

# Introduction to Automotive

## Report

### Lab 1: Braking System



Student Name	Ahmed Mohsen Abd El Fattah
ID	1901061

## Brake System:

The braking systems consists of several components:

- Pedal:  
Human force is applied on the pedal and is amplified mechanically.
- Servo unit (Booster):  
It adds an additional force to the force coming from the pedal to assist the human, the servo force added depends on ratio between the human force applied over the maximum human force possible, and this force is due to the pressure difference as one side of the diaphragm is vacuumed while the other side is at atmospheric pressure multiplied by the area of the booster.
- Master cylinder:  
The force outputted from the pedal and servo unit is then applied on the master tandem cylinder to pressurize the brake fluid into the brake pipes and hoses.
- Disc brakes:  
A disc is mounted on the axis of the wheel and a caliper is installed on it, the pressurized brake fluid pushes the piston in the caliper which will push the brake pads against the disc causing frictional torque and frictional force which will decelerate the wheel.

## MATLAB Snippets:

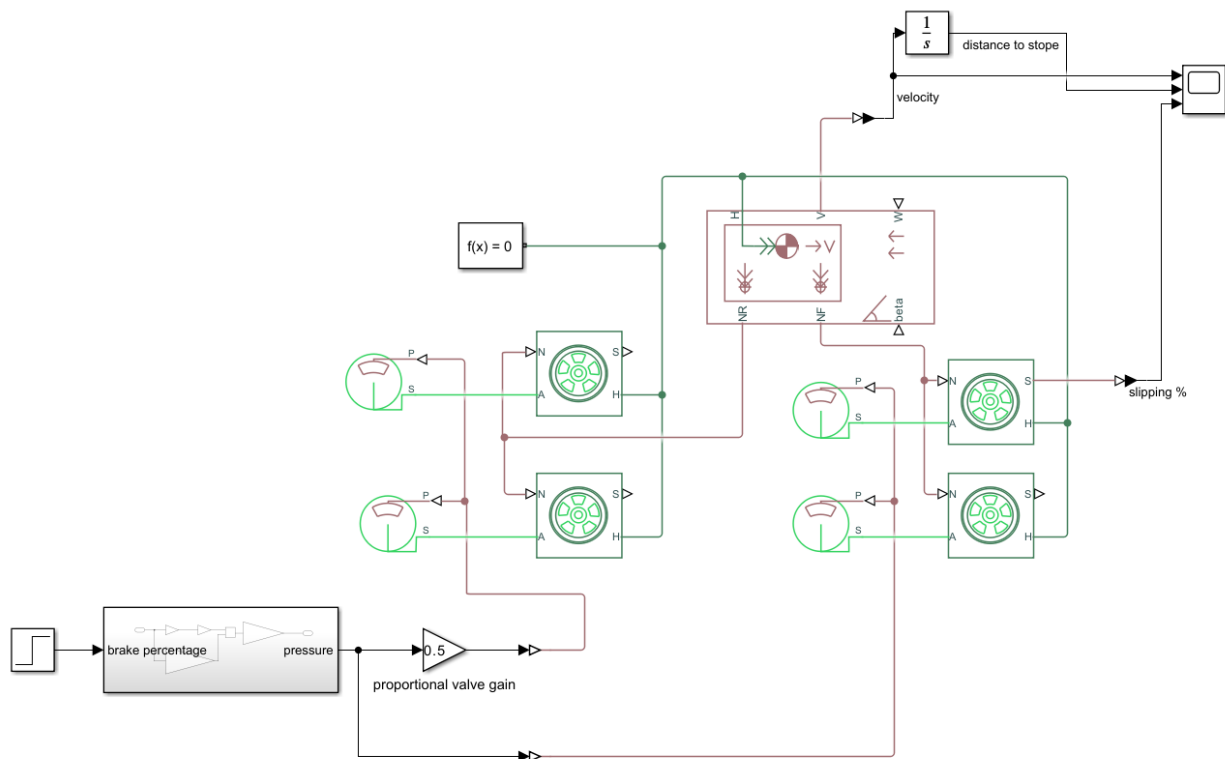


Figure 1 Braking System Model

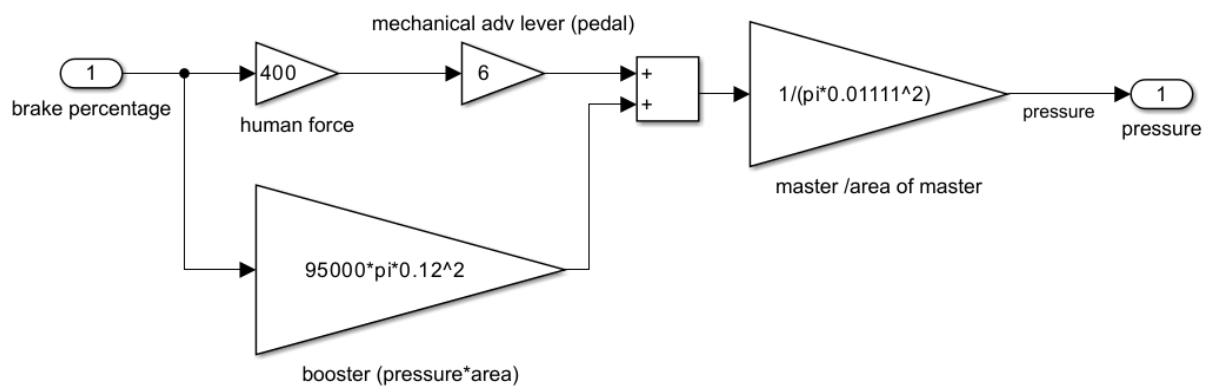


Figure 2 Pressure Line

Block Parameters: Vehicle Body

Vehicle Body
☒ Auto Apply

Settings
Description

NAME	VALUE
<div> Main </div>	
<div> <div>Mass</div> </div>	<div> <div>1100</div> <div>kg</div> </div>
