A+ v1.28.0 MEC-E5001 Mechatronic Machine Design • 👤 Binh Nguyen 🤊

Course **↑** MEC-E5001 Course materials Your points 2 Lab Queue 🖸

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Exercises round 5

Hint This round is different from other rounds. You will submit only one pdf report that contains solutions for all exercises in this round.

Exercise 1: Revolution speed controller (300 points)

a) Design a revolution speed controller for a variable-inertia load. The nominal inertia of the load is J = 1, but it can vary \pm 50 %.

i. Design the system time constant $\tau = 0.1$ s with nominal inertia. Report the Simulink model and your controller design

b) Analyse the system at the points - 50 %, - 25 %, 0 %, + 25 %, + 50 % of the nominal inertia. Report the step responses for the varying inertia [0.5*J;0.75*J;J;1.25*J;1.5*J]. c) What you need to do in order to have non-varying response?

Watch lectures. We speak quite a bit about speed control. You can run simulations all together by using gain vector in Matlab/Simulink as shown below. Notice "1./" means element-wise division. Block Parameters: Inertia Element-wise gain (y = K.*u) or matrix gain (y = K*u) or y = u*K. Main Signal Attributes Parameter Attributes Multiplication: Element-wise(K.*u) Cancel Help Apply OK

Exercise 2: Revolution speed controller (300 points)

a) Modify the model in Task 1 to represent a position servo control with a constant inertia J = 1. Report the modified model.

b) Design a controller with a short rise time (fast response), report the controller and the ways you can increase rise time.

c) Design a controller with no overshoot, report the controller and the ways you can prevent overshoot.

Exercise 3: Quadcopter control (400 points)

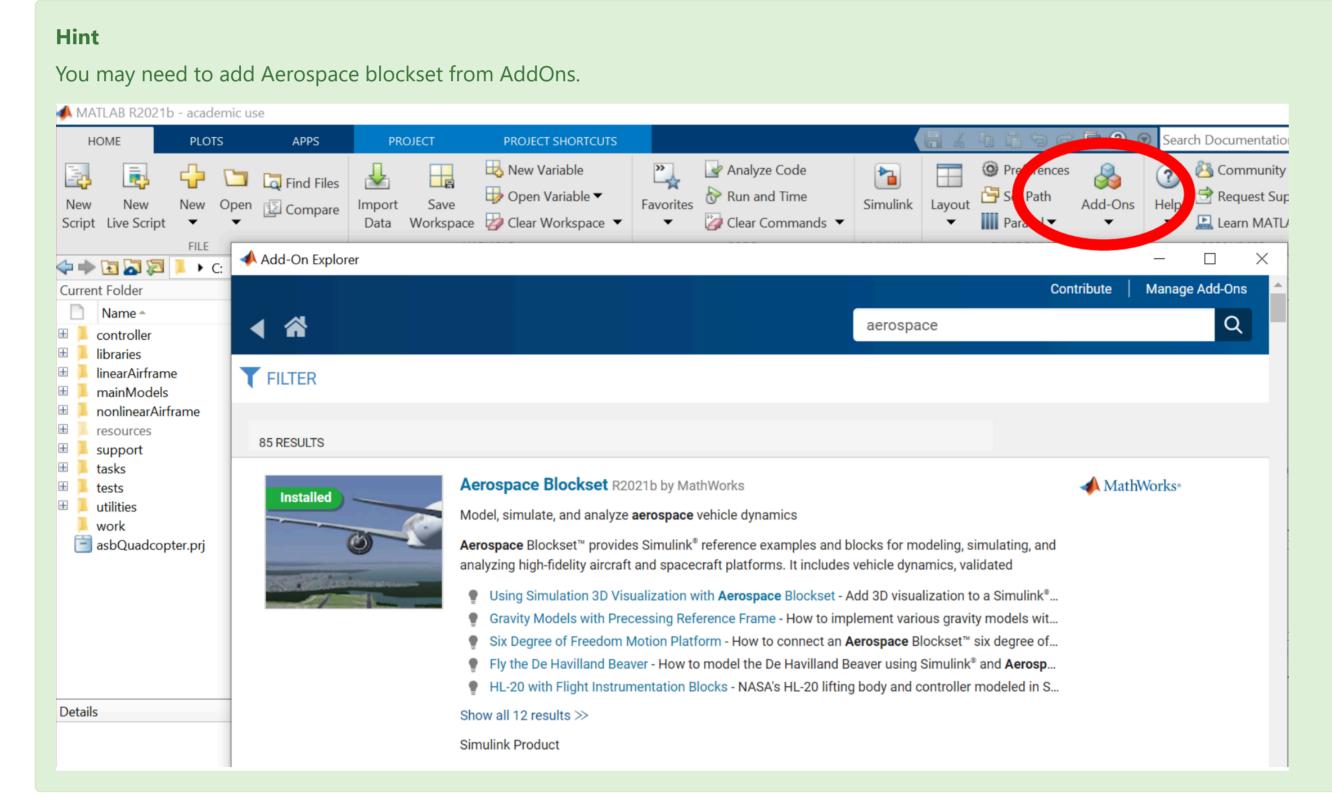
Watch the following videos, Tech Talk on Minidrone by Brian Douglas:

- Part 1: https://se.mathworks.com/videos/drone-simulation-and-control-part-1-setting-up-the-control-problem-1539323440930.html
- Part 2: https://se.mathworks.com/videos/drone-simulation-and-control-part-2-how-do-you-get-a-drone-to-hover--1539323448303.html
- Part 3: https://se.mathworks.com/videos/drone-simulation-and-control-part-3-how-to-build-the-flight-code-1539323453258.html • Part 4: https://se.mathworks.com/videos/drone-simulation-and-control-part-4-how-to-build-a-model-for-simulation-1539585112546.html
- Part 5: https://se.mathworks.com/videos/drone-simulation-and-control-part-5-tuning-the-pid-controller-1540450868204.html

Hint

openExample('aeroblks_quad/QuadcopterProjectExample') openProject('asbQuadcopter');

c) According to the videos: what you need to remember wear when testing the drone in practice?



a) Generate a Simulink model on a simplified system. You can omit all the other degrees-offreedom, but develop vertical controller for hovering the drone at 1 m height. Examine carefully the picture below. Essentially, you need to develop speed controller for four thruster units. The vertical thrust is generated by four thrusters each 0.2 N/1000 rpm. The drone mass is 1.0 kg. The default parameters in block 6DOF (Euler angles) were used. Report the Simulink model including the controller and model.

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b) Run a step response where position command rises from zero to 1 m at the time of 1 s. Simulate from 0 s to 10 s. Report the step response and final value of rpm command.

Hint Use 6DOF Euler Angles and visualization (Simulation 3D UAV Vehicle) blocks as below. Block Parameters: 6DOF (Euler Angles) 6DOF EoM (Body Axis) (mask) (link) Integrate the six-degrees-of-freedom equations of motion in body axis. **Parameters** State Attributes **⊑**◀ Units: Metric (MKS) Mass type: Fixed Simulation 3D Scene Configuration Sample time 0.1 sec Step to 9.81N @ 1 sec Representation: Euler Angles Initial position in inertial axes [Xe,Ye,Ze]: V_e (m/s) →= [0 0 0] Initial velocity in body axes [U,v,w]: φθψ (rad) [0 0 0] Initial Euler orientation [roll, pitch, yaw]: ω_k (rad/s) [0 0 0] Initial body rotation rates [p,q,r]: [0 0 0] Initial mass: 1.0

Return pdf report of your solutions below.

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« 5.2 Lecture Quiz 5