FIRST SEMESTER M.TECH (POWER ELECTRONICS & DRIVES)
END SEMESTER ON-LINE PROCTORED EXAMINATIONS
FEBRUARY 2022
DESIGN OF CONTROL SYSTEMS [ELE 5152]
REVISED CREDIT SYSTEM

Time: 75 Minutes + 10 Minutes **Date: 11 February 2022** **Max. Marks: 20**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Time: 75 minutes for writing + 10 minutes for uploading.

1A. Design zero of the PD controller so that a unity feedback system with open loop transfer function $G(s) = \frac{20}{s(s+2)(s+4)}$ will have the damping ratio of 0.8 and natural frequency of oscillation 2 rad/sec.

How is the design point put on the root locus, in the design of the PD controller? ***(05)***

1B. For the linear time invariant system represented by the state equation $\dot{x} = \begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix} x$, assess the stability of the equilibrium point using Lyapunov stability criterion. Find the corresponding Lyapunov function. Write the mathematical description of asymptotically stable. ***(03)***

1C. Obtain the state space model in controllable & observable canonical form for the transfer function $G(s) = \frac{2s+1}{s^2+7s+9}$ ***(02)***

2A. Design a linear state feedback controller that places the system poles at $s = -2 \pm j4 \; and \; s = -10$

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -5 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \qquad y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

Mathematically derive the design methodology of state feedback controller with integrator, including compensated and uncompensated system. ***(05)***

2B. Check the controllability and observability of the following system

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

Justify your answer with the help of a state diagram. ***(03)***

2C. Explain with suitable examples the validity of second order approximation ***(02)***