ELEC 341 – Graded Assignments

Assignment A-3

12 Marks

Learning Objectives

- Electro-Mech Equivalents
- CCT Analysis in Matlab
- Mixed Electro-Mech Systems

- Matlab
  - tf('s')
  - inv()
  - dcgain()
- Simulink
  - n/a

If you prefer to solve an electric circuit rather than a mechanical circuit, just transform the mechanical model into an equivalent electrical circuit.

Fig 1 2 mark(s) Electro-Mechanical Transformation

A mechanical system is modelled by the "Mechanical Circuit" shown.

- Draw the equivalent electric circuit
- Annotate it with component labels (R1, L1, C1, etc.)

Calc 1 2 mark(s) Spring & Damper Transfer Function

Use nodal analysis to compute the following transfer functions.
Use **minreal()** to cancel any common factors.

- G1 = τK2M/τM = Separating Torque exerted by spring K2M (Nm/Nm)
- G2 = τB1/τM = Separating Torque exerted by damper B1 (Nm/Nm)

*The command **s=tf('s')** defines the Complex Frequency variable which can be used just like a constant in your equations.*

*Once you have an Admittance matrix (Y), you can use **inv()** to get an Impedance matrix (Z). If you make a mistake and get a matrix that isn't full-rank, **inv()** will fail.*

Is the Final Value of the Natural Response = 0 or not ??? Is this what you expect from the mechanical system diagram use common sense ???

What is the electrical equivalent of angle ??? Can you measure it on a scope ???

Final Value is the value after a LONG TIME. To find a value at a SPECIFIC TIME, an easy way to get a quick answer is to plot the response and zoom in on curve at the time you're interested in. It won't be perfect but it should be pretty good.

Fig 2 2 mark(s) Value at 5s

The input is a step function applied at t=0s.
Find the specified spring and damper separation torques at **t=5s**.

- spring torque = τK2M (Nm)
- damper torque = τB1 (Nm)

Calc 2 2 mark(s) Accurate Value

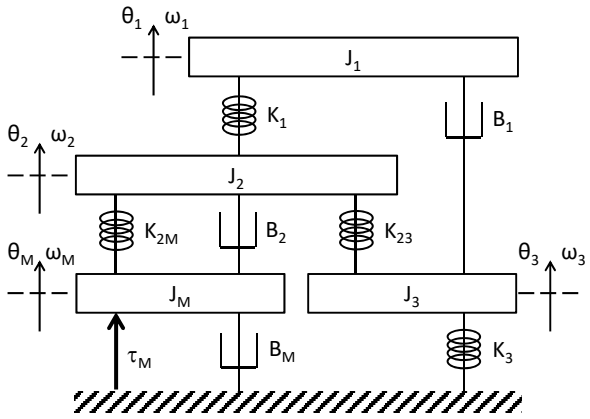
To find out how accurate your value is, calculate it and compute the %error with respect to the value you read from the figure.

- tau5fig = τB1 from figure (Nm)
- tau5calc = calculated τB1 (Nm)
- err = error (%)

Was it worth the extra trouble to do the calculation ???

Mechanical Circuit

- J1 = J2 = #F Kgm^2
- J3 = JM = #B Kgm^2
- K1 = K3 = #D Nm
- K2M = K23 = #E Nm
- B1 = #G Nms
- B2 = #C Nms
- BM = #H Nms
- τM = 3 Nm



An electric motor combines an electrical system with a mechanical system with two dependent sources. Mechanical torque depends on electrical current, and electrical back-EMF depends on mechanical speed. This is an odd looking problem until you convert the mechanical system into its electrical equivalent. Then it's no worse than ones you solved in ELEC 202.

Calc 3 3 mark(s) Motor Transfer Function

Compute the transfer function between mechanical speed and applied voltage:

- G = ω/V (rad/Vs)

Fig 3 1 mark(s) Motor Output

The input is a unit step with a magnitude of 5V. Plot the motor speed.

- motor speed = ω (RPM)

*Matlab has function called **dcgain().** Can you use it to check your work ???*

Do physical units matter ???

Electro-Mechanical Motor Model

- Lw = 10 + #A µH
- Rw = 50 + #B mΩ

- B = #C µNms
- J = (#D + #E) µNms^2

- K_b = (#F + #G + #H) mVs
- K_τ = (#F + #G + #H) mNm/A