins and society benefits.

2 Awards

2.1 Team Attributed Awards

2.1.1 Inspire Award

The team that receives this award is a strong ambassador for FIRST programs and a role model FIRST team. This team is a top contender for many other judged awards and is a gracious competitor. The Inspire Award winner is an inspiration to other teams, acting with Gracious Professionalism® both on and off the playing field. This team shares their experiences, enthusiasm, and knowledge with other teams, sponsors, their community, and the JUDGES. Working as a unit, this team will have shown success in performing the task of designing and building a ROBOT.

2.1.2 Think Award

This judged award is given to the team that best reflects the journey the team took as they experienced their season. The content within the PORTFOLIO is the key reference for JUDGES to help identify the most deserving team. The team could share or provide additional detailed information that is helpful for the JUDGES.

2.1.3 Connect Award

This judged award is given to the team that connects with their local science, technology, engineering, and math (STEM) community to learn and adopt new tools through effort and persistence. This team has a team plan and has identified steps to achieve their goals. A PORTFOLIO is not required for this award.

2.1.4 Reach Award

This award celebrates a team that has introduced and recruited new people into FIRST. Through their efforts, they have sparked others to embrace the FIRST culture. A PORTFOLIO is not required for this award.

2.1.5 Sustain Award

Sustainability and planning are essential for a FIRST team, because they ensure the program's long-term success. This award celebrates the team that has considered their future team members and has worked to ensure that their team or program will continue to exist long after they have gone on to develop their careers. A PORTFOLIO is not required for this award.

2.1.6 Innovate Award Sponsored by RTX

The Innovate Award celebrates a team that thinks imaginatively and has the ingenuity, creativity, and inventiveness to make their designs come to life. This judged award is given to the team that has an innovative and creative ROBOT design solution to any specific components in the FIRST Tech Challenge game. Elements of this award include design, robustness, and creative thinking related to design. This award may address the design of the whole ROBOT or of a MECHANISM attached to the ROBOT and should work consistently during MATCHES, but does not have to work all the time to be considered for this award. A PORTFOLIO is not required for this award.

2.1.7 Control Award

The Control Award celebrates a team that uses sensors and software to increase the ROBOT'S functionality during gameplay. This award is given to the team that demonstrates innovative thinking and solutions to solve game challenges such as autonomous operation, improving mechanical systems with intelligent control, or using sensors to achieve better results. The solution(s) should work consistently during MATCHES but does not have to work all the time.

Solutions considered for this award are not solely limited to the AUTO period of the MATCH and may also be used during TELEOP. The team's PORTFOLIO must contain a summary of the software, sensors, and mechanical control but would not include copies of the code itself.

2.1.8 Design Award

The Design Award celebrates the team that demonstrates an understanding of industrial design principles by striking a balance between form, function, and aesthetics while meeting the needs of this season's challenge. The design process used should result in a ROBOT which is efficiently designed and effectively addresses the game challenge. A PORTFOLIO is not required for this award.

2.1.9 Judges' Choice Award

This award is optional and not given at all FIRST Tech Challenge events. During the competition, the judging panel may meet a team whose unique efforts, performance, or dynamics merit recognition, but does not fit into any of the other award categories. To recognize these unique teams, FIRST offers a Judges' Choice Award.

2.2 Tournament Alliance Awards

2.2.1 Winning Alliance Award

This award will be given to the winning ALLIANCE represented in the final MATCH of the Playoffs of a single- division Tournament or Championship event. If the event is a dual-division or multi division event, there will be Winning Alliance Awards awarded to both the division playoff winners and the event finals playoff winner.

2.2.2 Finalist Alliance Award

This award will be given to the finalist ALLIANCE represented in the final MATCH of the Playoffs of a single- division Tournament or Championship event. If the event is a dual-division or multi-division event this will be awarded to the division playoff finalists and the event finals playoff finalist.

2.3 Individual Awards

2.3.1 FIRST Leadership Award

The STUDENTS who earn FIRST Leadership Award status as a semi-finalist, finalist or winner, are great examples of current STUDENT leaders who have led their teams and communities to increased awareness for FIRST and its mission, champion FIRST Core Values such as Inclusion, and embody Gracious Professionalism®. It is the goal of FIRST that these individuals will continue, post-award, as great leaders, STUDENT alumni, and advocates of FIRST. Please visit the FIRST Leadership Award Website to see complete award submission details and to see past FIRST Tech Challenge winners.

2.3.2 Compass Award

This is an optional award and is only offered at the Regional Championship tournament level of competition. All teams attending FIRST Championship will have an opportunity to submit for this award. The Compass Award recognizes an adult coach or mentor who has given outstanding guidance and support to a team throughout the year and demonstrates to the team what it means to be a Gracious Professional. The winner of the Compass Award will be chosen from candidates nominated by FIRST Tech Challenge STUDENT team members, via a 40-60 second video

submission. The video must highlight how their mentor has helped them become an inspirational team. The video should emphasize what sets the mentor apart.

