DBJ-003-1275001 Seat No. ______

M. Sc. (ECI) (Sem. V) (CBCS) (W.E.F. 2016) Examination

June - 2022

Basic Concepts of Control Systems : Paper - XVII

(New Course)

Faculty Code : 003
Subject Code : 1275001

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

Instruction : Attempt any 5 of the following questions. (Each question carries 14 marks.

1 Answer the following questions in brief.

(1) Give one example each of first and second order systems.

(2) What is Laplace Transform?

(3) How is closed loop system better than open loop system?

(4) With the help of initial value theorem find value of $F(s) = \frac{1}{s+6}$ at time $t = 0$.

(5) What is two-position control? Explain.

(6) Define state equation?

(7) Define steady state response.

2 Answer the following questions in brief :

(1) What is a transfer function?

(2) Define a linear time-invariant system?

(3) What are the limitations of an open loop control system?

(4) Define controlled variable?

(5) What is a mathematical model?

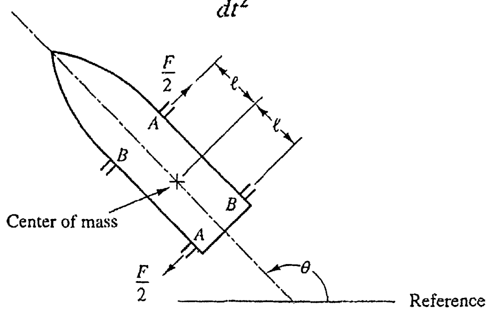
(6) Enlist the types of control action.

(7) Define disturbance.

3 Answer the following questions :

(1) Consider the satellite attitude control system shown in Figure below. The diagram shows the control of only the yaw angle θ. Small jets apply reaction forces to rotate the satellite body into the desired altitude. The two skew symmetrically placed jets denoted by A or B operate in pairs. Assume that each jet thrust is $F/2$ and a torque $T = F \cdot l$ is applied to the system. The jets are applied for a certain time duration and thus the torque can be written as $T(t)$. The moment of inertia about the axis of rotation at the centre of mass is *J*. Obtain the transfer function of this system by assuming that torque $T(t)$ is the input, and the angular displacement $\theta(t)$ of the satellite is the output.

$$J\frac{d^2\theta}{dt^2} = T$$



(2) Describe in brief unit-step, unit-ramp and unit-impulse functions. Derive Laplace transforms of each.

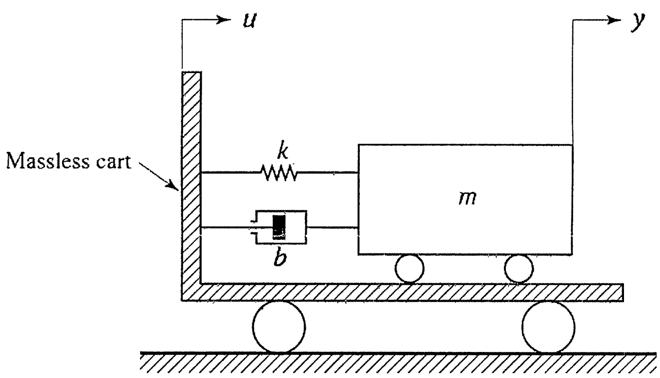
4 Answer the following questions :

(1) State and prove real differentiation theorem.

(2) Mention and explain all rules to manipulate block-diagrams.

5 Answer the following questions :

(1) Derive state-space equation for a spring-mass-dashpot system shown in figure below.

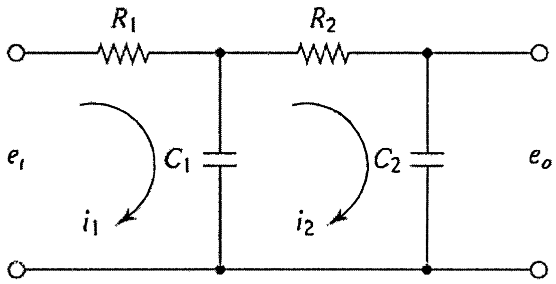


(2) Derive the ramp response of a first order system.

