AUBURN UNIVERSITY

Power Electronics

Homework: Introduction to Motor Drives

Contact: Dr. Eduard Muljadi

Source: Power Electronics (Converters, Applications and Design) by Ned Mohan, T. Undeland, W.P. Robbins, Published by John Wiley and Sons

Problem 1 Conveyor belt with a slope.

A motor controls the speed of a conveyor belt with a mass M as shown in Fig. below, except that the belt has a slope of $\theta := 20\text{deg}$ and there is a gear between the motor and the drum.

Mass of the load $M := 3000\text{kg}$

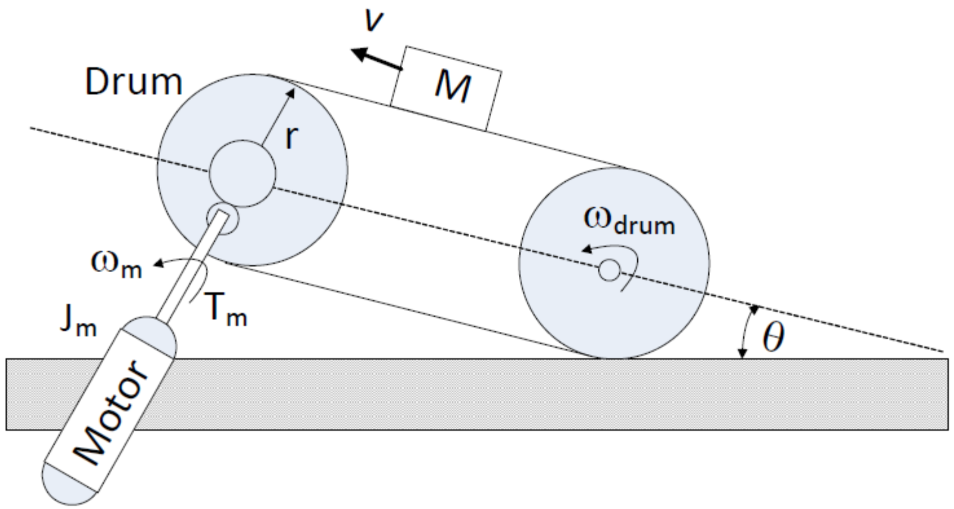
Inertia of the motor $J_m := 0.3\text{kg}\cdot\text{m}^2$

Inertia of each drum $J_{drum} := 45\text{kg}\cdot\text{m}^2$

Diameter of the drum $D := 0.5\text{m}$

Gear coupling ratio $a := \frac{1}{6.25} = \omega_{drum}/\omega_m$

Other inertias and friction are negligible.



(a) The belt moves the load uphill with a speed of $v := 2\frac{\text{m}}{\text{s}}$. Calculate the motor speed, ω_m (ans. 50rad/s) and the drum speed, ω_{drum}. (ans. 8rad/s)

(b) Calculate the total inertia J_{tot} (ans. 2.604 kg m^2) referred to the motor.
(c) Calculate the motor torque $T_{m,0}$ (ans. 402.5 Nm) at standstill.

Problem 2 Conveyor belt with a slope.

A motor controls the speed of a conveyor belt with a mass M as shown in Fig. below, except that the belt has a slope of $\theta := 20\text{deg}$ and there is a gear between the motor and the drum.

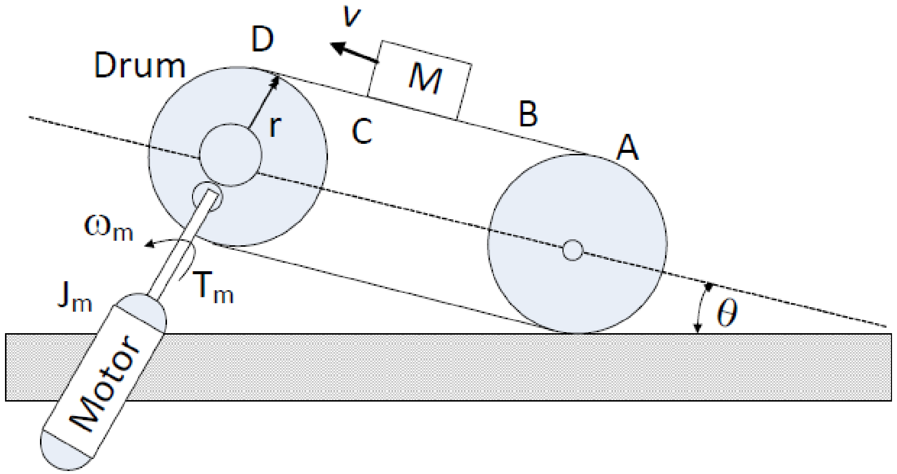
Mass of the load $M := 3000\text{kg}$

Inertia of the motor $J_m := 0.3\text{kg}\cdot\text{m}^2$

Inertia of each drum $J_{drum} := 45\text{kg}\cdot\text{m}^2$

Diameter of the drum $D := 0.5\text{m}$

Gear coupling ratio $a := \frac{1}{6.25} = \omega_{drum}/\omega_m$



Other inertias and friction are negligible.