3 Mechanical Elements

3.1 Control System

3.1.1 Rev Control Hub

In FTC (First Tech Challenge), our primary control system for motors, servos and sensors is REV Control Hub. In the control hub, there are 4 motor Ports, 4 motor Encoder ports, 4 I2C ports, 1 internal 6 axis IMU and 6 servo ports. To give power to the Control Hub, we use a 12 volt battery. Head over to https://revrobotics.global/rev-31-1595/ for more information.

3.1.2 REV Expansion Hub

To expand capabilities of the Control hub, we use an additional hardware called REV Expansion Hub. In the expansion hub, there are 4 motor ports, 4 motor encoder ports, 4 I2C ports and 6 servo ports. To link Control Hub with Expansion hub, we use a linkage power cable and 1 UART RS485 cable to transfer information between both hubs.

3.1.3 REV Driver Station

To use these hardware, we use REV Driver Station. This device is run by Android. Inside this device, there is the Robot Controller software. Inside this software, we configure ports, set the wifi address on the control hub and more.

3.1.4 REV Hardware Client Software

To do initial configuration of the hubs mentioned, to code in blocks and to update hardware we use REV Hardware Client Software.

IMPORTANT NOTE

Make sure that you configure these hardwares correctly, if not, changing them might be a problem. For any activities, please follow these official guidance:
Getting Started: Control Hub
Getting Started with the Control Hub and the REV Hardware Client
Wireless ADB on a Control Hub
Pairing Driver Station to a Control Hub
Troubleshooting: Control Hub to a Computer over WiFi
Troubleshooting: Connecting a Second Expansion Hub

3.2 Motors and Servos (Actuators)

3.2.1 Actuator Branches Which Are Season Legal Inside FTC

There are 4 major Companies which provide legal and high quality actuators. These companies are listed down below:

- Studica Robotics
- Gobilda Robotics
- Rev Robotics
- Andymark Robotics

To control these actuators, we plug power wires into the control or expansion hub. If you want extra confirmation or accurate input, please use inbuilt motor encoders. These encoders give accurate info to control or expansion hubs.

4 Drivetrain Types

4.1 One Way drivetrains

4.1.1 Tank Drive

Tank drive motion systems typically have 6 wheels in total. They are mostly powered by one motor on each side and can do forward, backward and to left and right turning motion. These systems are hard to be pushed sideways but they glide when pushed in the direction of the wheels.

4.1.2 Push bot drivetrain

These drivetrains typically have 4 wheels and are powered by one motor on each side. Only 1 of the wheels is powered on each side. They are like RWD cars. can do forward, backward and to left and right turning motion.

4.1.3 4 Wheeled Drivetrain

In this drivetrain type, all 4 wheels are powered but they are straight wheels. They can do forward, backward and to left and right turning motion.

4.2 Omni-directional Drive

4.2.1 Mecanum Drive

Mecanum drives are able to go in every direction (forward, backward, left, right, diagonal, left turning and right turning) and they have full mobility on the field. They are powered by 4 motors, one for each wheel, but they are easy to push diagonally because the wheels are designed to slide on the surface.

4.2.2 Kiwi Drive

Kiwi drives are powered by 3 motors and in total 3 wheels. They can do forward, backward, left, right, diagonal, left turning and right turning with fewer motors. But the coding is hard and for this to work, the weight balance and the chassis should be rectangular.

4.2.3 X Drive

This drive system is powered by 4 motors, one for each wheel, and has full mobility like mecanum drive and drive really quick diagonally. But they are prone to gliding and weird chassis design.

4.2.4 H drive

This drivetrain type typically includes 3 or 5 motors, and includes 5 to 7 wheels in total. This drivetrain type has mobility in every direction thanks to 2 to 3 wheels on each side and 1 sideways mounted wheel. But they are hard to control and hard to code because of additional motors.

4.2.5 Swerve Drive

4.2.5.1 2 pod swerve drive

This drivetrain type has full motion capability on the field and is powered by 2 wheels in total, 1 for each side. Each wheel has 1 motor for the forward and backward motion and has 1 servo for turning the wheel. This type is one of the most powerful omni direction drive systems, but it is really hard to code and really hard to make easy to control on controllers.

4.2.5.2 4 pod swerve drive

This drivetrain type has full motion capability on the field and is powered by 4 wheels in total, 2 for each side. Each wheel has 1 motor for the forward and backward motion and has 1 servo for turning the wheel. This type is one of the most powerful omni direction drive systems, but it is really hard to code and really hard to make easy to control on controllers.

