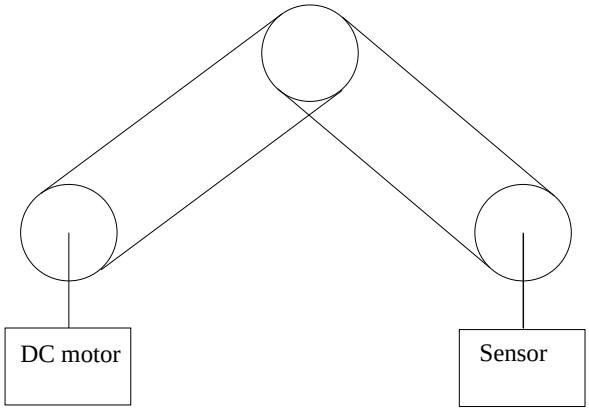
Handin - Flexible Servo

The process consists of three horizontal pulleys connected by two elastic belts.



The transfer function from motor to sensor can take 3 forms ($T_s = 50$ms):

Unloaded: $B = 0.28261z^{-3} + 0.50666z^{-4}$

$A = 1 - 1.41833z^{-1} + 1.58939z^{-2} - 1.31608z^{-3} + 0.88642z^{-4}$

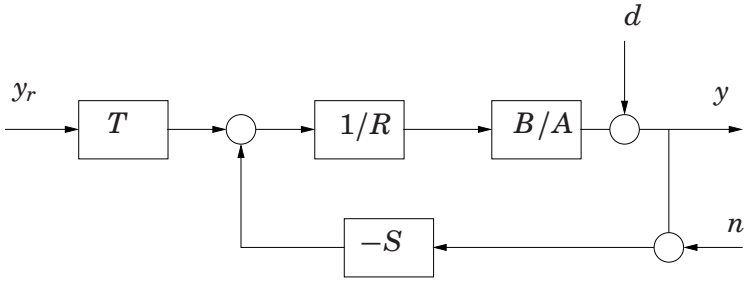
Half Load: $B = 0.10276z^{-3} + 0.18123z^{-4}$

$A = 1 - 1.99185z^{-1} + 2.20265z^{-2} - 1.84083z^{-3} + 0.89413z^{-4}$

Full load: $B = 0.06408z^{-3} + 0.10407z^{-4}$

$A = 1 - 2.09679z^{-1} + 2.31962z^{-2} - 1.93353z^{-3} + 0.87129z^{-4}$

A discrete-time 2DOF polynomial form RST controller is wanted.



$$Ru(t) = -Sy(t) + Ty_r(t+3)$$

Specifications, to be satisfied for all 3 cases

a Rise time (to 90 %) less than 1.0 sec. (Note that $y_r(t+3)$ is used)

b Overshoot for step response less than 10 %.

c Rejection of step output disturbance filtered with $1/A$ within 1.2 sec (for 90 % rejection of measured peak value)

d Perfect rejection of stationary disturbances (integral action)

e Disturbance attenuation for frequencies from 0 to 0.2Hz, (sensitivity function $S_o = 1/(1 + PC_{fb}) = AR/(AR + BS)$ magnitude less than 1).

f $|S_o| < 6$dB for all frequencies, i.e. $M_s < 2$.

g Delay margin of at least 40ms (80% of sampling period). Can be computed as phase margin in radians divided by cross-over frequency in rad/s.

h Magnitude of $C_{fb}/(1 + PC_{fb}) = AS/AR + BS$ less than 10dB for frequency range 8 to 10 Hz.