BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: VI**
BRANCH: BIOTECH **SESSION : SP/2020**

SUBJECT : BT6027 PROCESS MEASUREMENT AND CONTROL

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) Define process control? Discuss the necessity for process control applications. [2]
(b) Draw a block diagram for the closed loop control system generated for a heated water tank system. [3]

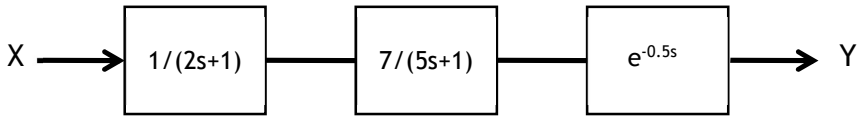
Q2 (a) Solve the following sets of ODEs using Laplace Transform [2]

$$\frac{dx}{dt} + y = \sin t$$

$$\frac{dy}{dt} + x = \cos t$$

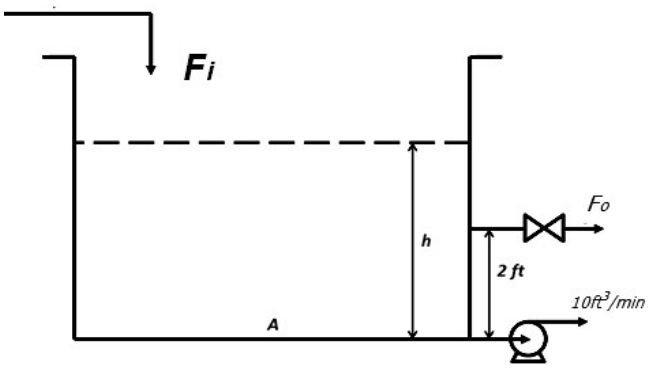
Where $x = 0$ and $y = 2$ at $t = 0$

(b) For the given open loop system: [3]



Derive the transfer function, identify the poles and zeros of the transfer function, obtain the process response to a unit step input change. Also, determine the ultimate response at $t \rightarrow \infty$, for an input of sin h(2t).

Q3 (a) Obtain the Laplace transform of a derivative of a function f(t). [2]
(b) Consider the following liquid storage tank with a cross-sectional area of 3 ft^2. The valve characteristic is given by $F_o = 8\sqrt{h}$. Show that the linearized process has a first order characteristic. Calculate the time constant of the system at an operating level of 12 ft. [3]



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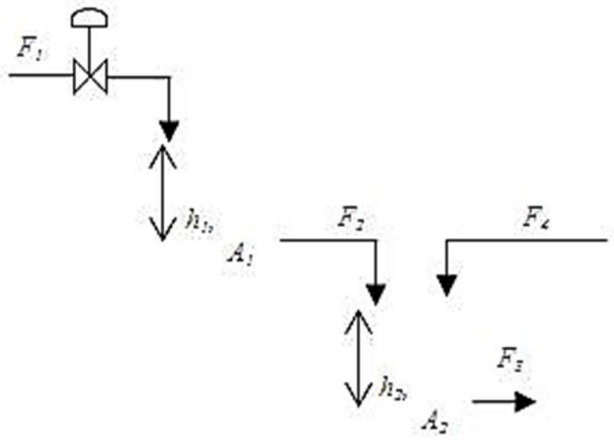
4. Consider two tanks in series as shown in figure. Inflows *F (F_1: inlet flow at tank 1, F_2 and F_4: inlet flow at tank 2, F_3: outlet flow from tank 2), h (h_1, h_2) and A (A_1, A_2)* represent the liquid flow rate, height of liquid and cross sectional area of tanks 1 and 2 respectively. Assume that the flow rate of an effluent stream from a respective tank is proportional to the liquid height. Take appropriate data if missing by giving proper justification. [5]



(i) Starting from usual material balance, develop a time domain mathematical model for this process.
(ii) Identify all the state(s), manipulated input(s), disturbance input(s) and process output(s).
(iii) It is intended to control height of liquid in the second tank. Develop a Laplace transfer function based model relating input-output variables.

Q5 (a) Determine y(t) at t=1 and 2 for the following function: [2]

$$\frac{\partial^2}{\partial t^2}\boldsymbol{y(t)} + \mathbf{16}\boldsymbol{y(t)} = \mathbf{16}\boldsymbol{u(t-3)} - \mathbf{16}$$

With initial conditions y(0)=0 and Dy(0)=0

(b) Determine the Laplace transform of a unit impulse function. [3]

Q6 (a) Two first order water storage tank processes with time constants 10 sec and 25 sec and gains 1.3 and 1 are in series (interacting mode). Evaluate the transfer function corresponds to height of the second tank with respect to the inlet flow of the first tank. [2]

(b) Obtain the Laplace transform of a function f (t). [3]