8.30. For the longitudinal dynamics of a flexible bomber described in Example 4.7, design a full-state feedback, digital optimal regulator with z.o.h and a sampling interval of $T = 0.1$ second, which would produce a maximum overshoot of less than ± 2 m/s^2 in the normal-acceleration, $y_1(t)$, and of less than ± 0.03 rad/s in pitch-rate, $y_2(t)$, and a settling time less than 5 s, while requiring elevator and canard deflections *not exceeding* ± 0.1 rad. (5.73°), if the initial condition is 0.1 rad/s perturbation in the pitch-rate, i.e. $\mathbf{x}(0) = [0; 0.1; 0; 0; 0; 0]^T$.

8.31. For the flexible bomber airplane of Exercise 8.30, design a digital Kalman filter based on the measurement of only the normal acceleration, $y_1(t)$, and combine it with the digital optimal regulator designed in Exercise 8.30 to form a digital optimal compensator such that the closed-loop performance requirements of Exercise 8.30 are met. Simulate the response of the digital closed-loop system to a measurement noise in both the output channels, using SIMULINK with *band-limited white noise* of power 10^{-8}.

8.32. For the digital optimal compensator designed in Exercise 8.31, compare the digital singular values of the return ratio matrix at the plant's input with those of the full-state feedback system of Exercise 8.30. How robust is the digital compensator?

8.33. Re-design the digital Kalman filter in Exercise 8.31 such that the loop-transfer recovery at the plant's input occurs in the frequency range 1–100 rad/s.

8.34. Design a digital optimal tracking system for the tank-gun turret described in Exercise 6.11 with z.o.h, a sampling interval of $T = 0.2$ second, and full-state feedback for achieving a constant desired state $\mathbf{x}_\mathbf{d}^\mathbf{c} = [1.57; 0; 0; 0; 0.5; 0; 0; 0]^T$, in less than seven seconds, if the initial condition is zero, i.e. $\mathbf{x}(0) = \mathbf{0}$, with the control inputs not exceeding five units.

8.35. Write a MATLAB computer program – a digital equivalent of *tpbvlti.m* – for solving the two-point boundary value problem for the terminal-time weighted digital optimal control.

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