ELEC 341 – Graded Assignments

Assignment A4
BD Manipulation & Gear-Motors

100 Marks

Required Files

Available on Canvas

- **e341-a4.pdf** — *Assignment description (this document)*
- **a4Submit.p** — *Grading script (**LATEST** version)*
- **e341-APE.pdf** — *Instructions for submitting graded work (for reference)*

Topics

BD Manipulation
- summing junctions & pick-off points

Motor Model
- block diagram equivalent

Mechanical Transmissions
- gear ratio & equivalent impedance

Figure 1

$$G_1 = \frac{1}{s + \#A} \qquad H_1 = \frac{100}{s + \#F}$$

$$G_2 = \frac{5}{s + \#B} \qquad H_2 = \frac{500}{s + \#G}$$

$$G_3 = \frac{5}{s + \#C}$$

$$G_4 = \frac{5}{s + \#D}$$

$$G_5 = \frac{1}{s + \#E}$$

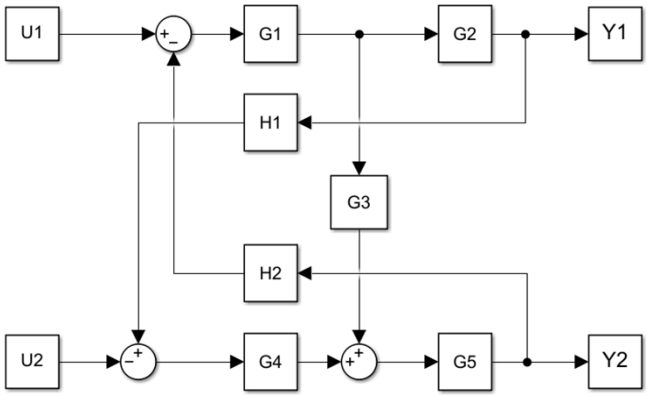


Figure 2

Example SN = 86753099

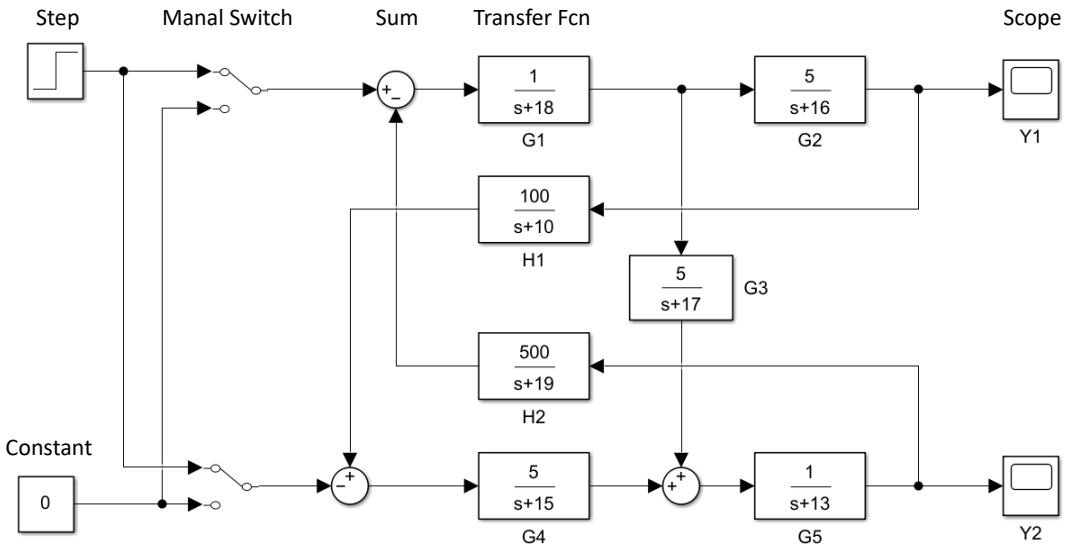


Figure 3

Parameter	Value	Physical Units
J_f	#A / 25	$mNms^2$
B_f	#B / 20	mNms
J_g	#C x 50	μNms^2
B_g	#D / 30	mNms
n	#E	pure