NOTE:

For more detail on every drive system, you can watch these videos;

- Omni-directional Drivetrain types
- One way drivetrain

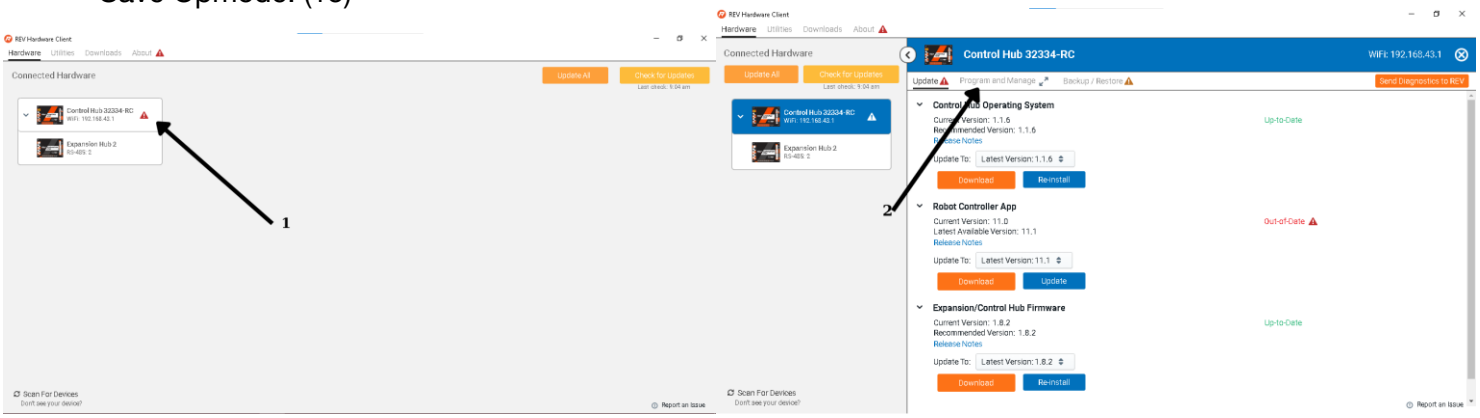
5 Coding

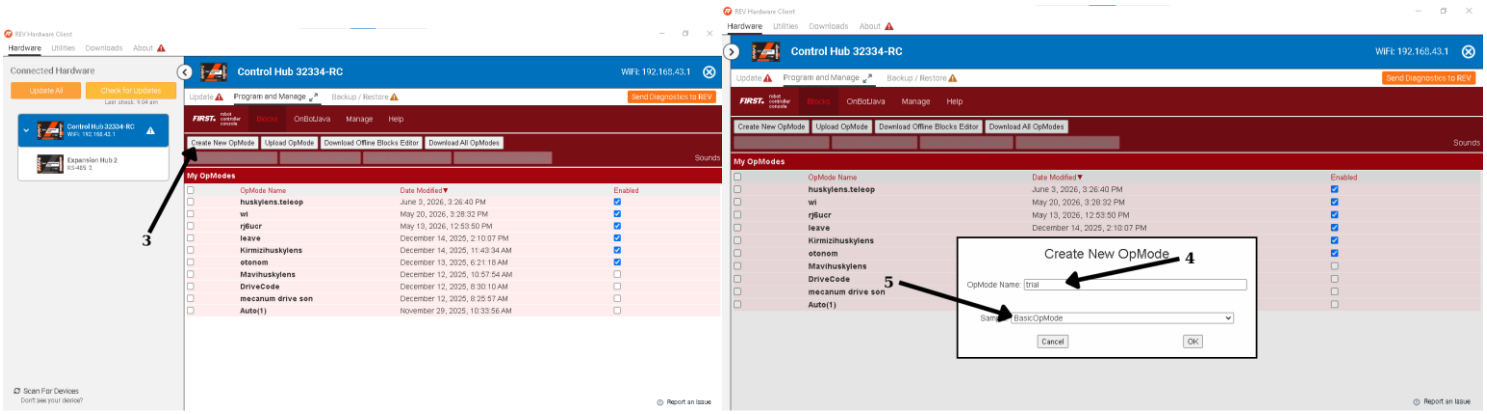
5.1 Block Coding

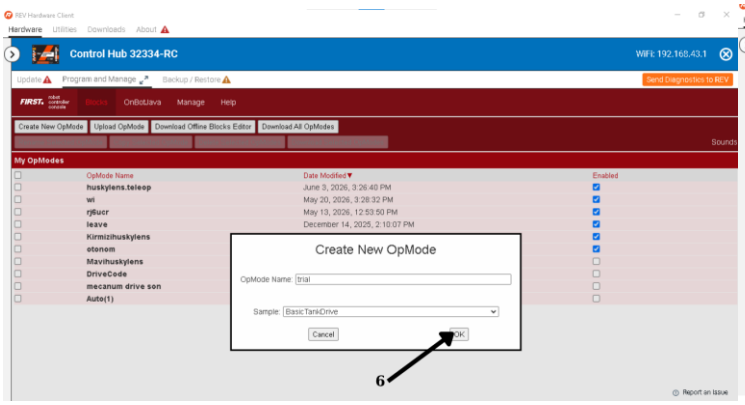
5.1.1 TeleOp

To code your robot in blocks, you need to install REV Hardware Client to your computer, which is the primary control software for everything.

