

# **ENG 4530 Video learning Bonus Opportunity 2**

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<b>Video Number</b>	<b>Rank</b>
<b>1</b>	<b>5</b>
<b>2</b>	<b>8</b>
<b>3</b>	<b>6</b>
<b>4</b>	<b>10</b>
<b>5</b>	<b>4</b>
<b>6</b>	<b>1</b>
<b>7</b>	<b>2</b>
<b>8</b>	<b>3</b>
<b>9</b>	<b>7</b>
<b>10</b>	<b>9</b>

## **GPS Videos**

### **Video 1**

**Title:** “Betaflight GPS Rescue Mode - All You Need To Know”

**Link:** <https://www.youtube.com/watch?v=YQeOmeMGpvE>

**Rank:** 5

**Reflection:**

In my study of the instructional video, I have deepened my comprehension of GPS technology's integral role in enhancing the operational efficacy of quadcopters, particularly for long-range and recovery applications. The detailed exposition of the GPS rescue feature, a failsafe mechanism that autonomously guides the drone back to a predefined home point upon control signal loss, was particularly instructive. The video, supported by Vaunt, also provided practical insights into selecting cost-efficient GPS modules like the HLRC M80 and their integration with the drone's flight controller. It included a meticulous step-by-step guide for setting up and configuring GPS in Betaflight, ensuring optimal performance through correct wiring and voltage supply. Additionally, the tutorial covered advanced settings such as failsafe parameters and on-screen display elements, reinforcing the importance of thorough testing protocols for safe drone operation. This knowledge is directly applicable to the second phase of our drone project, where incorporating such advanced navigational features could be a significant enhancement.

### **Video 2**

**Title:** “Beitian 880 & 220 GPS systems and Setup”

**Link:** <https://www.youtube.com/watch?v=aXTtu4n37WI>

**Rank:** 8

**Reflection:**

The video really broke down the differences between GPS modules for FPV drones, making it clear how much more you get with a high-end model like the 880 GPS that comes with telemetry. Learning that telemetry isn't just a nice extra but actually key for getting all the flight data you need was a game-changer. I appreciated the straightforward tips on installing these systems — like why soldering directly and using silicone wires is the way to go. The walkthrough on getting everything set up in Betaflight was super clear, even for the tricky parts like picking the right ports and getting the protocols to talk to each other. They also didn't skip over the GPS rescue setup and gave some solid troubleshooting advice if things get wonky. Plus, the pointers on making sure the GPS info is easy to read on the display and the heads-up on potential overheating with the Zeus board were really useful. This is all super relevant stuff as I think about how to fit a solid GPS into our own drone work, especially to make sure we're on point with accuracy and safety.

## **FPV videos**

### **Video 3**

**Title:** “How to Install and Setup a GPS on your FPV Drone (4K)”

**Link:** <https://www.youtube.com/watch?v=dQeNONerxEU>

**Rank:** 6

**Reflection:**

The video opened my eyes to how the BN220 dual GPS GLONASS module can up the safety game for drones. The return-to-home feature is a real stress-reliever for those longer flights where you might lose sight of your drone. It's pretty clear now that putting the GPS in just the right spot and getting the wires right is super important to keep the signals clean and the navigation accurate. Walking through the Betaflight setup was a breeze with their step-by-step guide, showing how to get the hardware and software to play nice together. They went deep on tweaking the GPS rescue mode and getting the on-screen display to show all the GPS stats you need, which is awesome for customizing your flight controls. And the part where they took it out for a field test and showed the OSD working in real-time was very interesting. It made me feel like I could really amp up the safety and control on my drone with a solid setup and some testing.

