**Lab 2.**

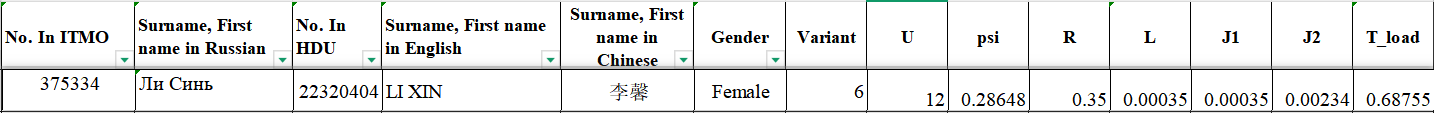
**Simulation components of dynamic systems**

1. My name and HDU ID

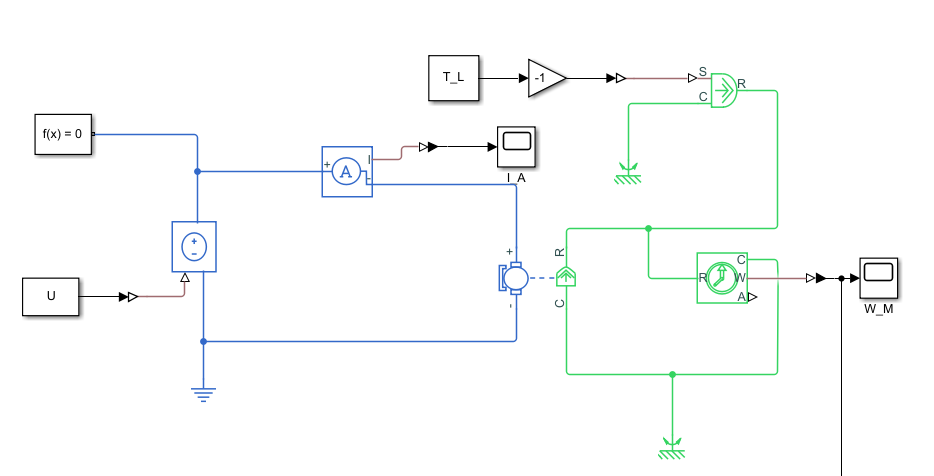
Name:Li Xin

HDU ID:22320404

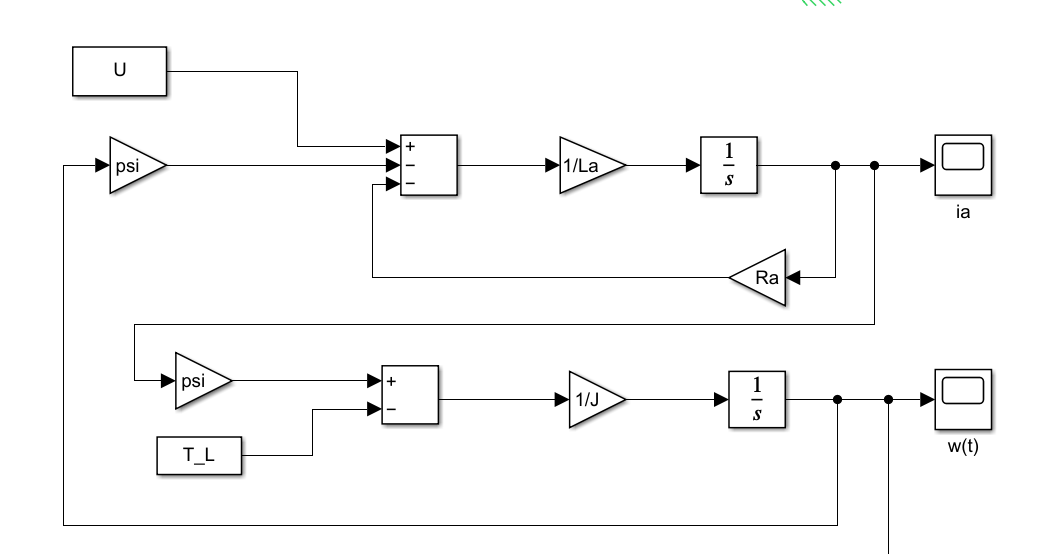
1. My variant and initial data



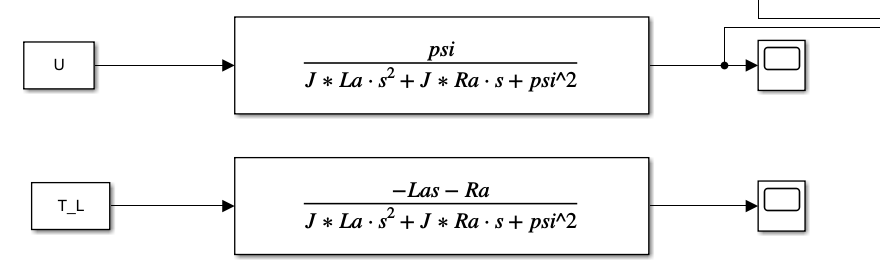
1. Simscape model of DC-motor



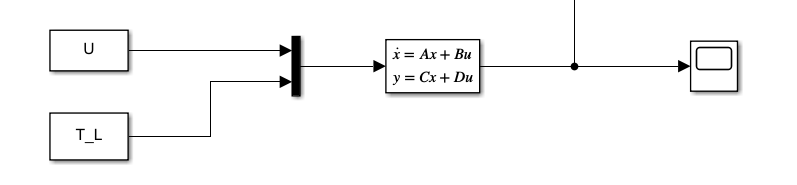
1. Block diagram model of DC-motor

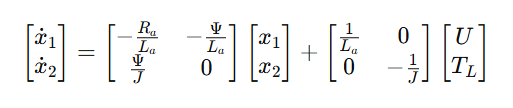


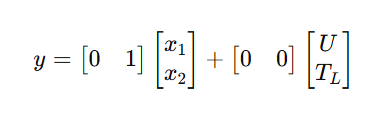
1. Transfer functions of DC-motor

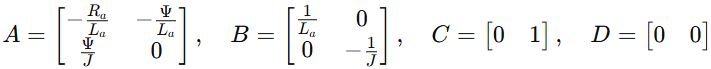


1. State space model of DC-motor

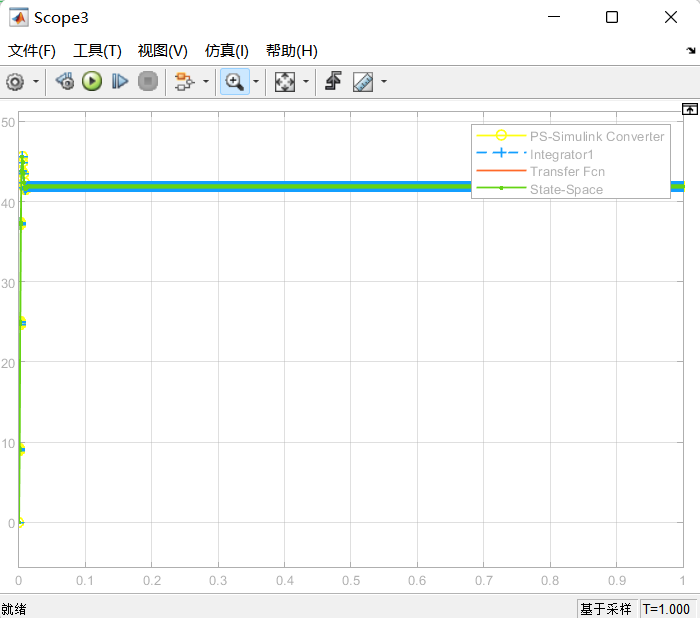




