M.E. ELECTRONICS & TELECOMMUNICATION ENGINEERING

FIRST YEAR FIRST SEMESTER. EXAM. - 2018

NONLINEAR CONTROL SYSTEM (CON)

Ref. No.:EX/PG/ETCE/T/113C/2018

Time: 3 Hours | Answer Q.1 & any *Four* from the rest | Full Marks:100

1. Indicate True(T)/ False (F) : 10x2

i. A limit-cycle phase-isocline represents a stable system
ii. Integral controller improves system stability
iii. A 2^{nd}.-Order system is unstable if its S-matrix is nonsingular
iv. Eigen values of a state-defined system are essentially the poles of system
v. State-space representation & choice of states for control system is unique
vi. The Describing Function (DF) method uses a time-domain approach
vii. The controller in a servomechanism is basically a Synchro element
viii. An all-pole system is stable if its phase-Lag $\theta = 210^{o}$ at gain cross-over frequency
ix Proportional Band is defined as equal to 100 x$\sqrt{}$(proportional gain value)
x. Ziegler recommendations on PID-controller tuning lead to (1/4) amplitude decay ratio for the closed loop response

2. (a) Define State Variable (SV); Show how the *n*-th. Order system is formulated by SV
(b) Deduce the SV formulation of an all-pole system with 3^{rd} order Butterworth transfer Function 10+10

3. (a) What is Canonic Variable (CV)
(b) Derive the CV-representation of a system transfer G(s) = (s+4)/{(s+1)(s+2} 10+10

4. (a) Define the features of PID controller 8+12
(b) A unity feedback system is given by H(s) = 20/{(s+1)(10s+1(20s+1)}
Using a Bode-plot, obtain the parameter settings of a PID controller as per Ziegler

5. Given for a system 10+10

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

(a) Determine the Transfer Function
(b) Find the State Transition Matrix (STM)

6. A feedback control system has a nonlinear element as $y = \pm$ sgn. e(t) connected to a linear block with denominator $D(t) = D^2 + D + 1$ and numerator = 1. Draw the phase plane trajectory assuming $de(0)/dt = e(0) = 1$. Comment on System stability by the method of Isocline assuming unit-step input. 20

7. (a) Define Describing Function (DF) 8+12
   (b) A relay with dead-zone element is cascaded to a linear system H(s) in closed loop. Given E=2, D=1.5 and T_m=1 for the nonlinear block, with $H(s) = 10/ \{s(s+1)(s+3)\}$. Determine the stability condition of the system using DF

8. Write Short Notes (Any Two) : 10x2

   (a) Controllability & Observability
   (b) Phase Variable
   (c) Charecteristics of Servomechanism
   (d) Lyapunov Stabilty conditions

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