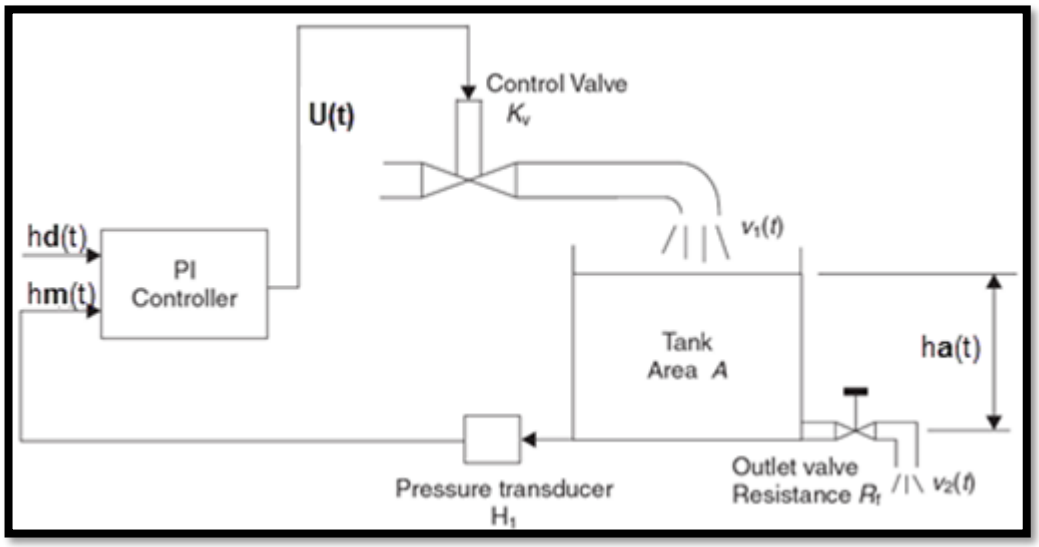
Mansoura University		Computer Engineering and Control Syst. Dept. Total Marks: 90 Marks	Faculty of Engineering
Course Title: **Control Engineering 1**			Course Code: **CSE 3116**
Date: **17 Jan. 2016**		Allowed time: 3 hr.	No. of Pages: (02)
Remarks: (Answer the following questions… assume any missing data)			

Question No. 1 [15 Points]

A liquid level process control system is shown next. The system parameters are

$\boldsymbol{A = 2\ m^2}$
$\boldsymbol{R_f = 15\ s/m^2}$
$\boldsymbol{H_1 = 1\ V/m}$
$\boldsymbol{K_v = 0.1\ m^3/sV}$
Controller gain $\boldsymbol{K_1 = 1}$



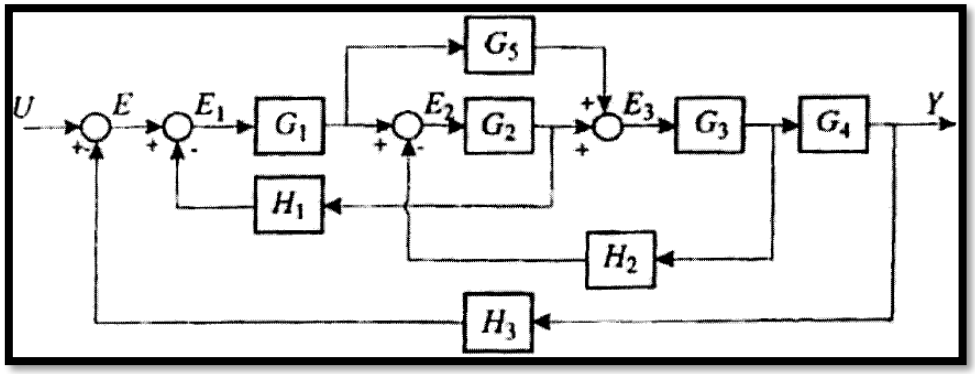
Given that:

PI controller used is $\boldsymbol{K_1(1 + \frac{1}{T_i S})}$	The inflow to the tank is $\boldsymbol{v_1(t) = K_v u(t)}$
The tank dynamics are expressed by $\boldsymbol{v_1(t) - v_2(t) = A\ \frac{dh_a}{dt}}$	Linearized outflow is $\boldsymbol{v_2(t) = h_a(t)/R_f}$
Hint: PI controller used $\boldsymbol{u = K_1(1 + \frac{1}{T_i S})E}$ where $\boldsymbol{E}$ is the error signal	

A. Sketch the block diagram of this system
B. What are the values of $\boldsymbol{T_i}$ and $\boldsymbol{\zeta}$ when the undamped natural frequency $\boldsymbol{\omega_n}$ is $\boldsymbol{0.1\ rad/s}$.

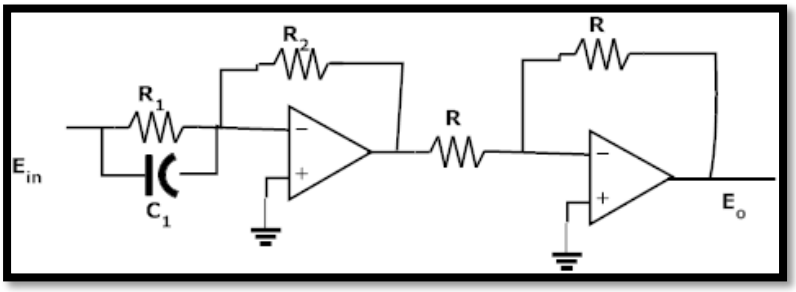
Question No. 2 [15 Points]

Use signal flow graph to find the transfer function
$\boldsymbol{TF = Y(s)/U(s)}$



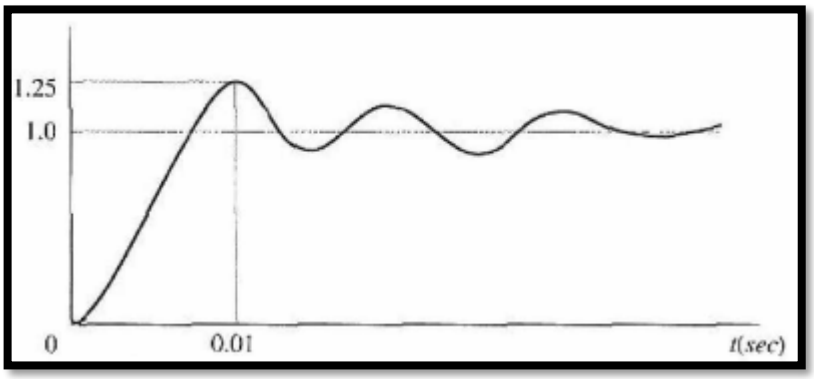
Question No. 3 [15 Points]

Show how the figure below can be used to implement the **PD controller**. The PD general transfer function is
$G_c = K_p + K_D S$



Question No. 4 [15 Points]

The unit-step response of a linear control system is shown in Fig. below. Find the transfer function of a second-order prototype system to model the system.



Question No. 5 [15 Points]

The following transfer function is given for a single loop **nonunity** feedback control system.

$$\boldsymbol{G(s) = \frac{1}{s^2 + s + 2}} \qquad \boldsymbol{H(s) = \frac{1}{s + 1}}$$

a. Find $\boldsymbol{K_p}$, $\boldsymbol{K_v}$, and $\boldsymbol{K_a}$
b. Find the steady-state error for a unit-step input
c. Under what conditions your answer in point **(b)** is valid
d. State the system type

Question No. 6 [15 Points]

The loop transfer function of a single-loop feedback control system is given as

$$\boldsymbol{G(s)H(s) = \frac{K(s + 5)}{s(s + 2)(1 + Ts)}}$$

The parameters $\boldsymbol{K}$ and $\boldsymbol{T}$ may be represented in a plane with $\boldsymbol{K}$ as the horizontal axis and $\boldsymbol{T}$ as the vertical axis. Determine the regions in the **T-versus-K** parameter plane where the closed-loop system is marginally stable

Best wishes
Dr. Mostafa Elhosseini