At point A, initially the motor torque is adjusted to keep the box at standstill (T_m=T_{mo})

(a) At t=0, the torque is changed to $T_m = T_A = 502.5\text{Nm}$, the motor starts to move the box from zero speed to a velocity of v = 2m/s at point B. Compute the mechanical power P_m at point B, the rotational speed of the motor $\omega_m(t)$

(b) Calculate the time it takes to reach point B (ans. t_{AB} = 1.32s), and distance between A and B (ans. 2.64m)

(c) From point B to point C, the velocity is maintained at v = 2m/s compute the motor torque needed (ans. T_{mBC} = 402.5Nm). Given distance BC = 10m, compute the time it takes to reach point C (ans. 5 s)

d) From point C, compute the motor torque to ensure that the slow down the box and to stop at point D within 3 second (ans. 358.5Nm).

e) At point D the motor torque will be adjusted to make sure that the box stays at point D. Compute the motor torque needed (ans. $T_{parkatD}$ = 402.5Nm)

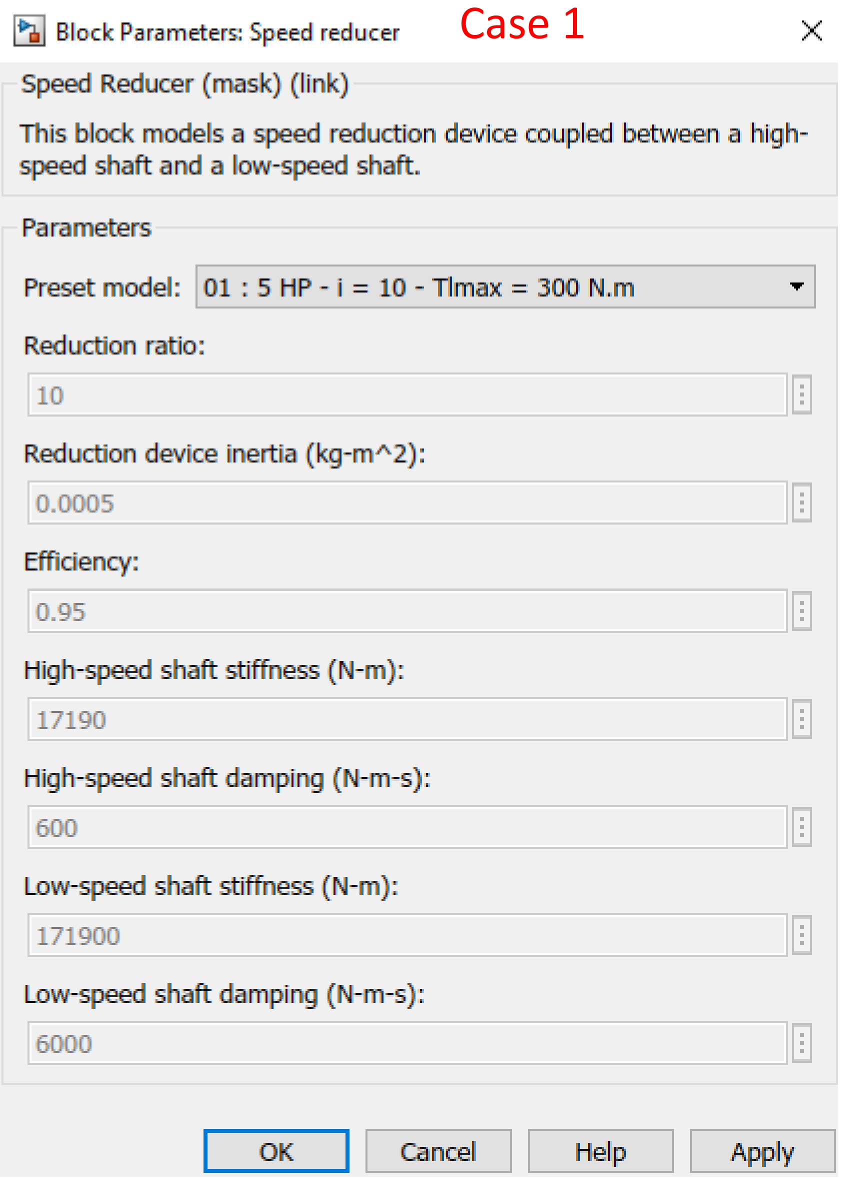
f) Draw the torque profile from A, B, C, D, park at D.

