Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent Institution of MAHE, Manipal)

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING) GRADE IMPROVEMENT EXAMINATIONS, JAN 2021

SUBJECT: CONTROL SYSTEMS DESIGN [ELE 4013]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 07 January 2021** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. For the unity feedback system with $G(s) = \frac{6}{(s+2)(s+1)(s+3)}$, design a stable PID controllers using Zeigler Nichols tuning method. **(05)**

1B Write the procedure for the design of PI controller using root locus method. Draw a circuit for realizing the PI controller. **(05)**

2A. Write the procedure for the design a lead compensator using frequency domain methods **(05)**

2B. For the system $\dot{x} = \begin{bmatrix} -3 & -1 \\ -2 & -2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$, Check the controllability and observability
Explain the significance of state Controllability
in design. **(05)**

3A. A linear continuous time system is represented by the state model
$\dot{x} = \begin{bmatrix} -2 & 1 \\ 0 & -3 \end{bmatrix} x + \begin{bmatrix} 3 \\ 2 \end{bmatrix} u, y = [2 \quad 3]x$, Design a state feedback controller to yield a peak overshoot of 17% and settling time less than 1 sec. Use coefficient matching or Ackerman's formula. ***(05)***

3B. A linear continuous time system is represented by the state model
$\dot{x} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u, y = [1 \quad 0]x$, The unit response of the plant has to have a peak overshoot of 21% and a settling time of 2 sec. Design an observer which is 10 times faster than the plant response. Use coefficient matching or Ackerman's formula. ***(05)***

4A. 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. What is meant by boundedness and asymptotically with respect to Lyapunov stability? ***(05)***

4B. Explain with a neat block diagram and relevant equations i) model reference control system ii) adaptive control scheme using MIT rule and Lyapunov rule. ***(05)***

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.

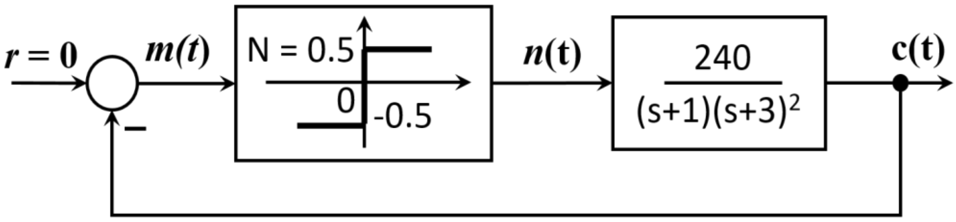

Fig.Q5A

(05)

5B. Design an optimal feedback control law that minimizes the performance measure using reduced matrix Riccati equation

$J = \frac{1}{2}\int_0^\infty 2x_1^2 + 2u^2)dt,$ for the system described by

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \quad x(0) = [1 \quad 0]^T$$

(05)