RME30003 Robotic Control

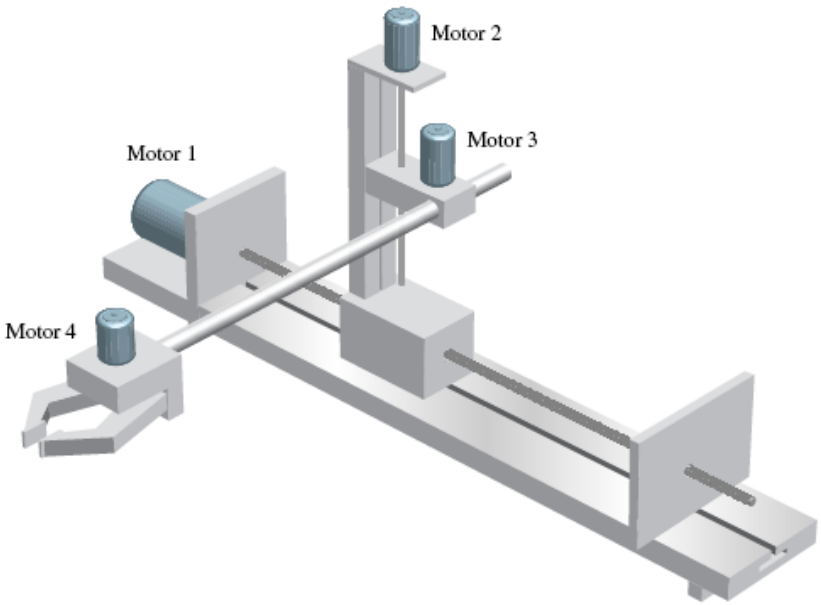
Assignment

Due by Friday of Week 7 (26/09/2025)

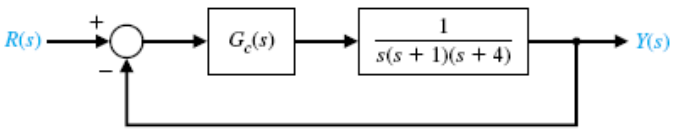
Instructions: Please present your work with detailed working steps, justification supported by calculations, verification, and analysis.

1. A three-axis pick-and-place application require the precise movement of a robotic arm in three dimensional spaces as shown in Figure 1 for joint 2. The arm has specific linear paths it must follow to avoid other pieces of machinery. Design lead/lag compensator or compensators so that the system overshoot for a step input is less than 9%, the settling time is less than 2.3 seconds, and the steady state error for a unit ramp input is less than 0.1. Using Matlab, show the performance of the compensated system.

(12 Marks)



(a)



(b)

Figure 1

2. The aircraft attitude control system is modelled by the block diagram shown in Figure 2a. The transfer function block diagram of the system is shown in Figure 2b. The system parameters are given in Table 2.

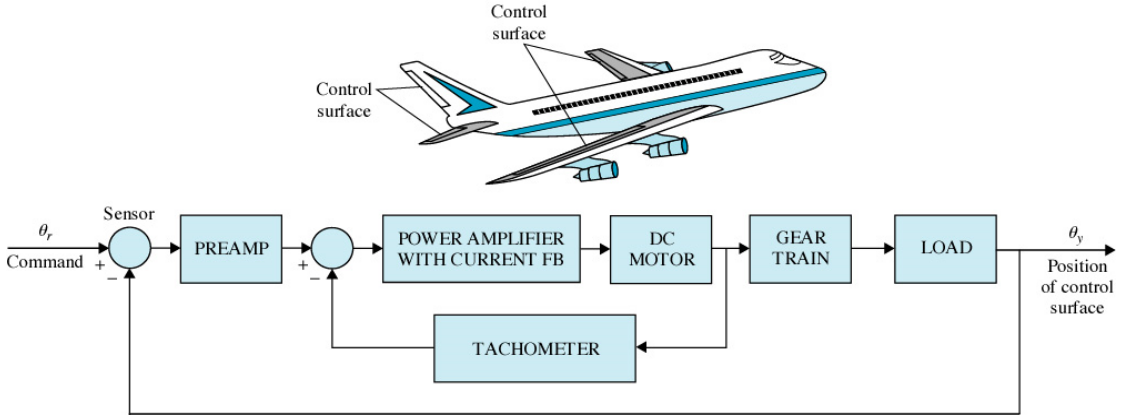


Figure 2a

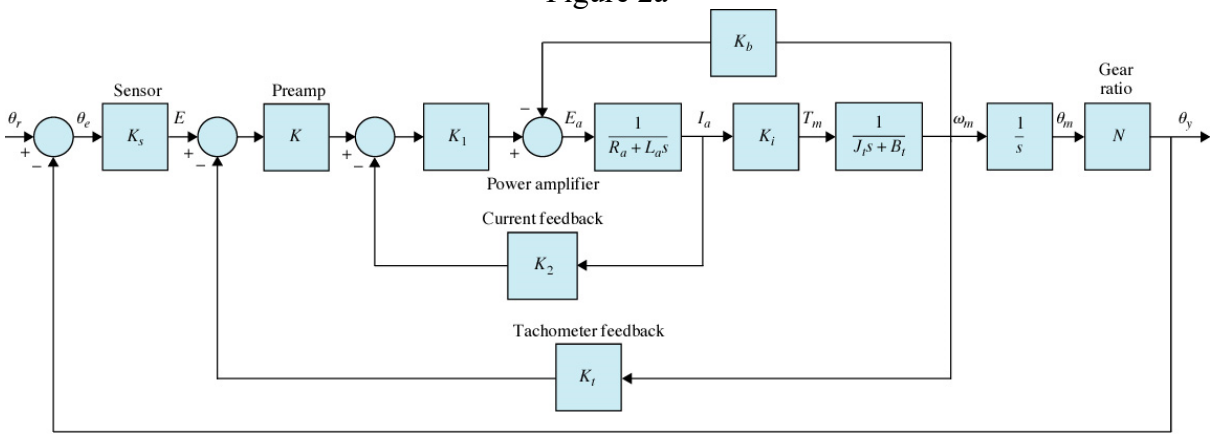


Figure 2b

K=variable Gain of preamplifier	K_s=1 Gain of sensor	K_1=10 Gain of power amplifier	K_2=0.5 Gain of current feedback	K_t =variable Gain of tachometer feedback	R_a=5 Armature resistance of motor
L_a=0.003 Armature inductance of motor	K_i=9.0 Torque constant of motor	K_b=0.0636 Back-emf constant of motor	J_m=0.0001 Inertia of motor rotor	J_L=0.01 Inertia of load	
B_m=0.005 Viscous-friction coefficient of motor	B_L=1.0 Viscous-friction coefficient of load	N=0.1 Gear train ratio between motor and load			

Table 2

Find the values of K and K_t so that the following specifications are satisfied:

Ramp-error constant K_v = 150

Relative damping ratio of the complex roots of the characteristic equation is approximately 0.6.

If there are multiple solutions, analyse their performances.

(Hints: $J_t = J_m + N^2 J_L$, $B_t = B_m + N^2 B_L$)

(**8 Marks**)

Reference

[1] Ogata, K., *Modern Control Engineering,* Prentice Hall.

[2] Dorf, RC., *Modern Control Systems*, Addison-Wesley.

[3] Kuo, C., Automatic Control Systems, Wiley.