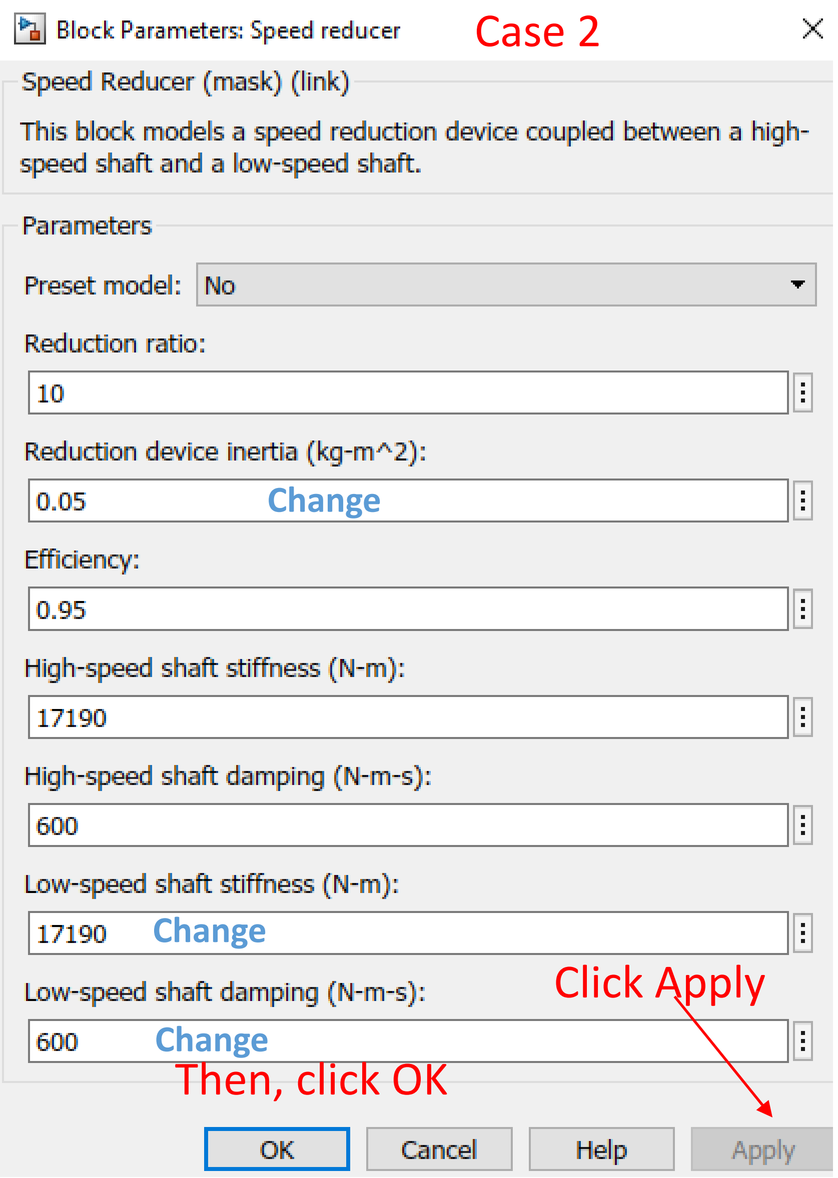
Before you work on Homework 3 – Problem 3.

Please review and run the practice program for Matlab/Simulink/SimScape in the Module: “Programming Tools”

Download the files, read the pdf files, play the videos, and run the example of the simulations with “filename.slx”.

