PROCESS CONTROL B-Tech 7th Semester
TARGET SYLLABUS/CONTENTS and ASSIGNMENT UP TO MINOR 1st

Reference Book: **PROCESS SYSTEMS ANALYSIS AND CONTROL**
By Donald R. Coughanowr and Koppel (McGrawHill Publishers)

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Assignment

. Find $x(s)$ for the following differential equations.

(a) $\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 3x = u(t) \quad x(0) = x'(0) = 0$

(b) $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + x = u(t) \quad x(0) = x'(0) = 1$

(c) $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + x = u(t) \quad x(0) = x'(0) = 0$

Solve the following by using Laplace transforms.

(a) $\frac{d^2x}{dt^2} + \frac{dx}{dt} + x = 1 \qquad x(0) = x'(0) = 0$

(b) $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + x = 1 \qquad x(0) = x'(0) = 0$

(c) $\frac{d^2x}{dt^2} + 3\frac{dx}{dt} + x = 1 \qquad x(0) = x'(0) = 0$

Sketch the behavior of these solutions on a single graph. What is the effect of the coefficient of *dx/dt?*

Solve the following differential equations by Laplace transforms.

(a) $\frac{d^4x}{dt^4} + \frac{d^3x}{dt^3} = \cos t \qquad x(0) = x'(0) = x'''(0) = 0 \qquad x''(0) = 1$

(b) $\frac{d^2q}{dt^2} + \frac{dq}{dt} = t^2 + 2t \qquad q(0) = 4 \qquad q'(0) = -2$

Invert the following transforms.

(a) $\frac{3s}{(s^2 + 1)(s^2 + 4)}$

(b) $\frac{1}{s(s^2 - 2s + 5)}$

(c) $\frac{3s^3 - s^2 - 3s + 2}{s^2(s - 1)^2}$

Watch Video Link :
https://www.youtube.com/watch?v=sj0PsMFpTKY&list=PLF404D44A280B5C77

4.1. A thermometer having a time constant of 0.2 min is placed in a temperature bath, and after the thermometer comes to equilibrium with the bath, the temperature of the bath is increased linearly with time at a rate of 1°/min. Find the difference between the indicated temperature and the bath temperature.

(*a*) 0.1 min after the change in temperature begins
(*b*) 1.0 min after the change in temperature begins
(*c*) What is the maximum deviation between indicated temperature and bath temperature, and when does it occur?
(*d*) Plot the forcing function and response on the same graph. After a long enough time, by how many minutes does the response lag the input?

4.2. A mercury thermometer bulb is $\frac{1}{2}$ in long by $\frac{1}{8}$-in diameter. The glass envelope is very thin. Calculate the time constant in water flowing at 10 ft/s at a temperature of 100°F. In your solution, give a summary that includes

(*a*) Assumptions used
(*b*) Source of data
(*c*) Results

4.3. Given: a system with the transfer function $Y(s)/X(s) = (T_1 s + 1)/(T_2 s + 1)$. Find $Y(t)$ if $X(t)$ is a unit-step function. If $T_1/T_2 = 5$, sketch $Y(t)$ versus t/T_2. Show the numerical values of minimum, maximum, and ultimate values that may occur during the transient. Check these by using the initial-value and final-value theorems of App. 3A.

4.4. A thermometer having first-order dynamics with a time constant of 1 min is placed in a temperature bath at 100°F. After the thermometer reaches steady state, it is suddenly placed in a bath at 110°F at $t = 0$ and left there for 1 min, after which it is immediately returned to the bath at 100°F.

(*a*) Draw a sketch showing the variation of the thermometer reading with time.
(*b*) Calculate the thermometer reading at $t = 0.5$ min and at $t = 2.0$ min.

4.5. Repeat Prob. 4.4 if the thermometer is in the 110°F bath for only 10 s.

4.6. A mercury thermometer, which has been on a table for some time, is registering the room temperature, 75°F. Suddenly, it is placed in a 400°F oil bath. The following data are obtained for the response of the thermometer.

Time, s	Thermometer reading, °F
0	75
1	107
2.5	140
5	205
8	244
10	282
15	328
30	385

Give two independent estimates of the thermometer time constant.