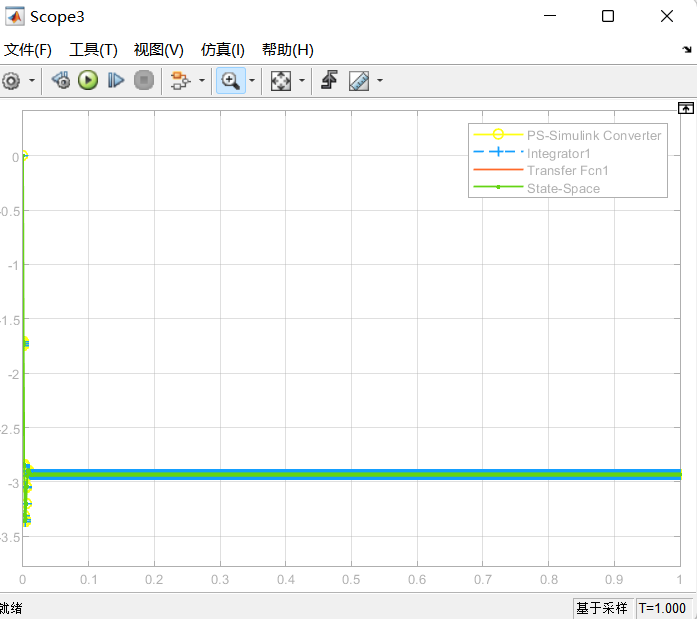




1. Simulation results for 2 cases



With rated voltage and zero load torque



With zero voltage and rated load torque

1. Calculation of transient response function based on transfer function of DC-motor for two values of inertia

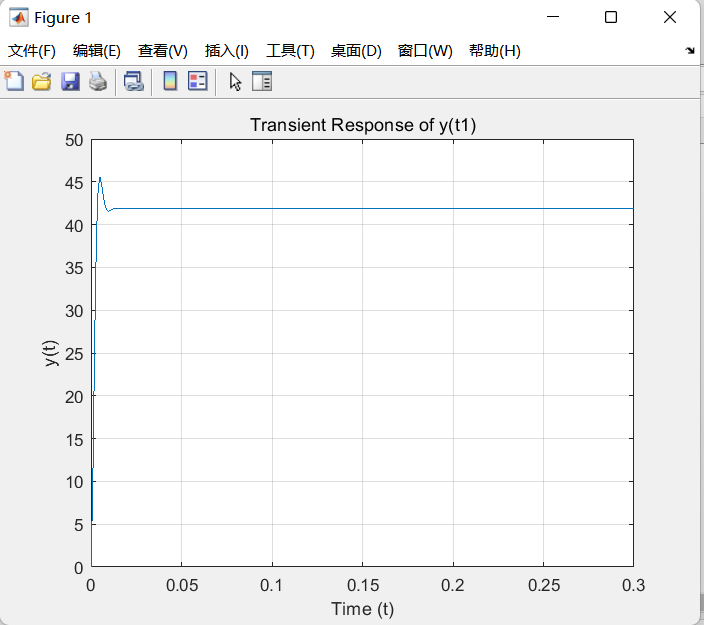
*<1*

*>1*

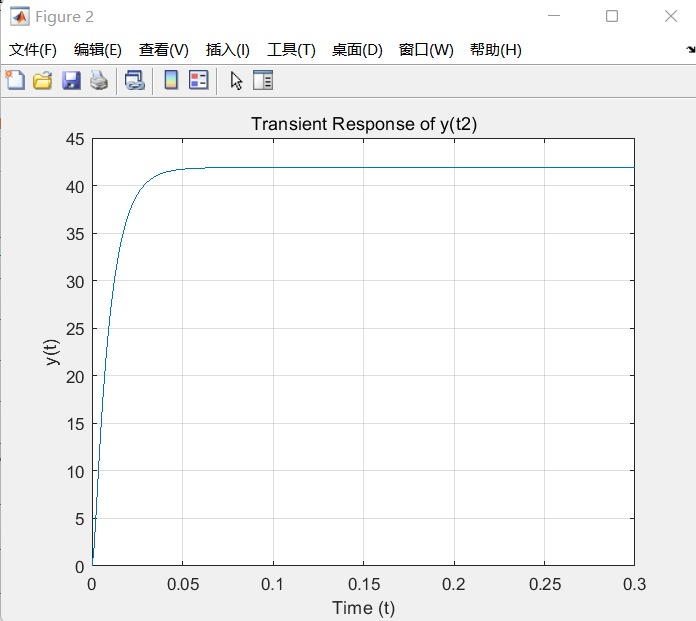
*So the transient response function ω(t) for U(t) = U\_rated , J=J1 is underdamped.*

*After inverse Laplace transform,*

1. Graphs of transient responses



With J=J1



With J=J2

1. Values of rise time, maximum overshoot and settling time

For J1

Rise Time (10% to 90%): 0.003 s

Max Overshoot: 8.85%

Settling Time (5% tolerance): 0.008 s

