University of California, Davis

Dept. of Mechanical and Aerospace Engineering

MAE 275

Homework Assignment 3

Due: Thursday, April 30

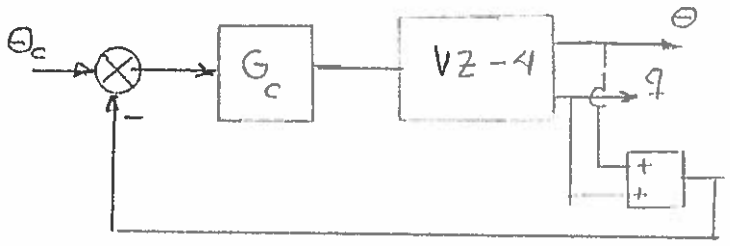
Consider the VZ-4 "Doak" vehicle in the hover flight condition given in Appendix A of the reader. Concentrate on the longitudinal motion.

1.) Determine the open-loop eigenvalues. How many modes of motion are there?

2.) Using MATLAB, determine the following transfer functions: $\frac{\theta}{\delta e}(s)$ and $\frac{q}{\delta e}(s)$

Note that, in hover, the action of the "elevator" is replaced by the force generated by the rear thrustor.

3.) Assume that an attitude gyro and a rate gyro are available to measure θ(t) + q(t). The control system below is to be designed and simulated, with the determination of G_c as the design objective.

