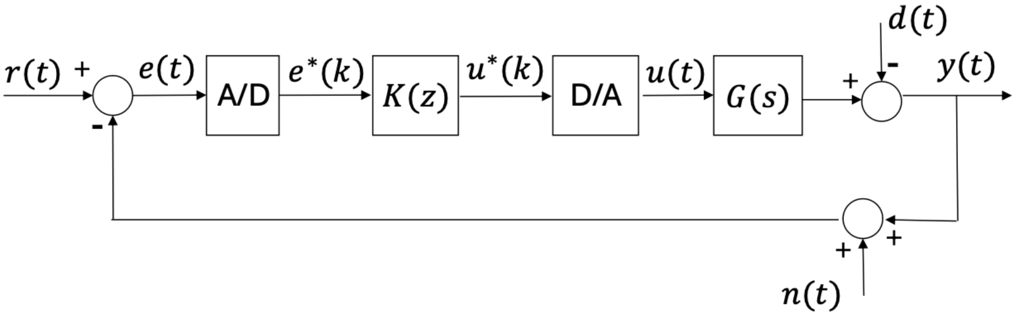
Industrial Automation – February 6th, 2025

Student:____ **ID:**______________________________

1. For the closed-loop control system shown in figure,



where

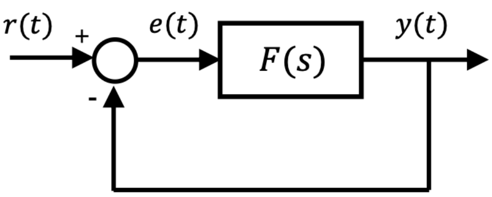
$$G(s) = \frac{3}{s^2 + 4s + 4},$$

a. design a digital control $K(z)$ by emulation of a continuous control design (i.e. by computing the discrete equivalent using Tustin's method) with a sampling time $T = 0.05$ sec, in order to satisfy the following requirements:

   i. $e_{\infty r} \leq 0.1$ for multi-frequency disturbances, $d(t)$, in the range $[0 \;\; 1]$ rad/s;
   ii. $y(t)$ with overshoot to a step reference signal, $r(t)$, less than or equal to 20%;
   iii. settling time $t_{s5\%} \leq 0.7$ sec;

b. discuss the action to be implemented for reducing the effect of high-frequency noise $n(t)$ (i.e., $n(t) = 0.1\sin(\omega t)$, with $\omega \in [110 \;\; 130]$ rad/s).

2. For the closed-loop control system show in figure,



where the open loop function is defined by

$$F(s) = \frac{\rho(s + 3)}{s(s^2 + 2s + 10)},$$

draw the root locus and discuss the stability of the closed-loop control system for $\boldsymbol{\rho}$>0.

Time available: 2 hours