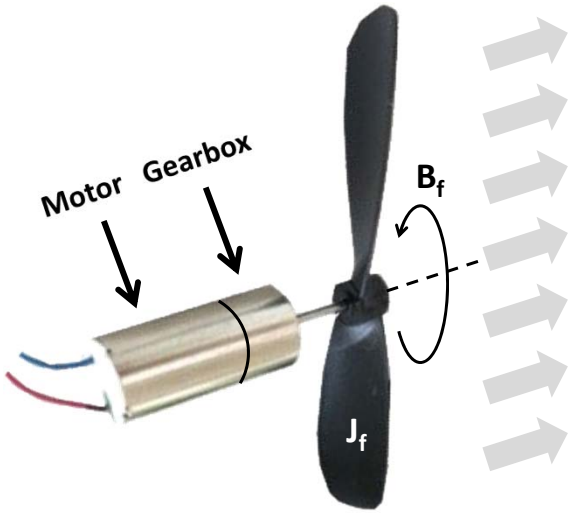


Figure 4

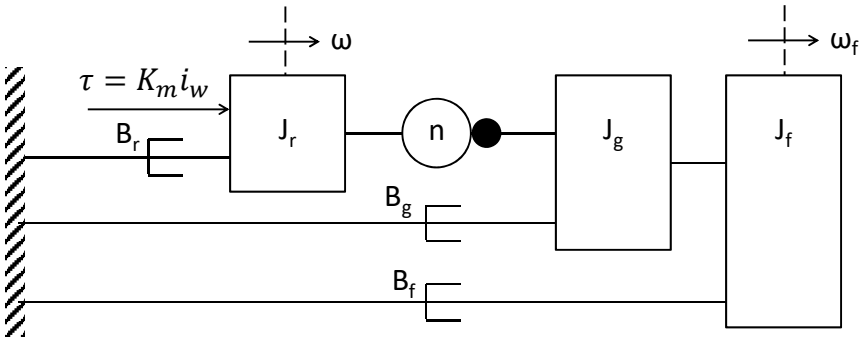
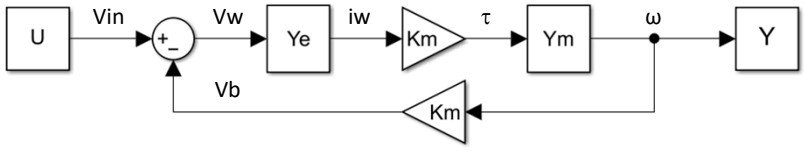


Figure 5



The **MIMO Block Diagram** in **Figure 1** has 2 inputs ($\mathbf{U_1}$ & $\mathbf{U_2}$) and 2 outputs ($\mathbf{Y_1}$ & $\mathbf{Y_2}$).
Use block diagram manipulation to solve the system.
Find: $\mathbf{G_{11} = Y_1/U_1}$ $\mathbf{G_{12} = Y_1/U_2}$
$\mathbf{G_{21} = Y_2/U_1}$ $\mathbf{G_{22} = Y_2/U_2}$

1. 40 mark(s) SISO System

- Q1.G11 (pure) LTI
- Q1.G12 (pure) LTI
- Q1.G21 (pure) LTI
- Q1.G22 (pure) LTI

If the same signal is applied to both inputs $\mathbf{U_1=U_2=U}$, it becomes a SIMO system.
Use super-position to solve the system.
Find: $\mathbf{G_1 = Y_1/U}$
$\mathbf{G_2 = Y_2/U}$

2. 20 mark(s) SIMO System

- Q2.G1 (pure) LTI
- Q2.G2 (pure) LTI

COW: *Use Simulink to draw the figure **EXACTLY** as in **Figure 2**, but using your **SN**.*
Use the switches to implement either super-position or SIMO.

The fan in **Figure 3** is constructed by attaching a fan blade to a motor & gearbox.
An over-drive gearbox is used to increase the speed of the fan blade, as shown in **Figure 4**.
The fan blade has inertia $\mathbf{J_f}$ and damping $\mathbf{B_f}$ (air resistance).
The gearbox also has inertia $\mathbf{J_g}$ and damping $\mathbf{B_g}$ (gear tooth & bearing friction).
The motor is from **Assignment A3**, and has the admittances shown in **Figure 5**.
Find electrical admittance: $\mathbf{Y_e = i_w/V_w}$
Find mechanical admittance: $\mathbf{Y_m = \omega/\tau}$

3. 20 mark(s) Admittance Functions

- Q3.Ye (A/V) LTI
- Q3.Ym (rad/Nms) LTI

Use **feedback()** to find: $\mathbf{G_i = i_w/V_{in}}$
Use **feedback()** to find : $\mathbf{G_w = \omega_f/V_{in}}$

4. 20 mark(s) Fan Gains

- Q4.Gi (A/V) LTI
- Q4.Gw (rad/Vs) LTI

COW: Compare the step response of the fan to the unloaded motor in **Assignment A3**.