Reg. No.

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: CONTROL SYSTEMS DESIGN [AAE-303]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

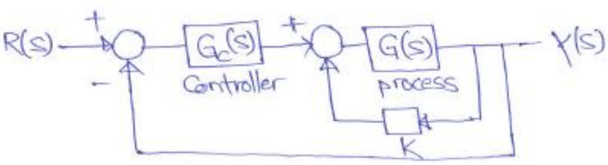
Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A. An automobile driver uses a control system to maintain the speed of the car at a prescribed level. Sketch a block diagram to illustrate this feedback system (02)

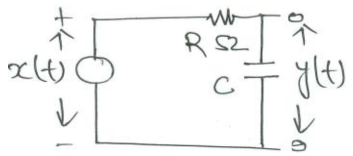
1B. Derive the transfer function of DC Motor. (03)

1C. Determine an internal controller $G_c(s)$ for the system shown in figure below. It is desired that the steady-state error to a ramp be zero and that settling time (2% criterion) of the ramp response be less than 8 seconds. Where, process is $1/(s+5)(s+7)$. Also find the suitable K. (05)

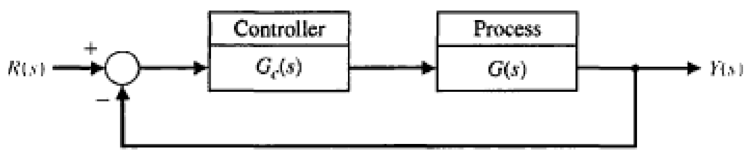


2A. Sketch the signal $x(t)=5r(t)u(-t)+\sin(-t)u(-t+5)$, r(t) ramp input. (02)

2B. Find the response of the circuit to the input $x(t)=r(t)-2r(t-1)+r(t-2)$ (03)

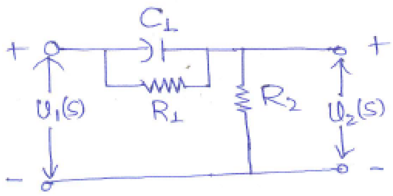


2C. Design a root locus system and analyze the stability of a system as given below (05)



Where, $G_C(s)=K_P+K_Ds+K_I/s$ and $G(s)=1/(s+5)(s+6)$.

3A. Model the following system given below (02)



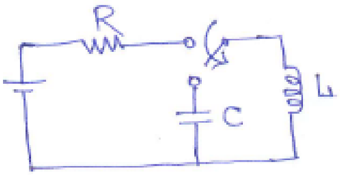
3B. Sketch the signal flow graph of series RLC circuit and derive its transfer function using Mason's gain formula. (03)

3C. Explain the bode plot of a system given as below: (05)

$$G(j\omega)=\frac{K_b\prod_{i=1}^{Q}(1+j\omega\tau_i)}{(j\omega)^N\prod_{m=1}^{M}(1+j\omega\tau_m)\prod_{k=1}^{R}[(1+(2\varsigma_k/\omega_{nk})/j\omega+(j\omega/\omega_{nk})^2)]}.$$

4A. Derive the Laplace transform of integration of a system $L[\int_{-\infty}^{t}x(\tau)d\tau]$. (02)

4B. In the circuit shown the switch is at position for a very long time and at t=0, the switch moved to position 2. Solve for current $i(t)$, for $t\geq 0$ using Laplace transform. (03)



4C. Derive the transient response of mass-spring-damper system in underdamped case and find the %Overshoot, settling time, rise time and peak time. (05)

5A. Analyze stability of a system given below for non-negative values of K. (02)

$$\frac{d^3y(t)}{dt^3}+K\frac{d^2y(t)}{dt^2}+5\frac{dy(t)}{dt}+6y(t)=\frac{dx(t)}{dt}+4x(t)$$

5B. Explain the frequency response of mass-spring-damper system. (03)

5C. State Space representation of a system is given below, (05)

$$\dot{x}=\begin{bmatrix}0&1&0\\0&-2&1\\0&-8&-5\end{bmatrix}x+\begin{bmatrix}0\\0\\K\end{bmatrix}u$$

$$y=[1\quad 0\quad 0]x+[0]u$$

Design a state feedback controller which suits the following design parameters (i) Settling time (2% criterion) less than 5 sec and (ii) overshoot 12%.

6A. A hovering vehicle control systems is represented by following equation, (02)

$$\dot{x}_1=6x_2 \text{ and } \dot{x}_2=-x_1-5x_2.$$

Find the state transition matrix and roots of characteristics equation.

6B. Consider the third-order system (03)

$$\dot{x}=\begin{bmatrix}0&1&0\\0&0&1\\-10&-8&-5\end{bmatrix}x+\begin{bmatrix}0\\0\\2\end{bmatrix}u$$

$$y=[3\quad -5\quad 0]x+[0]u$$

Verify that the system is observable. If so, determine the observer gain matrix required to place the observer poles at (-1 ± *j2)* and -5.

6C. An *RL* circuit is shown in Figure (05)

(a) Select the two stable variables and obtain the vector differential Equation, where the output is $v_0(t)$

(b) Determine whether the state variables are observable when $R_1/L_1=R_2/L_2$

(c) Find the conditions when the system has two equal roots.