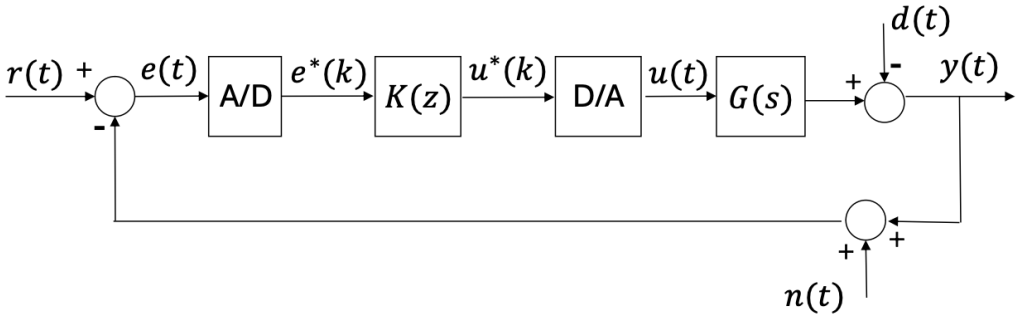
Industrial Automation – July 23rd, 2024

Student:_____ **ID:**_____

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



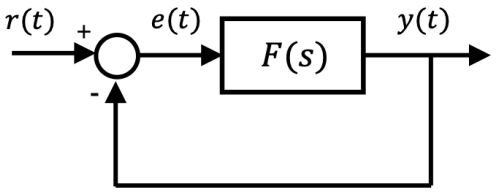
where

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

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. $e_\infty = 0$ w.r.t. a step disturbance signal $d(t)$;
   ii. $e_\infty \leq 0.1$ w.r.t. a ramp signal $r(t) = 0.5t \cdot 1(t)$;
   iii. $y(t)$ with overshoot to a step reference input $r(t)$ less than 30%;
   iv. settling time $t_{s5\%} \leq 3$ sec.

b. discuss the action to be implemented for reducing the effect of high-frequency noise n (i.e., $n(t) = 0.1\sin(120t)$).

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



where the open loop function is defined by

$$F(s) = \frac{\rho}{(s+1)(s^2+4s+5)},$$

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

Time available: 2 hours