Lab # 08

Designing DC Motor in Simulink

Aim:

In this lab we will see how to model a DC motor using a physical modeling method. The system which we want to model looks like that



Procedure:

We have a DC motor with electrical inputs that is connected to a companion to produce translational motion. We want to model this with a physical modeling approach. To do this we use simscape. The model which we will build look like this



We see that electrical and mechanical components are connected using physical connections. And we will see when we run the simulation the results of mechanical and electrical portion of our systems. Now to see how it is done.

We want to build a DC motor. First we need DC voltage source. We will get it from Electrical source library. Next we need some more electrical components. That is to take resistor, an inductor and an electrical reference and connect them using physical connections. These physical connections represent ideal electrical connections between the electrical components. We want to measure current from our circuit during our simulation so we use a current sensor.



Scope is used to view our simulation results. The output of the current sensor is a physical signal. The physical signal is the unit associated with it. We use the converter block in order to assign the unit of Ampere to the signal that we want to view. We connect this to the sensor block and then to the scope.



Simscape use solver technology above and beyond and available in normal Simulink to have an access to important settings we use the solver configuration block.



Select:	Simulation time							
Solver Data Import/Export > Optimization > Diagnostics Hardware Implementation	Start time: 0.0			Stop time: 10.0				
	Solver options							
Model Referencing	Type:	Variable-step	•	Solver:	ode15s (stiff/NDF)	•		
 Simulation Target Code Generation 	Max step size:	auto		Relative tolerance:	1e-3			
 HDL Code Generation 	Min step size:	auto		Absolute tolerance:	auto			
Simscape SimMechanics 1G	Initial step size:	auto		Shape preservation:	Disable All	•		
SimMechanics 2G	Solver reset method:	Fast	-	Maximum order:	5	•		
	Number of consecutive min steps: 1							
	Solver Jacobian metho	od:		auto		•		
	Tasking and sample time options							
	Tasking mode for periodic sample times:			Auto				
	Automatically handle rate transition for data transfer							
	Higher priority value indicates higher task priority							
	Zero-crossing options							
	Zero-crossing control:	Use local settings		Algorithm:	Nonadaptive	•		

Finally we use a Simulink solver that is recommended for the physical system. We use ode 15s.

At this point run the simulation and see the current produced. We notice that the current remains 1 Amps.



Next we model the mechanical portion of the system. To convert power to mechanical power we need the rotational electromechanical converter. This block allows exchanging power between electrical and mechanical portion of our system. It has two electrical ports and two mechanical ports.



The mechanical portion represents the shaft of the motor. We go to the mechanical rotational elements and pick the inertia block. Rotate it and connect it. The lower part represents the housing of the motor and we know the housing does not move so we connect it to the mechanical rotational reference block.



Now we run the simulation and see what effect will produce by these components. We see that the current slowly drops as the motor comes up to speed.



Now we want to add some damper to our motor so we add rotational damper block and connect it here as shown.



Now we re-run the simulation and see what effect will produce by it? We notice that the motor reaches to a different final speed.



Now to measure the speed of the motor we go to the mechanical sensor and then pick up the rotational motion sensor and connect one end to the shaft and we measure the speed of the shaft with respect to the housing of the shaft as shown.



Cur DC Voltage Source ⊊Elect ical Reference	PS-Simulark Converter rent Servor Resistor Inducbr Mechanical With Rotational Damper Inducbr Mechanical With Rotational Damper	PS Sinurik Conversent				
f(x) = 0 Solver Configuration						
	Block Parameters: PS-Simulink Converter1					
	PS-Simulink Converter					
	Converts the input Physical Signal to a unitless Simulink output signal.					
	The unit expression in 'Output signal unit' parameter must match or be commensurate with the unit of the Physical Signal and determines the conversion from the Physical Signal to the unitless Simulink output signal.					
	'Apply affine conversion' check box is only relevant for units with offset (such as temperature units).					
	Parameters					
	Output signal unit: rpm -					
	Apply affine conversion					
	OK Cancel Help Apply					

Copy the converter block to view the result on the Simulink scope. We connect it to the speed port and assign the output signal unit to the rpm.

Now run the simulation. We see that the speed of the motor reaches to the final speed after about 6 seconds.



Our motor needs to produce translation motion to do this go to the mechanism library and pick wheel and axel block. This will take the rotational motion of the block and convert it to the translation motion.



For load we will take the translation spring. This spring need to attach to the ground. Go to the translational element and pick the translational mechanical reference and connect to the other end of the spring.



Run the simulation we will notice that the speed of the motor oscillates as the motor tempts to acts against the spring.



Now to see the angle the converter pin is change to the A port and change the output signal to deg. It will display it in degrees. Now run the simulation. Again the motor acts against the spring and we see the oscillation.



If we weakens the spring by double clicking on the spring and change the spring rate to 10 N/m and run the simulation we see that it will very quickly reaches to its final value which is somewhat less then rotation and less than 360° .

🚹 Block Parameters: Translati	onal Spring		×				
Translational Spring							
The block represents an ideal mechanical linear spring.							
Connections R and C are mechanical translational conserving ports. The block positive direction is from port R to port C. This means that the force is positive if it acts in the direction from R to C. Source code							
Settings							
Parameters Variables	3						
Spring rate:	10		N/m 👻				
]				
		OK Cancel	Help Apply				



Lab Task:

a) Why we are using PS-Simulink Converter?

b) Briefly explain the need of solver configuration.

c) Why we are using rotational electromechanical converter in our system?

d) Explain the function of wheel and axle block.

e) How we can measure the speed of the motor?

Marks Obtained:

Remarks: