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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent Institution of MAHE, Manipal)

I SEMESTER M.TECH (ESM / PED)
END SEMESTER EXAMINATIONS, NOVEMBER 2018
SUBJECT: CONTROL SYSTEM DESIGN [ELE 5101]

REVISED CREDIT SYSTEM

Time*: 3 *Hours **20 *November* 2018** ***Max. Marks*: 50**

***Instructions to Candidates*:**

- *Answer **ALL** the questions.*
- *Missing data may be suitably assumed.*
- Use of MATLAB is permitted

1A. Design lag –lead compensation using Root locus method for the antenna azimuth position control system with feed forward transfer function, $G(s) = \dfrac{6K}{s(s+1.8)(s+100)}$ to satisfy the following specifications.

- 16% Overshoot
- 2sec settling time
- $K_V = 20$

Tabulate the important points of each stage of design. ***(08)***

1B. Explain with neat figures the condition of i) boundedness ii) asymptotically with respect to Lyapunov stability. ***(02)***

2A. A boost converter is represented by the following state model

$$\begin{bmatrix} \dot{i}_L \\ \dot{v}_C \end{bmatrix} = \begin{bmatrix} 0 & -83.33 \\ 500 & -10 \end{bmatrix} x + \begin{bmatrix} 166.67 \\ 0 \end{bmatrix} E_s \quad y = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} i_L \\ v_C \end{bmatrix}$$

i_L be the current through the inductor, E_S be the dc input voltage and u_c the capacitor voltage which is the converter output i) design a state feedback controller to obtain 20% overshoot and a settling time of 0.5second ii) design an observer that should have time constant 10 times smaller than the system with controller iii) design an integrator and state feedback controller combination iv) plot the estimated states i_L and u_c. ***(08)***

2B. What is meant by state controllability and observability? ***(02)***

3A. The Nikon camera uses CCD automatic focusing system represented by a negative unity feedback system with feed forward transfer function $G(s) = \dfrac{100K}{s(s+36)(s+100)}$,

i) design a Lead compensator using frequency domain methods to satisfy the following specifications of 20% OS , $K_V = 40$ with a peak time of 0.1 seconds

ii) obtain passive circuit realization for the compensator

iii) compare the uncompensated and compensated system time domain & frequency domain specifications. ***(06)***

3B. Derive the mapping of constant ζ lines from s plane to z plane. ***(02)***

3C. Explain model reference predictive control with a neat block diagram and relevant equations. ***(02)***

4A. The digital controlled process of a unity feedback control system is described by the transfer function $G_H(z) = \frac{k(z+0.5)}{(z-1)(z-0.5)}$. Design a Cascade Phase– Lag Controller with the transfer function $G_c(z) = \frac{kc(z-z1)}{(z-p1)}$, so that the following design specifications are satisfied. Ramp error constant is 6, z-domain dominant poles Z = 0.71± j0.19, Max over shoot < 15%. ***(06)***

4B. Investigate the stability of the following system using Lyapunov stability analysis.

$$\dot{x}_1 = -x_1^3 + x_2$$
$$\dot{x}_2 = -ax_1 - bx_2;\; a > 0, b > 0$$

(02)

4C. Describe Kalman filter with relevant equations block diagram. ***(02)***

5A. For the system given in Fig.Q5A, predict the possibility of a limit cycle. If it exists determine the amplitude and frequency. Also investigate the stability of the limit cycle.

The describing function for the non-linear element is $G_N = \frac{K[\pi-2\beta-sin2\beta]}{\pi}$ for M ≥ 1 with input $m(t) = M\sin\omega t$.

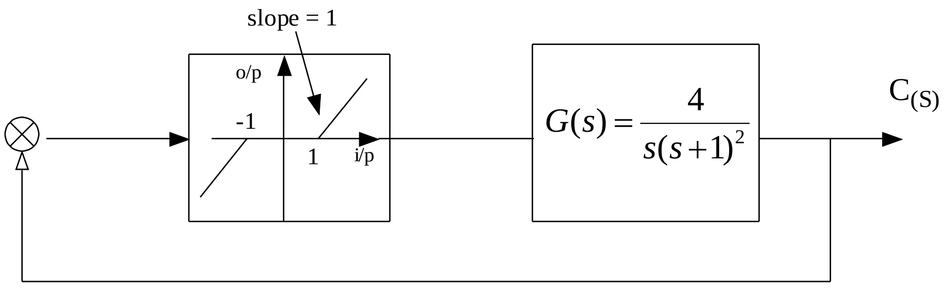

Fig.Q5A ***(06)***

5B. For the negative unity feedback system with plant transfer function $G(s) = \dfrac{4}{s^3 + 6s^2 + 8s + 4}$, design a PID Controller and obtain the range of controller parameters such that the closed loop system have overshoot between 15% and 10% and the resulting settling time will be less than 3 sec. ***(04)***