To start coding, first you need to connect to the control hub from your computer. (1) Then you can click the control hub icon and switch to program and manage tab. (2) After that click create new opmode. (3) Then write the Opmode name(4), then click sample and choose basic TankDrive (5) and click OK button (6). Then choose the correct motor names and if you are done then click Save Opmode. (15) If you want to add new motors, please click actuators (8) and then DC Motors. (9) Then click and drag ‘set…….power to -1-’ (10) to the coding area. Then set motor power and choose the correct motor. If you want to use encoders on any motors also drag the set…..MODE to -> RUNMODE - RUN_WITHOUT_USING_ENCODER to the field. And click to RUN_WITHOUT_USING_ENCODER and choose RUN_WITH_USING_ENCODER, and make sure that the motor name is the one that you want to use with encoders. If you are done then click Save OpMode. (15) But, if you want to control the motors power by the joystick's X axis, first click Math, (11) and then click and drag ‘- 9’ to ‘1’ which is next to set motor power to … Then click to Gamepad (13) and then drag gamepad1.LeftStickX and drag to 9 of the ‘-9’ section (14) and click Save Opmode. (15)



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Sample: BasicTankDrive
Cancel
OK
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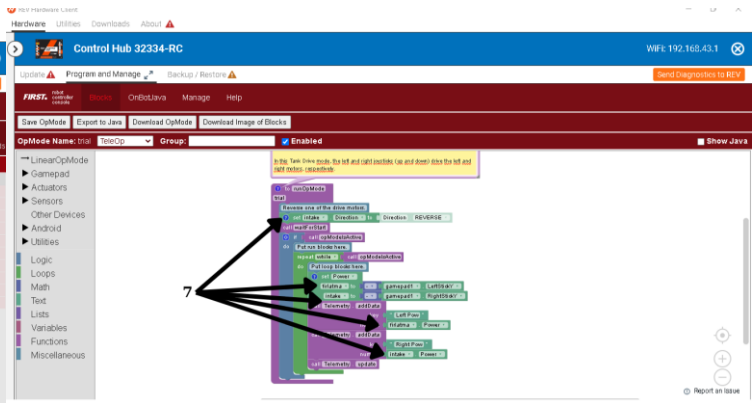
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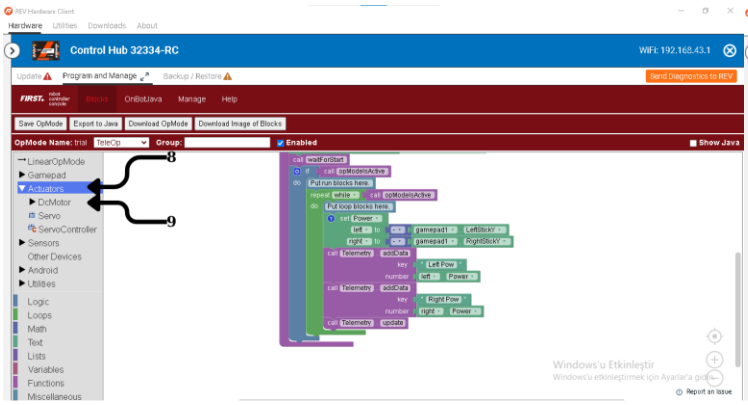
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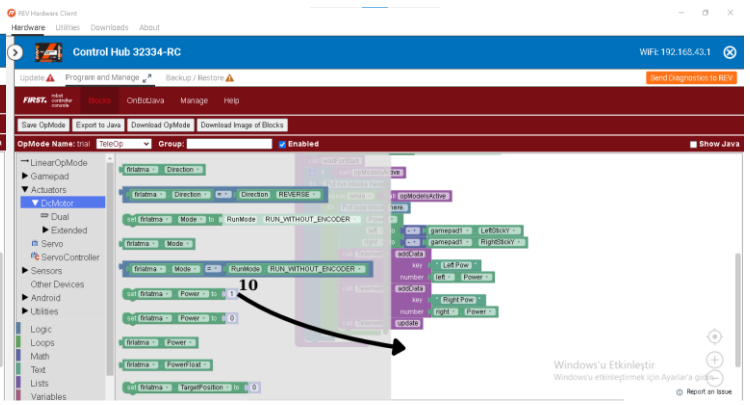
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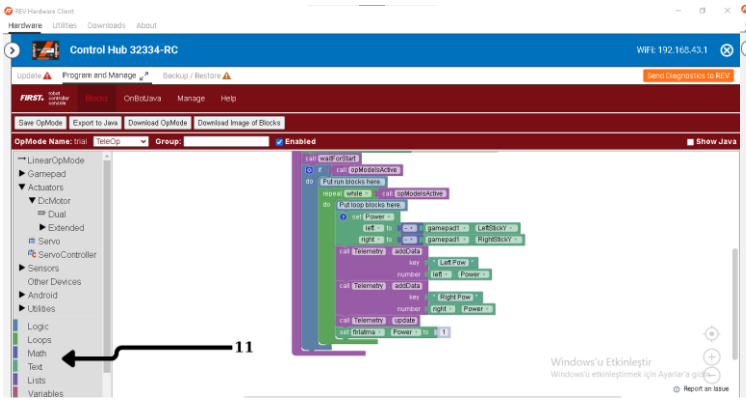
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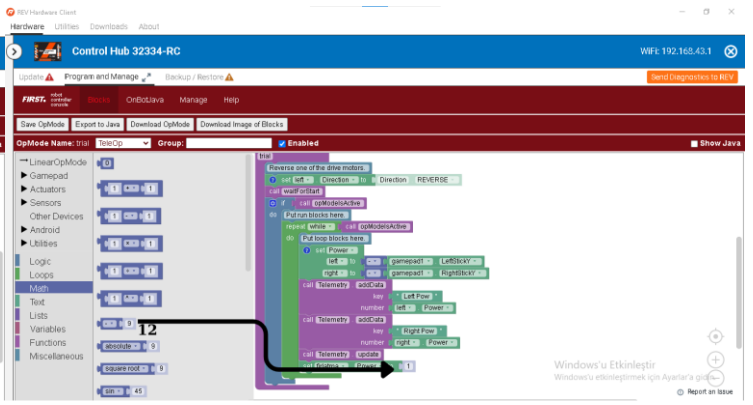
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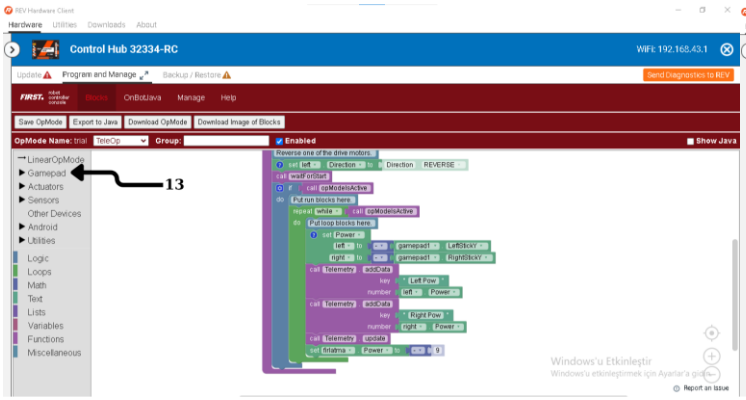
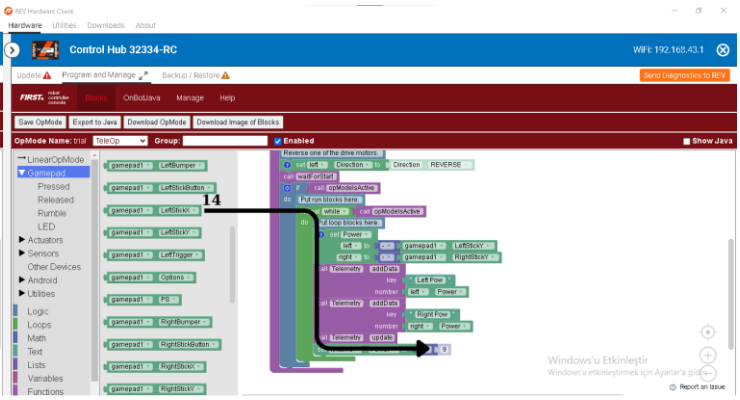
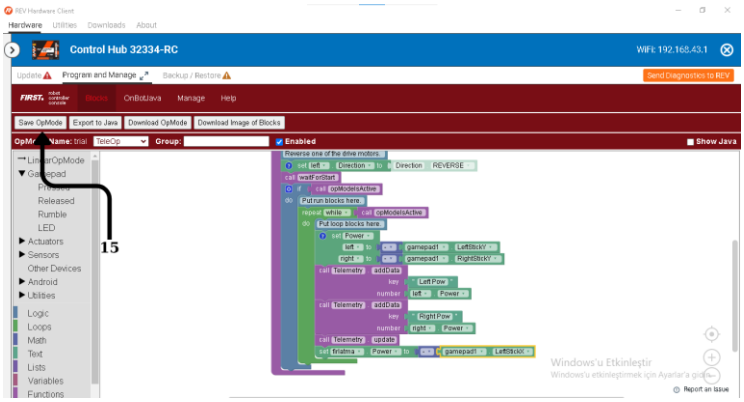


