Indian Institute of Technology, Kanpur.

Even semester, 2020 - 2021.

AE 630 Autonomous Unmanned Aerial Systems

Assignment 3

(Deadline - April 12th)   **Answer all questions**   **Marks - 90**

1. Derive the flight dynamics model of a VTOL vehicle following the steps given.
   - (a) Derive the rigid-body dynamics.   **(10 marks)**
   - (b) Derive the rotor aerodynamics (forces and moments).   **(5 marks)**
   - (c) Derive the wing aerodynamics (forces and moments).   **(5 marks)**
   - (d) Express all forces and moments in the body frame.   **(5 marks)**

        (25marks)

2. How do you define stability? Differentiate static and dynamic stability?   (**8 marks**)
   Comment on the stability of the following systems. (Derive equations if required.)
   - (a) $\dot{x} = ax$.   **(2 marks)**
   - (b) $\dot{X} = AX$.   **(4 marks)**
   - (c) A simple pendulum.   **(6 marks)**
   - (d) Pitch dynamics of fixed-wing UAV.   **(10 marks)**
   - (e) Attitude dynamics of quadcopter.   **(10 marks)**

        (40 marks)

3. Find and list five kinds of VTOL vehicles based on quadcopter. Please explain their advantages and disadvantages. Also, explain their operation and control mechanisms. (Hint: Quad-plane, Bi-plane quadcopter)

        (25 marks)