KON-C2004 - Mechatronics Basics, Lecture, 22.10.2024-12.12.2024

This course space end date is set to 12.12.2024 **Search Courses: KON-C2004**

5.4 Hydraulic servomotor with Simulink - 10 points

Opened: Tuesday, 12 November 2024, 10:00 AM
Due: Tuesday, 26 November 2024, 10:00 AM

Convert the DC servo motor model from exercise round 3 to a hydraulic servo motor. Again, use a PI controller with a feedback from the angular velocity of the motor. Modeling instructions below.

1. Model the hydraulic motor as a pressure dependent torque source with the equation given in the lecture slides. The input to the motor is a pressure difference over the motor.*

2. Keep the same conveyor (r=0.1 m) and mass (100 kg) attached to the motor as in the previous rounds. Because hydraulic motors do not usually rotate as fast as electric motors, the gear ratio of the reduction gear between the conveyor belt's pulley and the motor is changed a bit. Now the gear attached to the motor has 20 teeth instead of 15. To keep the conveyor belt's speed the same as before, the target angular velocity of the motor is decreased.

3. Instead of a simple total/hydromechanical/volumetric efficiency factor, we'll represent the motor's internal losses more accurately with the following model.

Model the volumetric losses inside the motor as a laminar leakage flow from the pressure source to the tank. The flow rate of a laminar flow through an orifice can be modeled with a simple conductance C where the leakage flow rate Q_l through the motor is calculated with equation $Q_l = C\Delta p$.**

The hydromechanical losses of the motor are represented by a similar angular velocity dependent damping coefficient as in the electric motor model. Therefore, there is no need to use the hydromechanical efficiency constant. ***

Parameters

Motor displacement per rotation Vr = 8.2 cm3

Damping coefficient b = 0.001

Maximum pressure 12.5 MPa

Leakage flow conductance 1*10^-12 (m3/s)/Pa

Teeth in motor's gear 20

Target angular velocity 210 rad/s

Tasks:

1. Show an image of your hydraulic motor model with all the required blocks for all the following tasks.

2.Tune the PI controller so that the motor reaches the target speed of 210 rad/s with the same time and accuracy requirements as in exercise 3.2. The input pressure must stay below the maximum pressure of 12.5 MPa. Show the controller gains you used.

3. Plot the angular velocity of the motor as well as the proportional, integral and total output of the controller. Use the model plotting script from exercise round 3 as a template.

4. Plot the hydraulic input power to the motor, mechanical output power from the motor, hydromechanical loss power and volumetric loss (leakage) power in the same figure. Again, for plotting just modify the previous model script a little.

5. Explain why the hydromechanical and volumetric losses behave as they do.

Tip: You can use your previous servo motor model if it works. If you are not sure, use the model answers from exercise round 3 as your basis. The mechanical part of the motor should be fine, just replace the electrical torque producing part with hydraulic equations.

Return your answers as a .pdf file in the box below. Return also the model and script files.

* In reality such a pressure difference would be realized with for example a constant pressure source and a proportional valve which would throttle the pressure i.e. create a pressure loss in the control valve. In this exercise you can assume that any pressure is available and also the direction of pressure differential can be changed.

** The conductance value represents the geometry of the flow path as well as the viscosity of the fluid.

*** Usually hydromechanical losses are modeled with the hydromechanical efficiency constant i.e. as a percentage of the produced torque. In reality, there are also pressure and velocity dependent components. We'll keep the changes to the model minimal this time. That's why only the velocity dependent component is used now.

Maximum 10 points.

Submission status

Submission status	No submissions have been made yet
Grading status	Not graded
Time remaining	Assignment is overdue by: 90 days 23 hours