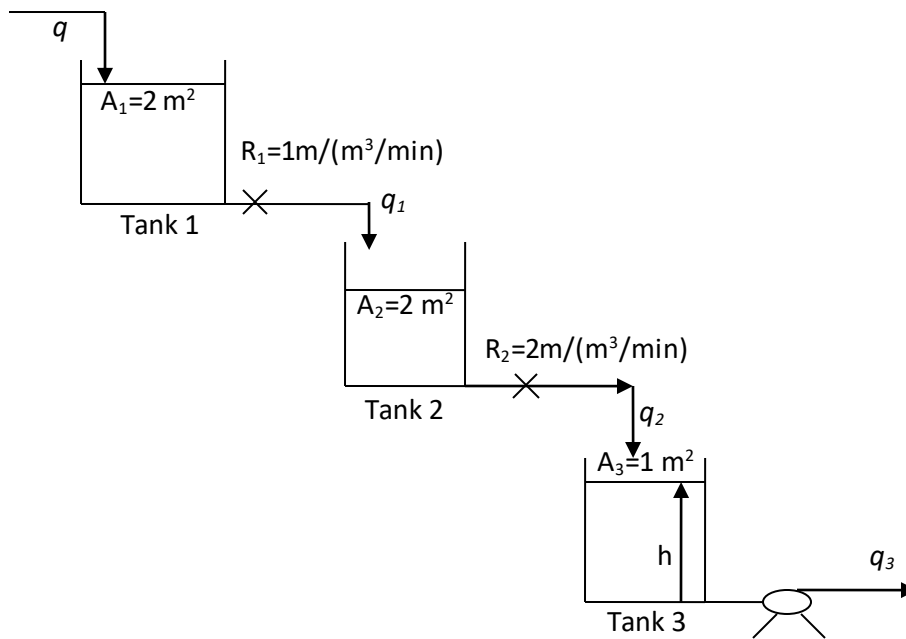


Instructions

1. Please write your roll number, class and name at the top of all the pages/answer sheets.
2. Please scan all the pages/answer sheets as a single pdf file and upload the same in google classroom.
3. Attempt all questions.

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- Q1 A mercury thermometer having a time constant of 0.5 min is placed in a temperature bath at 95°F and allowed to come to equilibrium with the bath. At time  $t=0$ , the temperature of the bath begins to vary sinusoidally about its average temperature of 95°F with an amplitude of 5°F. If the frequency of oscillation is  $1/\pi$  cycles/min, plot the ultimate response of the thermometer reading as a function of time on an ordinary graph paper. What is the phase lag? (10)
- Q2 Derive transfer function of pure dead time by considering suitable example. (7)
- Q3 Consider the liquid level system as shown in Fig 1. The tanks are non-interacting in which resistances  $R_1$  and  $R_2$  are linear. The system is operating at steady state. Suddenly a disturbance is observed in the inflow to the first tank. Assume that the disturbance to be a unit impulse function. Calculate the level in tank three, 2 min after the disturbance in inflow occurs, if initially tank three is showing a steady state level of  $h_s=0.2$ m. The flow rate from tank three is independent of head ( $h$ ). You can write the transfer functions of individual tanks directly. There is no need to derive the transfer functions across individual tanks. (8)



**Fig. 1**

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