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

CLASS: BE | **SEMESTER: VI**
BRANCH: BT | **SESSION : SP/2019**

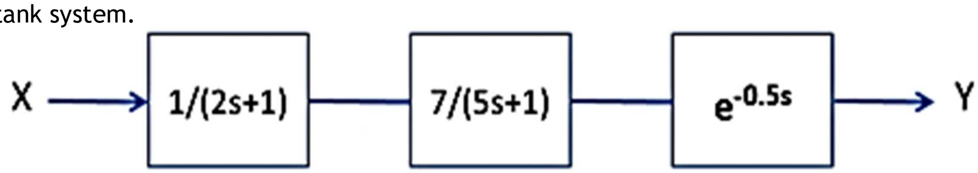
SUBJECT: BT6027- PROCESS MEASUREMENT AND CONTROL

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) Draw a block diagram for the closed loop control system generated for a heated water tank system. [2]

(b) [3]



i) Find the transfer function and determine Y(0) and Y(∞) when the input is 2 sinh (wt).

ii) Determine Y(t) at t=0 if X(t) = 0.5 δ(t-1).

Q2 (a) Determine the Laplace transform of a delta function. [2]

(b) For the transfer function given below : [3]

$$G(s) = \frac{10e^{-s}}{0.2s+1} - \frac{5}{0.3s+1}$$

Draw the corresponding block diagram, identify the poles and zeros of the transfer function, plot (qualitatively) the process response to a unit step input change, determine the ultimate response, at $t \to \infty$ to a sinusoidal input sin (2t).

Q3 (a) The two tank system is connected in an interacting fashion as shown in Fig. 1. The system is initially at steady state with q= 10 cfm. The pump removes water at a constant rate of qo cfm. The following data applied to the tanks: A1=1 ft^2, A2= 1.25 ft^2, R1=1 ft/cfm, R2=0.8 ft/cfm. [5]

(i) Derive the generalized transfer functions H1/Q and H2/Q.

(ii) If the flow changes from 10 cfm to 11 cfm according to an impulse function, determine H2(s).

(iii) Determine H2(1), H2(4) and H2(∞).

(iv) Determine the initial levels h1(0) and h2(0) in the tanks.

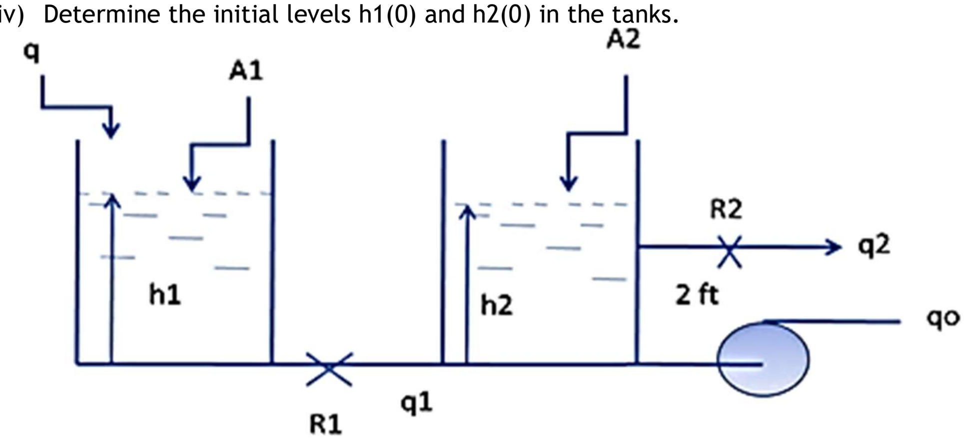


Fig. 1: Two tanks connected in interacting fashion

Q4 (a) Determine y(t) at t=1 and at t=2 for the following function: [2]

$$\frac{\partial^2}{\partial t^2} y(t) + 4y(t) = cos(t)$$

With initial conditions $y(0) = a, y'(0) = b$

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(b) The liquid level system as shown in Fig. 2, is initially at steady state with an inlet flow rate of 1 cfm. At time zero, one ft^3 of water is suddenly added to the tank; at t=1, one ft^3 is added and so on. In other words, a train of unit impulses is applied to the tank at intervals of one minute. Ultimately the output wave train becomes periodic as shown in the figure 2. Determine the maximum and minimum value of this output and determine the level at t=0.5, 1 and 1.5. Data: Area= 1 ft^2; Time constant=1. [3]

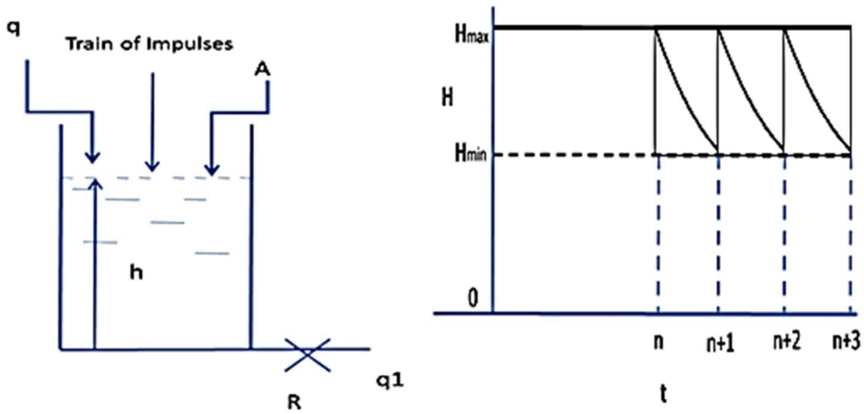

Fig. 2: The liquid level system and periodic output wave train

Q5 (a) Consider two tanks in series as shown in Fig. 3. 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 tank is proportional to the cubic root of the liquid height. Take appropriate data if missing by giving proper justification. [3]

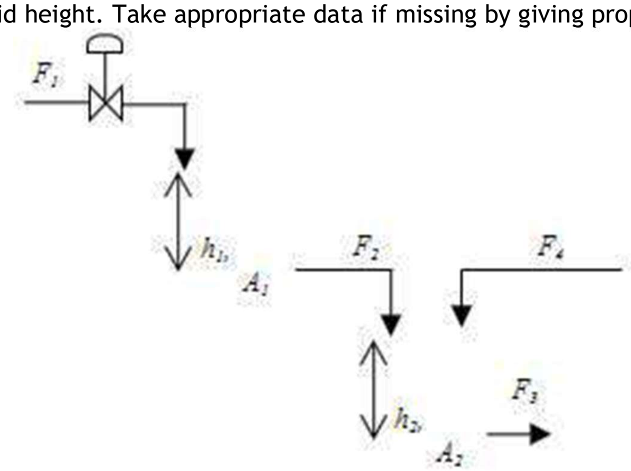

Fig. 3: The Two tanks connected in non-interacting fashion

(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.

(b) Proof that [2]

$$\mathcal{L}\{t^n\} = \frac{n!}{s^{n+1}}$$

Q6 (a) Explain the construction and principle of working of a LVDT. Explain how the magnitude and direction of the displacement of the core of an LVDT is detected. [2]

(b) Describe with neat sketches the following types of primary detecting elements: [3]

a) Bourdon Tube

b) D.C and A.C tachometer generator