### **Video 4**

**Title:** “Beginner Guide // How To Build Budget Micro FPV Drone kit 2019 - Eachine Tyro69”

**Link:** <https://www.youtube.com/watch?v=31ArBvYoG2Q>

**Rank:** 10

**Reflection:**

This video was like hitting the easy button on building the Tyro69 quadcopter. It was a full-on beginner's guide that walked through everything without making my head spin. They showed how to wield a soldering iron like a pro, with a nod to some seriously cool tools, like that on-the-go soldering iron and the hex drivers that look like they'd last a lifetime. It was all about getting the details right, from sticking the ESCs in the right spot to making sure the motor wires were not just connected but looking neat too. And the tips on installing the wires, popping on the capacitor, and getting the receiver hooked up to the flight controller were gold – clear, concise, and totally doable. They even made sure to point out how to tuck in the camera, VTX, and receiver so they'd stay put. I'm feeling pretty good about putting together a Tyro69 that's solid and looks clean, with no solder drama on the flight controller and everything else in its perfect place. Plus, the final look with the 20x20 stack is just sweet. All in all, it's a solid guide that could be very helpful if I wanted to make one of these in the future.

## **PID tuning videos**

### **Video 5**

**Title:** “How to Get that Perfect PID Tune in Betaflight 4.4 | 2023”

**Link:** <https://www.youtube.com/watch?v=N5DbiWFjbh8>

**Rank:** 4

**Reflection:**

The Betaflight configuration tutorial provided a detailed exploration into the art of drone tuning, emphasizing the necessity of customizing settings for optimal quadcopter performance. The introduction of Black Box for detailed flight data logging set the stage for a nuanced approach to advanced tuning techniques. Through systematic adjustments of PID values and mastering the use of tools like the Black Box Explorer and PID Toolbox, the tutorial underscored the precision required to fine-tune the delicate interplay between drone responsiveness and stability. Understanding the intricacies of Feed Forward, I-Term, Dynamic Damping, and the master multiplier, and then seeing these adjustments reflected in flight characteristics, showcased the impact of meticulous tuning. The process was not only about making theoretical changes but also about validating these through practical flight tests, ensuring motor temperatures remained within safe limits for sustained performance. The tutorial culminated with real flight footage, demonstrating the successful application of tuning, and invited viewers to engage in a dialogue to further refine the tuning process. This comprehensive guide has armed me with a strategic framework for approaching Betaflight configurations, elevating my capability to tailor drone behavior to precise flying conditions.

### **Video 6**

**Title:** “Betaflight PID tuning. The easy way to a great PID tune. EVEN WITHOUT BLACKBOX!”

**Link:** [https://www.youtube.com/watch?v=WoxDbIbpP\\_Q&t=4s](https://www.youtube.com/watch?v=WoxDbIbpP_Q&t=4s)

**Rank:** 1

**Reflection:**

The tutorial provided an in-depth examination of Betaflight's PID tuning, a critical process for optimizing drone flight performance. It offered a comprehensive breakdown of the PID components—Proportional, Integral, Derivative, and Feed Forward—and their collective impact on motor behavior. Insights into optimizing D gain underscored the balance between responsiveness and thermal management, with an emphasis on customization to match pilot preferences and drone build qualities. Utilizing tools such as PID Toolbox for P to D ratio adjustments and Black Box logging for meticulous fine-tuning, the guide effectively illustrated how precise tuning can significantly enhance flight characteristics. The process also included practical steps for achieving a critically damped response and fine-tuning feed-forward settings for precise maneuverability. Overall, the tutorial bridged the gap between theoretical knowledge and

practical application, equipping me with the tools and confidence to pursue the nuanced art of drone tuning for superior flight control.

### Video 7

**Title:** “How to Tune a PID Controller for an Inverted Pendulum | DigiKey”

**Link:** <https://www.youtube.com/watch?v=hRnofMxEf3Q>

**Rank: 2**

**Reflection:**

The video provided an engaging walkthrough of the inverted pendulum system, illustrating the practical application of control theory through PID controllers. Using an Arduino as the control hub, it skillfully demonstrated how to translate encoder feedback into precise stepper motor movements to keep the system balanced. The tutorial offered a clear, step-by-step guide on implementing and tuning the PID controller on the Arduino, emphasizing the importance of fine-tuning the proportional, integral, and derivative constants to achieve system equilibrium. The iterative process of calibrating motor control, along with the adjustment of acceleration and speed parameters, was meticulously covered, showcasing the depth of control required to optimize the system's performance. Through manual tuning and Python code integration, the project refined the PID constants, KP, KI, and KD, to successfully stabilize the pendulum with minimal oscillation, underscoring the effectiveness of carefully applied control strategies. This demonstration enhanced my understanding of PID controllers in dynamic control systems.

