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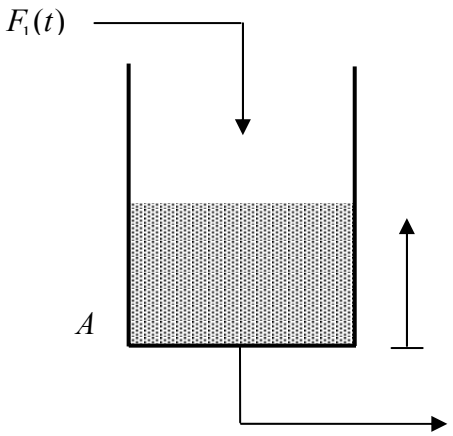
Fall 2002 **SHOW ALL WORK!**

Problem 1 (25 pts)

The flow out of the tank shown below is given by $F_0 = cH^{\frac{1}{2}}$. The cross-sectional area of the tank $A = 50$ ft^2 and the constant $c = 2$ ft^3/min per ft$^{1/2}$. The initial level in the tank is $H(0) = 16$ ft.



a) The flow into the tank is $F_1(t) = \overline{F}_1 = 10$ ft^3 per min, $t \geq 0$.
Find the steady-state height of liquid in the tank, $H(\infty)$.

b) Use explicit Euler integration with a step size T and find the equation for updating the state $H_A(n)$, i.e. the equation with $H_A(n+1)$ only on the left hand side. Leave your answer in terms of c, A, and T.

C) Use the result from Part B) to find $H_A(1)$ and $H_A(2)$ when the step size $T = 0.25$ min. Express your answers to 4 places after the decimal point.

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Problem 2 (25 pts)

A first order system is modeled by the differential equation $\frac{dy}{dt} = ky$.

a) Find the equation for updating $y_A(n)$, the approximation to $y(nT)$, using trapezoidal integration with step size T. Leave your answer in terms of k and T.

b) Suppose $k = -0.4$, $y(0) = 1$ and the step size $T = 0.1$ Find $y_A(2)$.

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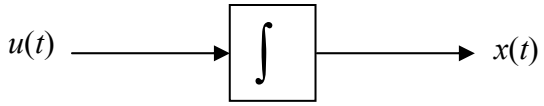
Problem 3 (25 pts)

The input to the integrator shown below is the continuous signal $u(t) = 1, \quad t \geq 0$



a) Find the equation for updating the state $x_A(n)$ recursively when the Improved Euler integrator with a step size T is used.

b) Find $x_A(1)$ if $x(0) = 0$ and $T = 0.5$.

c) Compare $x_A(1)$ to the exact value $x(T)$.

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Problem 4 (25 pts)

For the first order system with input $u = u(t)$ and output $y = y(t)$ modeled by

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + 3y = 6\frac{du}{dt}$$

a) Draw a simulation diagram

b) Write the equations for the system in state variable form

$$\dot{\underline{x}} = A\underline{x} + Bu$$

$$y = C\underline{x} + Du$$