Pre-defined project milestones –

Milestone	Deliverable	Due Date
Software for data communication/debugging	Code, documentation & screenshots	4/16/2021
Bring-up plan (hardware & software)	Written test plan	4/21/2021
Build Mechanism and PCB	Photos of mechanism and PCB	4/26/2021
Test hardware	Results of your tests	4/28/2021
Motor and thrust modeling	Documentation on tests and results	4/30/2021
Dynamics tests (hanging down)	“	5/04/2021
Apply state feedback, “hand placing” poles	Code, documentation & videos	5/12/2021
Place poles using LQR	Documentation & videos	5/17/2021
Full Order Observer	Code, documentation & videos	5/21/2021
Reduced Order Observer	“	5/21/2021
Kalman Full Order Observer	“	5/26/2021
Final Documentation	“	6/02/2021

Plans for completing each milestone –

Software for data communication/debugging:

- See Milestone One submission

Bring-up plan (hardware & software):

- This document
    - Think together on all parts of the project and the processes required to complete the milestones and write them down
    - More information may be added as we learn more about what we need to complete for a given milestone

Build mechanism and PCB:

- Assemble PCB, following the schematic part values
    - Use solder mask to apply solder
    - Place SMD components carefully, making sure they are in the correct spot
    - Solder THT components
    - Test connections, check for shorts
    - Test that the motor control output can be properly enabled and would turn on the motor
- Put together mechanism:
    - Get parts from drone (if not already disassembled), assemble motor arm with the shaft angle encoder (SAE) at the pivot and mount motor at the end of the arm
    - Connect the motor with the propeller, making sure it will spin the correct way to produce upward force

Test hardware:

- Use modified example code to read the SAE angle to see if it is aligned and measuring with appropriate precision.
- Apply proper power to the motor to ensure that it works and that the propeller spins in the right direction

Motor and thrust modelling:

- Write code to control the motor speed by changing the duty cycle
- Use motor thrust measurement device to determine the thrust produced when the motor has been on for a long time
- Get a characterization of the thrust as a function of the duty cycle of turning the motor on and off
- Measure/find/calculate the wind-up and spin-down time of the motor

Dynamics tests (hanging down):

- Test system input by swinging the motor arm slightly from the vertical downward position (with the motor off)
- Calculate (?) the friction force from the SAE
- Measure time to settle after impulse

Apply state feedback:

- After modelling the dynamics and motor characteristics, we can get the state model and then the transfer function (should be similar to that in the homework)
- Solve for the poles of the system and then find zeros that will make our system stable
    - Apply feedback to implement

Place poles using LQR:

- Use linear-quadratic regulator (LQR) to find the control parameters
- Implement these new parameters and/or functions into the system for control
- Test to see how it affects the functionality of the hovering

Full order observer:

- Implement a full order observer for the system (most likely in discrete time)
- Test how the system functions after implementation

Reduced order observer:

- Implement a reduced order observer
- Test how the system responds

Kalman full order observer:

- Implement Kalman full order observer
- Test system response

Final documentation:

- Assemble all test results into project archive
- Report on the ability to control the system based on the control methods used in the different milestones
- Summarize lessons learned and valuable take-aways