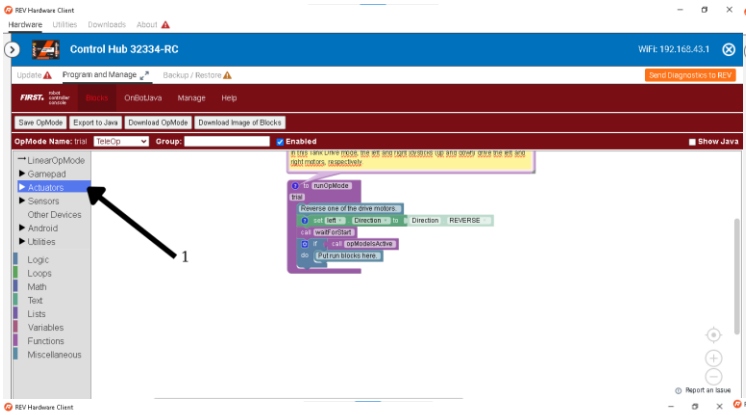




To use the program you coded, please open Driver Hub, then please open Driver controller app, then click the down looking arrow on right, then click the name you wrote for the code. Then click INIT then click the arrow pointing to right. Then test the functions.

5.1.2 Autonomous

To code an auton code, first click actuators, (1) then click dual (2) and click and drag ‘set power: motor to 1, motor to 1’ under if call opmode is active. (3) Then click linear opmode (4) and click and drag ‘call sleep milliseconds 1000’ under ‘set power: motor to 1, motor to 1’. Then click dual (5) and then click and drag ‘set power: motor to 0, motor to 0’ under ‘call sleep milliseconds 1000’. (6) Then change the names of the motors (7) to correct corresponding ones and click save opmode. (8)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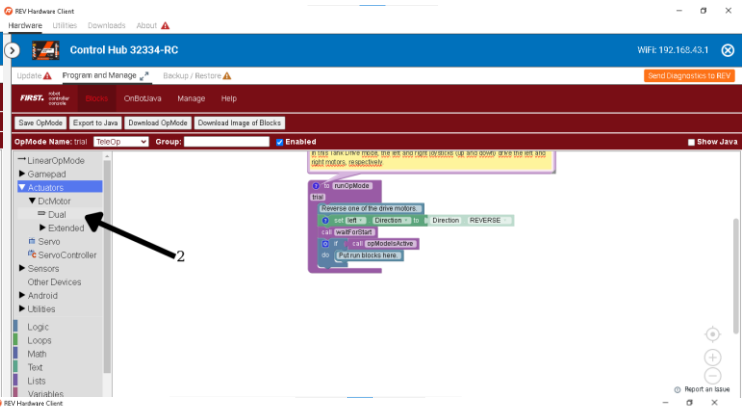
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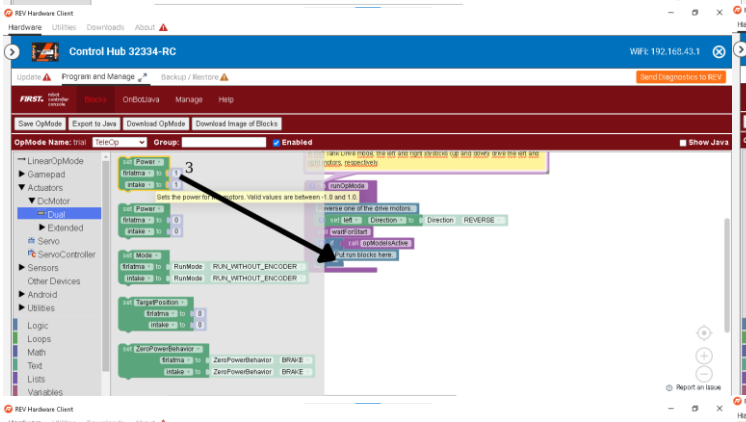
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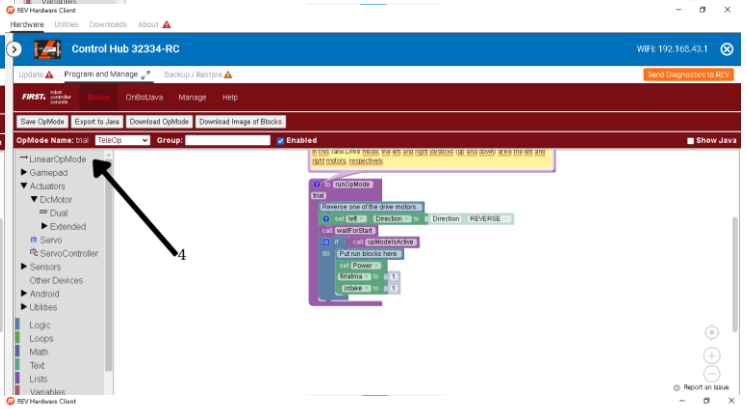
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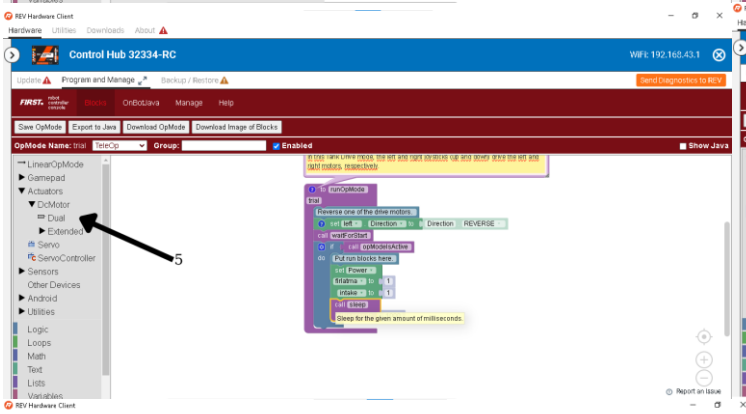
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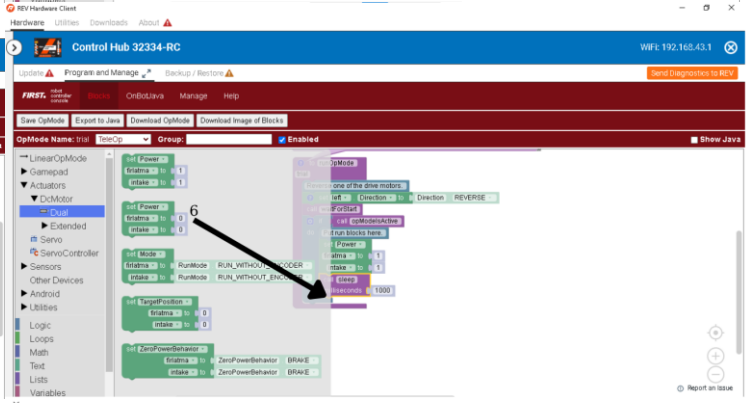
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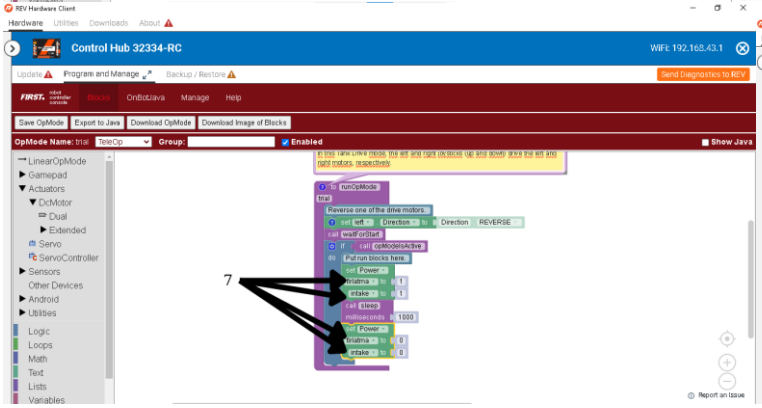
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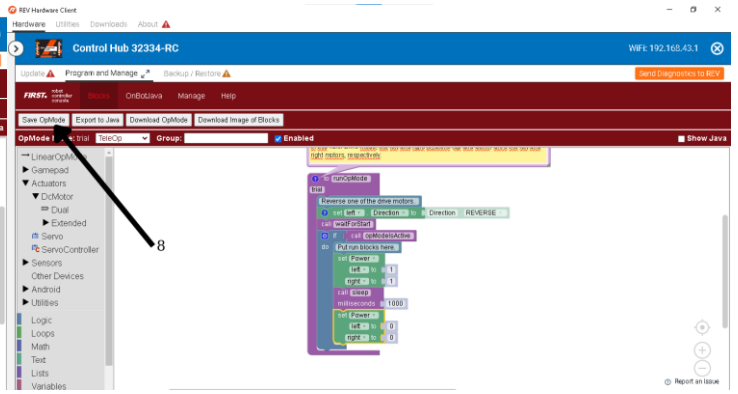
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6. Engineering Documentation

6.1 Engineering Notebook

Your Engineering Notebook is basically your team's memory for the entire season. Judges read it to understand how you actually think and learn, not just what you built at the end.

Use a proper **bound notebook** (not spiral). Write with pen — if you make a mistake, just cross it out and keep going. Never erase. On every page, write the date and the names of the people who worked that day.

Document everything: your ideas, rough sketches, measurements, why something didn't work, test results, and what you learned from failures. Take lots of photos of each prototype version and stick them in. Under each photo write what changed and why.

Judges love honesty. Don't try to look perfect. They want to see that you tried things, failed, learned, and improved. That's real engineering.

6.2 Portfolio

The Portfolio is the main document Judges use to decide most awards, especially Inspire and Think. When writing your portfolio, gather every info. You wrote in your Engineering notebook. When meeting with judges, speak about your engineering notebook shortly. Just say 'we wrote every info, every process' and no more. Portfolio is the main thing they look into. Focus on every aspect of your portfolio. Write everything you have done throughout the season, like your social impact and your robot and everything else.