- ExSimulink.slx
- FEEDER Modeling in Simscape Electrical.pdf
- Simscape 1.mp4
- Simscape 2.mp4
- Simscape 3.mp4
- Simscape 4.mp4
- Simulink Basics Tutorial.pdf
- ExSimScape.slx





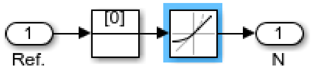
Problem 3:

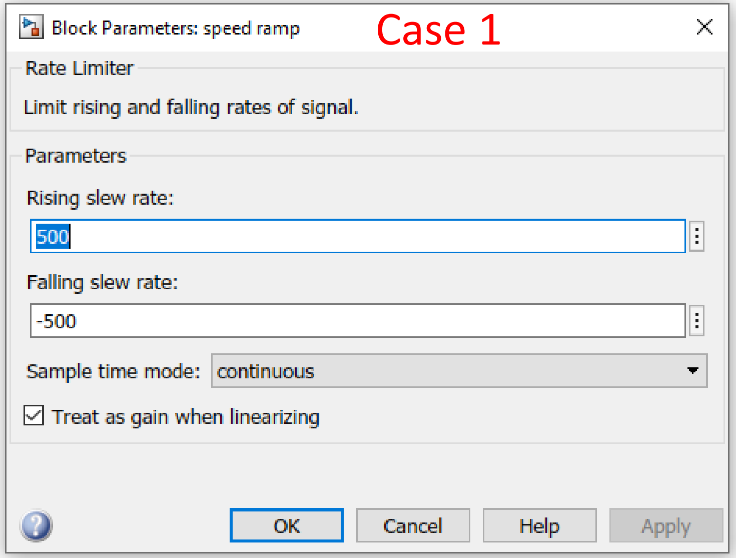
a) Downloaded from Canvas Run the original file “reducer_example.slx” then run the simulation (call this simulation run “Case 1”). Plot the output of the scope (Speed and Torque).

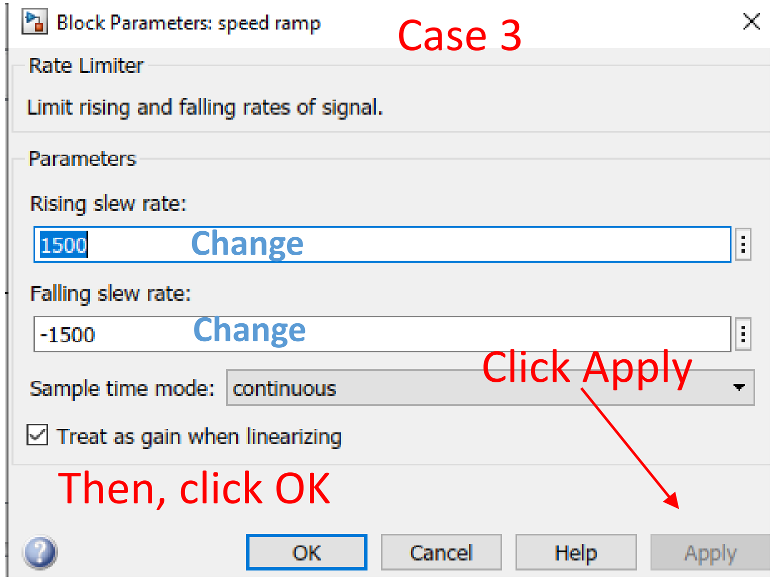
Click on the block “Speed Reducer” and change the parameters of the Speed Reducer.

Case 2: Change the parameters to shown. Run the simulation, and plot the scope and compare the results between Case 1 and Case 2. (use cut and paste to make it easier to compare) Describe your observation.

b) Choosing the same shaft stiffness and damping for the low speed shaft, it means that the size, length, and material of low speed shaft are the same as the high speed shaft (True or False)







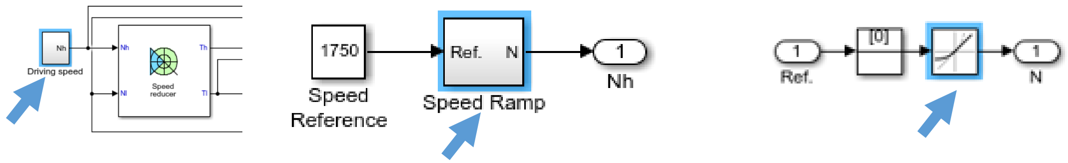
Problem 3:

Downloaded from Canvas Run the original file "reducer_example.slx" then run the simulation (call this simulation run "Case 1"). Plot the output of the scope (Speed and Torque).

c) Case 3:

Click on the block "Driving speed" and change the parameters of the Driving Speed.

Change the speed ramp for Case 1 from ± 500 rpm/s by clicking the blue boxes in the following sequence (left to right):



Run the simulation, and plot the scope and compare the results between Case 1 and Case 2. (use cut and paste to make it easier to compare). Describe your observation.