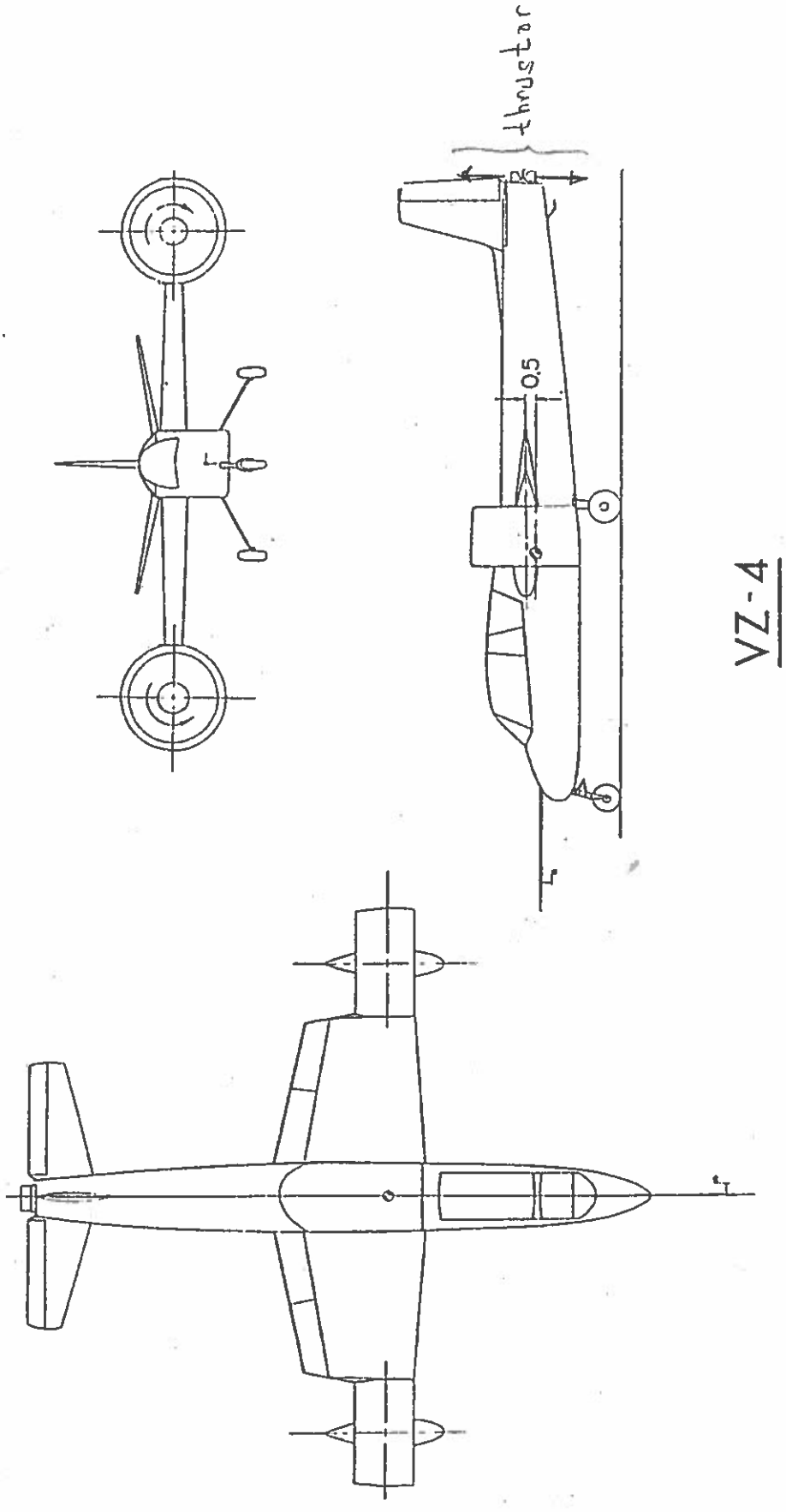


a.) Using loop-shaping principles, determine G_c such that:
- i.) The closed-loop system is stable
- ii.) The G_c has more poles than zeros.
- iii.) The closed-loop bandwidth (-3 dB criterion) is at least 5 rad/sec
- iv.) The gain and phase margins are at least 6 dB and 40 deg. Sketch the Nyquist diagram and show these margins (which can be determined form the open-loop Bode diagram).
- v.) There is zero stead-state error to a step input θ_c

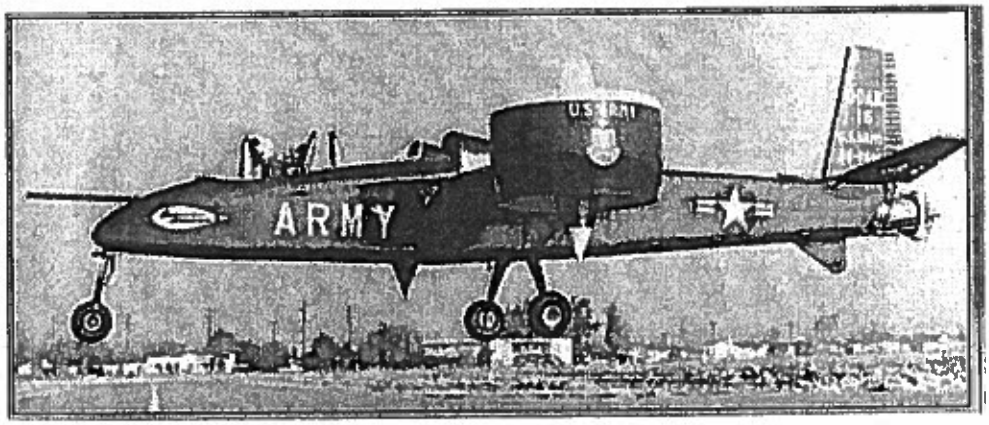
4.) Create a Simulink simulation of your system and demonstrate the pitch attitude response to a pitch attitude command of 5 deg (5/57.3 rad). Filter your step command with a filter given by 10^2/(s^2+20s +10^2). Note that the pitch attitude command can be considered as coming from the pilot's control stick.

Your solution should include

1.) the A, B, C, D matrices of the vehicle with no feedback.
2.) Open-loop eigenvalues and determination of number of modes
3.) Appropriate open and closed-loop Bode plots with the compensated open-loop Bode diagram showing the gain and phase margins
4.) Nyquist plot sketch indicating the gain and phase margins
5.) G_c
6.) Simulink diagram
7.) Step response



VZ-4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