Make it look clean and professional — good cover, table of contents, consistent fonts and colors. Start with a team photo and short introduction.

The biggest and most important part should be **Robot Design & Iterations**. For every major mechanism (drivetrain, intake, outtake, etc.), explain:

- What problem were you trying to solve?
- What did you try first (V1)?
- Why wasn't it good enough?
- What did you change in V2 and V3?
- What were the results?

Use lots of clear photos and CAD screenshots. Add simple tables and graphs instead of long paragraphs. Show each team member's contributions. Most importantly — tell a story. Don't just list what you did. Explain the journey.

6.3 Judging Presentation

You usually get 5–7 minutes with the Judges. This is your chance to bring everything together.

Practice the presentation many times as a team. Every member should speak. If possible, bring the robot and show the important mechanisms live.

Tell your story naturally: What were your goals at the beginning? What challenges did you face? Where did you fail? What did you learn? How did you improve?

Be ready for common questions like:

- What was your biggest failure this season?
- How did you share tasks in the team?
- Why did you choose this design?
- How have you helped your community?

7. Competition Strategy & Scouting

7.1 How the Season and Tournaments Work

The FTC season is a long journey. It usually starts in September and goes until April. There are different levels of competitions:

- **League/Qualifier Tournaments**: These are your first real competitions. You get to test your robot against other teams and learn how the game actually works under pressure.
- **Regional Championship**: The best teams from the leagues advance here. The competition gets much harder.
- **FIRST Championship**: The world finals. Only the top teams reach this level.

At every tournament, there are two main parts: **Robot Performance** (on the field) and **Judging** (off the field). Even if your robot is not the strongest, a great portfolio, strong outreach, and good presentation can still win you the Inspire Award.

7.2 Scouting

Many teams focus only on building their robot and forget scouting. That's a big mistake. Good scouting can help you reach the finals even with an average robot.

What You Should Record During Matches:

- Team number and drivetrain type (Mecanum, Tank, Swerve, etc.)
- How reliable their autonomous is (does it score consistently?)
- Main scoring method and average points per match
- End game performance (can they hang, park, etc.)
- Defense ability — do they play strong defense?
- Overall reliability — how often does their robot break or stop working?
- Special strengths or weaknesses

How to Do It Effectively:

- Assign at least 2-3 people to scout every match
- Use a simple scouting sheet or digital form (you can use the app you're building)
- Take quick notes during the match
- After the match, quickly write down your impressions

Alliance Selection Strategy:

When it's time to choose alliance partners, you need to be prepared. Know which robots are strong in auto, which ones are good at scoring, and which ones play good defense. Look for robots that **complement** your robot's weaknesses.

Talk respectfully with other teams. Be honest about your robot's capabilities. Teams remember how you behave during alliance selection.

8. Outreach & Sustainability

8.1 Outreach

Outreach is not just “extra work.” For the Inspire Award, it is one of the most important things Judges look at. They want to see that your team is making a real positive impact.

Always keep track of numbers: How many people did you reach? How many students did you inspire? Take lots of photos and collect feedback.

8.2 Sustainability

Sustainability means making sure your team continues strongly even after you graduate.

Things You Should Do:

- Create a detailed **Team Handbook** that explains everything: roles, meeting format, budget management, sponsor communication, Gracious Professionalism rules, etc.
- Start training younger students early so they are ready to take over
- Document all your robot designs properly in OnShape with full build instructions
- Build strong, long-term relationships with sponsors
- Create a clear leadership transition plan (like you are doing now — moving from captain to young mentor)

The best teams don’t just have a good season. They build something that lasts for many years.

9. Tips & Common Mistakes

9.1 Golden Tips for New Teams

- Start building a strong drivetrain as early as possible. A reliable base is more important than a fancy mechanism.
- Document everything from day one. Don't leave it to the last month.
- Test your robot a lot — on the real field if possible.
- Cable management is boring but extremely important. Bad wiring causes most robot failures.
- Begin working on autonomous early. Even a simple autonomous can win matches.
- Practice your judging presentation many times.
- Be good people. Gracious Professionalism is not just a slogan — judges can feel it.

9.2 Common Mistakes We See Every Year

- Focusing 90% of time on the robot and only 10% on documentation and outreach
- Waiting until the last weeks to work on the portfolio
- Not testing mechanisms enough before competitions
- Poor cable management and organization
- Ignoring scouting completely
- Trying to build very complicated mechanisms instead of reliable simple ones
- Forgetting to enjoy the process and have fun as a team

Final Advice:

The robot is important, but the Inspire Award usually goes to the team that shows the best **overall journey** — technical improvement, teamwork, community impact, and learning.

Work hard, stay kind, document everything, and enjoy the season. The experience and friendships you gain will be much more valuable than any trophy.