ME576 HW#4 Due 2/28/2019

1. Obtain a discrete model of a system defined by the following equation

$$\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + 2y(t) = u(t)$$

when $u(t)$=1 for $t \geq 0$. Assume that the sampling interval T=0.1 second.

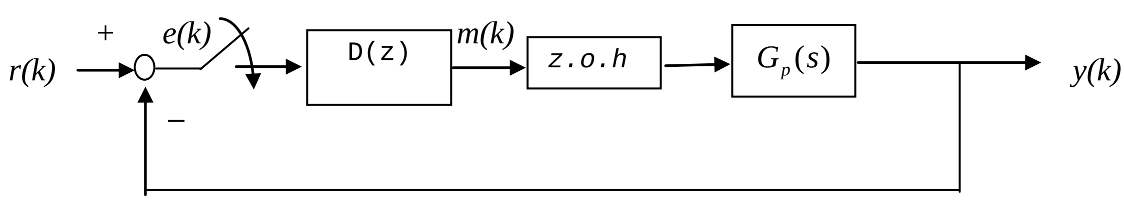
   (a) Use the transformation method covered in class for the second order derivative.
   (b) Use the entry 6 of Table 2.1 on pp. 34 of Bollinger.
   (c) Simulate the responses using the difference equations obtained in (a) and (b).

2. Bollinger 2.19 (b) and (d): Obtain the closed loop transfer function and derive a difference equation relating input and output.

3. Bollinger 3.16.

4. A work motion system in a manufacturing system is shown in the figure below. This system is to be computer-controlled with a proportional-integral controller, with the gains of K_p and K_I, in the discrete domain with the sampling interval of 0.02 seconds. The transfer function of the system is known to be

$$G_p(s) = \frac{1}{(0.01s+1)}$$



   (a) Show the difference equation to be implemented for the PI controller, using the backward transformation.

   (b) Obtain the closed-loop transfer function and calculate the first three responses to a unit step input for K_p=1 and K_I=2. r(k)=1 for k =0,1,2,3,…. and assume y(k)=0 for k≤0.

   (c) Calculate the steady state value of the system output to a unit step input.