### Video 8

**Title:** “Introduction to PID Control”

**Link:** [https://www.youtube.com/watch?v=\\_VzHpLjKeZ8](https://www.youtube.com/watch?v=_VzHpLjKeZ8)

**Rank: 3**

**Reflection:**

The video provided an insightful primer into the workings of PID control, elucidating the three critical components: Proportional, Integral, and Derivative. It adeptly laid the groundwork for understanding how these elements function to maintain control in complex systems. With a clear explanation of proportional control's immediate yet sometimes insufficient response to system errors and how integral control compensates for steady-state discrepancies, the content was both informative and engaging. The video's use of everyday analogies, likening the proportional element to a spring, the integral to inertia, and the derivative to damping, made the abstract principles of PID control tangible and easier to grasp. The physical demonstrations effectively showcased the nuanced behavior of a Proportional-Integral controller, leading to an understanding of zero steady-state error achievement. The discussion on tuning, highlighting the balance required between the PID elements for system stability, and the suggestion of a more rigorous mathematical approach for optimal tuning, provided a comprehensive view of PID control's complexity and precision. This educational overview not only deepened my theoretical knowledge but also sparked a keen interest in the practical challenges of control system optimization.

## LQR controller videos

### Video 9

**Title:** “What Is Linear Quadratic Regulator (LQR) Optimal Control? | State Space, Part 4”

**Link:** [https://www.youtube.com/watch?v=E\\_RDCFOIJx4](https://www.youtube.com/watch?v=E_RDCFOIJx4)

**Rank:** 7

**Reflection:**

The video provided an incisive comparison between Linear Quadratic Regulator (LQR) and pole placement control strategies, emphasizing LQR's optimization of the gain matrix  $K$  for desired closed-loop behavior versus pole placement's target pole locations. It employed transportation analogies to clarify LQR's cost function, which balances system performance against actuator effort over time, through the strategic weighting in the  $Q$  and  $R$  matrices. The application of MATLAB's LQR command to solve for the optimal  $K$  was illustrated, underscoring the absence of a universal approach to the weightings and the importance of experience and iteration in control system design. The video successfully demystified the adaptive nature of LQR, contrasting with the more rigid pole placement method, and highlighted LQR's practical advantage in intuitively adjusting system performance metrics. This exploration deepened my understanding of the elegance and utility of LQR in achieving efficient and precise control system outcomes.

### Video 10

**Title:** “Introduction to Linear Quadratic Regulator (LQR) Control”

**Link:** <https://www.youtube.com/watch?v=wEevt2a4SKI>

**Rank:** 9

**Reflection:**

The video illustrated the principles of optimization through a daily commute analogy, making the complex topic of control systems relatable and understandable. It introduced concepts like the feasible set and the cost function, drawing parallels between choosing commuting options and designing control systems, such as a linear quadratic regulator (LQR) for satellite orientation. The discussion on the trade-offs between system performance and energy expenditure mirrored everyday decisions, effectively demonstrating optimization's role in both personal and technical scenarios. Delving into the LQR's application, the video explained how  $Q$  and  $R$  matrices are used to fine-tune control systems, addressing real-world engineering challenges like control saturation and state measurement limitations. By translating these advanced concepts into tangible examples, the video provided a clear and comprehensive overview of optimization in control system design, highlighting the LQR's adaptability and the importance of tuning for specific engineering requirements. This engaging approach not only clarified advanced control system concepts but also showcased the omnipresence of optimization in life and technology.