Reg. No.										

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

IV SEMESTER B.TECH. (AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL/MAY 2018

SUBJECT: LINEAR CONTROL THEORY [AAE 2204]

REVISED CREDIT SYSTEM
(27/04/2018)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. The transfer function of a system is given below. Sketch the bode plot, find gain margin, phase margin and comment on the stability of the system. **(07)**

$$G(s) = \frac{23.7(1 + j\omega)(1 + 0.2j\omega)}{(j\omega)(1 + 3j\omega)(1 + 0.5j\omega)(1 + 0.1j\omega)}$$

1B. The characteristic equation of certain feedback control system is given below, determine the range of value of K for the system to be stable. **(02)**

$$s^4 + 4s^3 + 13s^2 + 36s + K = 0$$

1C. A thermometer requires 1 minute to indicate 98% of the response to a step input. Assuming the thermometer to be a first order system, find the time constant. **(01)**

2A. Find the transfer function $\frac{C(s)}{R(s)}$ of the signal flow graph shown in figure 1 using the mason's gain formula. **(05)**

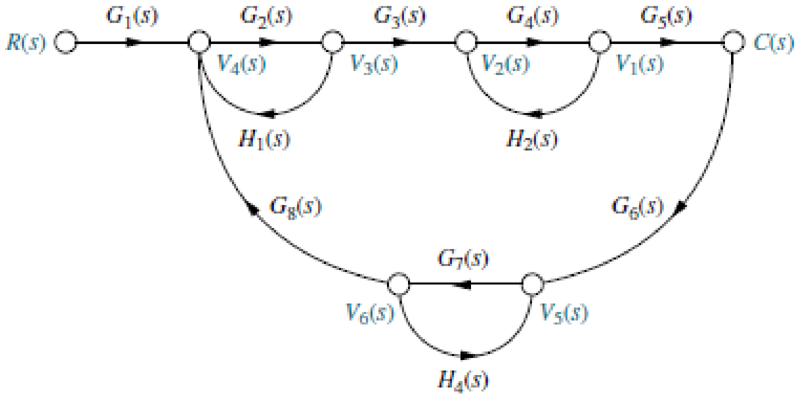

Figure. 1

2B. Consider a unity feedback control system with the closed loop transfer function as: **(03)**

$$\frac{c(s)}{R(s)} = \frac{Ks + b}{s^2 + as + b}$$

Determine the open loop transfer function. Show that steady state error in unit ramp input response is given by

$$e_{ss} = \frac{a - K}{b}$$

2C. Determine the position, velocity and acceleration error constants for a unity feedback control system whose transfer function is given as: **(02)**

$$G(s) = \frac{K}{s(s+4)(s+10)}$$

If $K = 400$, determine the steady state error for a unit ramp input.

3A. A system has a transfer function given below. Sketch the polar plot of the frequency response and comment on stability of the system. **(05)**

$$G(s) = \frac{(s+3)(s+5)}{s(s+2)(s+4)}$$

3B. For the system of figure 2, find the values of K_1 and K_2 to yield a peak time of 1.5 second and a settling time of 3.2 seconds for the closed-loop system's step response. **(03)**

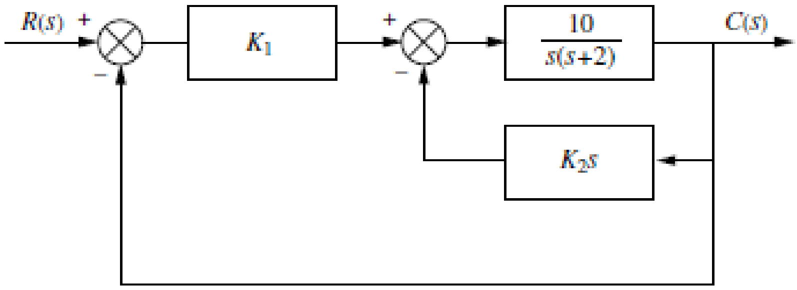

Figure. 2

3C. The open loop transfer function of a control system is **(02)**

$$G(s)H(s) = \frac{K(s+2)}{s(s+3)(s+5)}$$

If $K = 8$, check all the roots of the characteristic equation of the system to obtain damping factor greater than 0.5.

4A. Simplify the block diagram shown in figure 3 using block diagram reduction technique and obtain the closed-loop transfer function $\frac{C(s)}{R(s)}$. **(05)**

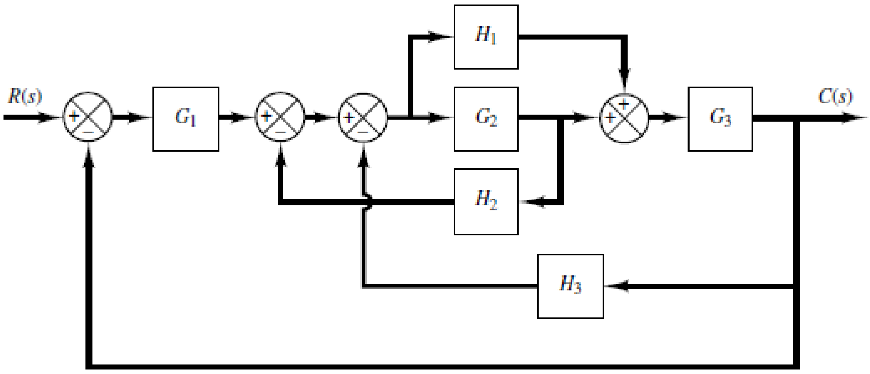

Figure. 3

4B. Find the transfer function $\frac{X_2(s)}{F(s)}$ of the mechanical system shown below in figure 4. The mass attached is $10\ kg$. **(03)**

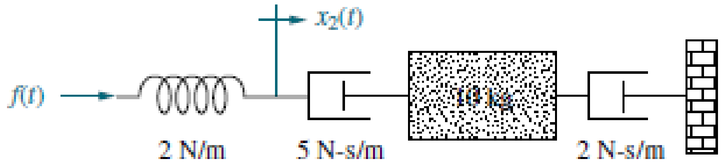

Figure. 4

4C. Find the time domain specifications (rise time, peak time, peak overshoot and settling time) for a unity feedback control system whose transfer function is given as: **(02)**

$$G(s) = \frac{25}{s(s+6)}$$

5A. Plot the root locii for the closed loop control system with transfer function as **(07)**

$$G(s) = \frac{K}{s(s+1)(s^2+4s+5)}, H(s) = 1$$

5B. Draw the polar plots of functions $\frac{1}{s}$ and $\frac{1}{s^2}$. **(02)**

5C. For a RLC circuit with $E = 6V$, $R = 1\Omega$, $L = 10mH$ and $C = 0.01\mu F$ as shown in figure 5, determine the undamped natural frequency and damping ratio of the circuit. Assume initial conditions are zero. **(01)**

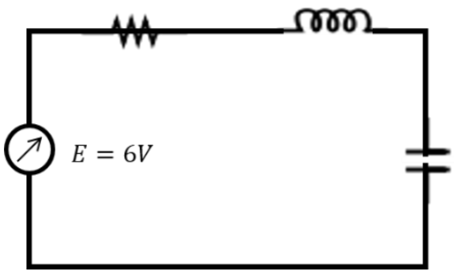

Figure 5