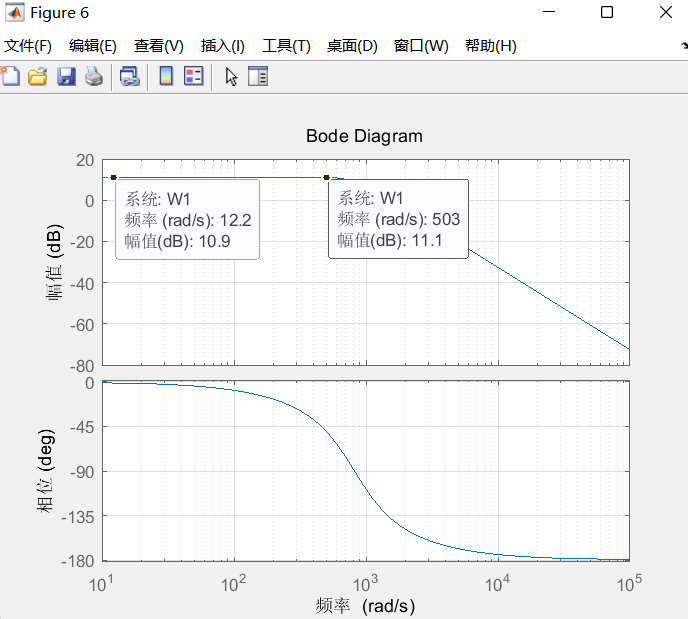
For J2:

Rise Time (10% to 90%): 0.0197 s

Max Overshoot: 0.00%

Settling Time (5% tolerance): 0.0358 s

1. Bode plot of underdamped model of DC-motor



12.Values of the static gain and damped natural frequency calculated from Bode plots

Static Gain K ==3.50

Damped Natural Frequency wd = 503 rad/s

13.conclusion

**Model Validation**  
The derived transfer function and state-space model of the DC motor align with the physical principles of electromechanical systems. The transfer function  and state-space matrices were successfully validated through Simulink simulations, confirming their accuracy in describing the motor’s dynamics under both no-load and rated load conditions.

**Impact of Inertia (*J*) on Transient Response**

For *J*=*J*1​: The system exhibited ​**underdamped behavior** (*ζ*1​=0.61), resulting in a fast rise time (0.003s) but with an overshoot of 8.85%.

For *J*=*J*2​: The system became ​**overdamped** (*ζ*2​=1.58), eliminating overshoot at the cost of slower response (rise time 0.0197s).

**Frequency Domain Analysis**  
The Bode plot of the underdamped model (*J*=*J*1​) revealed a ​**static gain *K*=3.50** and ​**damped natural frequency *ωd*​=503rad/s**. These values align with theoretical predictions, confirming the system’s bandwidth and resonance characteristics.