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

FIRST SEMESTER M.TECH. (AEROSPACE ENGG.)

END SEMESTER DEGREE EXAMINATIONS, NOVEMBER - 2019

SUBJECT: CONTROL SYSTEM DESIGN [ICE 5172]

TIME: 3 HOURS MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A. Write the steps with formula for designing PI controller by ultimate gain method.

1B. Transform the state model into transfer function form if

$$A=\begin{bmatrix}2 & 0 & 2\\ 1 & 3 & 1\\ 1 & 0 & 2\end{bmatrix},\quad B=\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}\quad C=\begin{bmatrix}1 & 0 & 1\end{bmatrix}\quad D=1$$

1C. Design a lag compensator for the system using time domain approach $G(s)=\dfrac{K}{s(s+1)}$ to satisfy the design specification overshoot 15%, ramp error gain 20. Also plot the root locus after compensation.

(2+3+5)

2A. For standard second order system if OS=15% calculate required Phase margin.

2B. Plot bode diagrams for $G(s)=\dfrac{10}{s(s+1)}$. Also comment on closed loop stability of the system.

2C. Plot root locus and comment on closed loop stability of $G(s)=\dfrac{K}{s(s+1)(s+2)}$.

(2+3+5)

3A. Obtain the dominant pole locations of a standard second order closed system, if OS=5%, settling time is 1 s.

3B. Derive state model for $\dfrac{Y(s)}{U(s)}=\dfrac{s+3}{s^3+9s^2+24s+20}$ in controllable canonical form.

3C. For the electrical system shown in Fig. Q3C select minimal state variables and find the state model in physical variable form. Take $V_o(t)$ as the output.

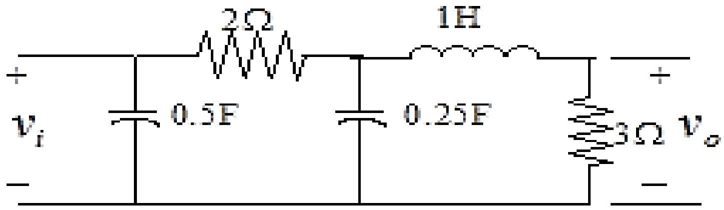

Fig. Q3C

(2+3+5)

4A. Obtain state model of the system

$G(s) = \frac{10}{s^2}$; $H(s) = \frac{10}{s}$ by cascade decomposition, where G(s) is system transfer function and H(s) feedback transfer function.

4B. Find the complete solution for the state equation for

$\dot{x} = 8x + 2u$; $y = x + u$.

with ramp input and initial state x(0) =1.

4C. Derive the observable canonical form. Draw the state diagram.

$$\frac{Y(s)}{U(s)} = \frac{s^2 + 6s + 8}{s^3 + 9s^2 + 20s + 13}$$

(2+3+5)

5A. Check for complete state controllability by diagonalisation technique,

$\dot{x} = \begin{bmatrix} 0 & 2 \\ -2 & -4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u;\ y = [1 \quad 0]x$;

5B. Design full order state observer based state feedback control law using Ackermann's formula if the desired poles are at double the original pole locations.

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -8 & -6 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t) \quad + y = [1 \quad 0]x$$

(3+7)

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