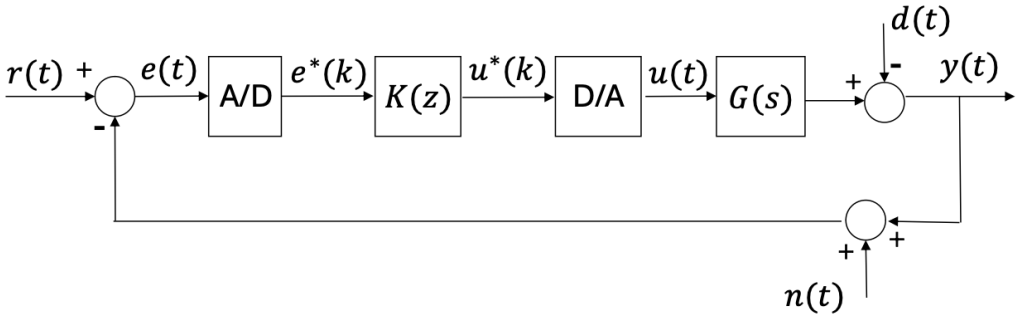
Industrial Automation – February 25th, 2025

Student:_____ **ID:**_____

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



where

$$G(s) = \frac{25}{s^2 + 15s + 50},$$

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 $T = 0.1$ sec, in order to satisfy the following requirements:

i. $e_\infty = 0$ w.r.t. a step reference signal $r(t)$;

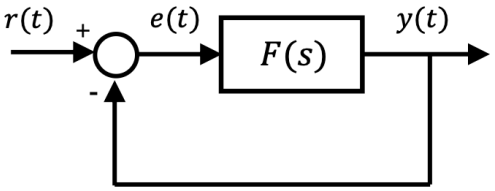
ii. $e_{\infty r} \leq 0.05$ for multi-frequency disturbances, $d(t)$, in the range $[0.01 \;\; 0.1]$ rad/s;

iii. $y(t)$ without overshoot to a step reference signal, $r(t)$;

iv. settling time $t_{s5\%} \leq 1$ 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 $\omega \in [50 \;\; 70]$ rad/s).

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



where the open loop function is defined by

$$F(s) = \frac{\rho(s + 10)}{(s^2 + 4s + 13)},$$

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

Time available: 2 hours