6 Answer the following questions :

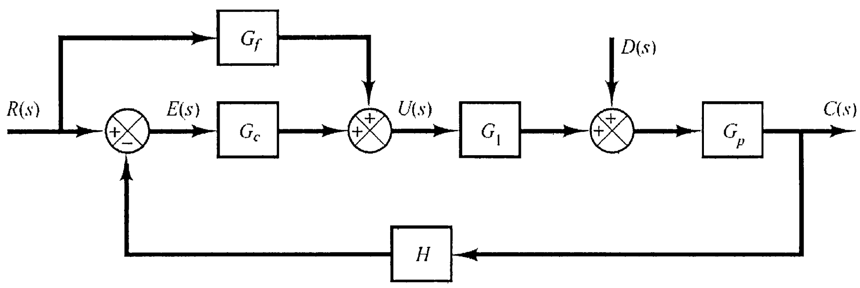
(1) Define pulse and impulse functions. Also derive Laplace transform for both.

(2) With the help of necessary equations derive the transfer function of cascaded RC circuit shown here.



7 Answer the following questions :

(1) Derive $\frac{C(s)}{R(s)}$ and $\frac{C(s)}{D(s)}$ from the block diagram shown below.

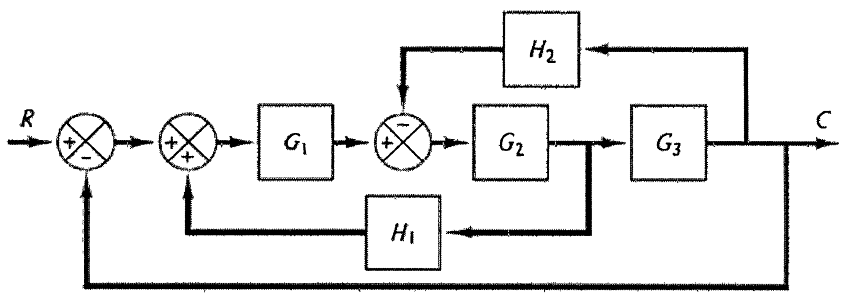


(2) Derive the inverse Laplace of Laplace function

$$F(s) = \frac{5(s+2)}{s^2(s+1)(s+3)}.$$

8 Answer the following questions :

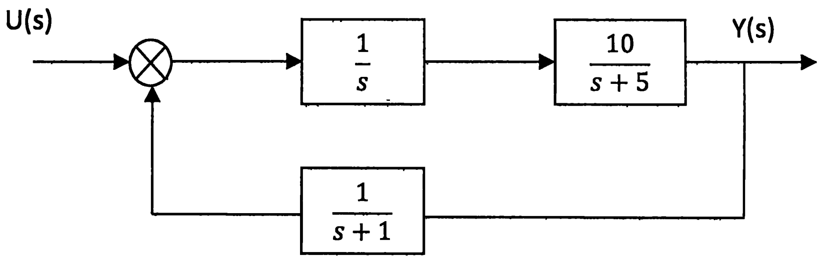
(1) Reduce the block diagram to minimum.



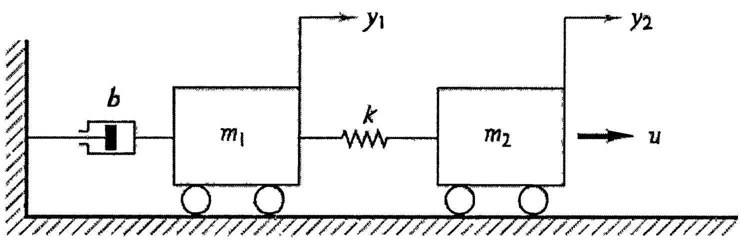
(2) Define delay time, rise time, peak time, maximum overshoot and settling time for a transient response with necessary diagram.

9 Answer the following questions :

(1) Derive state space representation for the system in the block diagram.

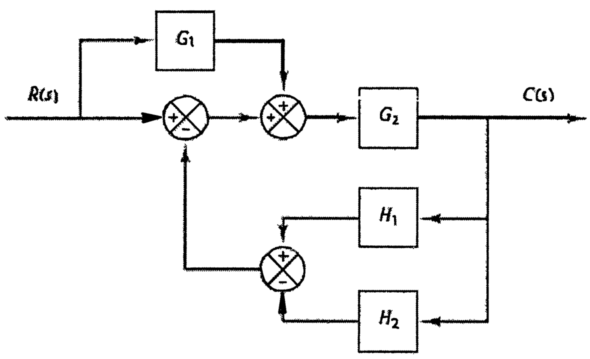


(2) Obtain state-space equation of the mechanical system shown below.



10 Answer the following questions :

(1) Reduce the following block diagram.



(2) Derive the solution of following differential equation.

$2x'' + 7x' + 3x = 0$, where $x(0) = 3$ and $x'(0) = 0$.