<div> <div>Configurability</div> </div>	<div> <div>Compile-time</div> </div>
<div> <div>Number of wheels per axle</div> </div>	<div> <div>2</div> </div>
<div> <div>Horizontal distance from CG to front axle</div> </div>	<div> <div>1.7</div> <div>m</div> </div>
<div> <div>Horizontal distance from CG to rear axle</div> </div>	<div> <div>1.94</div> <div>m</div> </div>
<div> <div>CG height above ground</div> </div>	<div> <div>0.5</div> <div>m</div> </div>
<div> <div>Externally-defined additional mass</div> </div>	<div> <div>Off</div> </div>
<div> <div>Gravitational acceleration</div> </div>	<div> <div>9.81</div> <div>m/s<sup>2</sup></div> </div>
<div> <div>Negative normal force warning</div> </div>	<div> <div>Off</div> </div>
<div> <div>Drag</div> </div>	
<div> <div>Frontal area</div> </div>	<div> <div>3</div> <div>m<sup>2</sup></div> </div>
<div> <div>Drag coefficient</div> </div>	<div> <div>0.34</div> </div>
<div> <div>Air density</div> </div>	<div> <div>1.18</div> <div>kg/m<sup>3</sup></div> </div>
<div> <div>Pitch</div> </div>	
<div> <div>Initial Targets</div> </div>	
<div> <div> <input checked="" type="checkbox"/> Velocity </div> </div>	
<div> <div>Priority</div> </div>	<div> <div>High</div> </div>
<div> <div>Value</div> </div>	<div> <div>100</div> <div>kph</div> </div>
<div> <div>Nominal Values</div> </div>	

Figure 3 Vehicle Body Settings


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Tire (Magic Formula)
☒ Auto Apply
?

Settings
Description

NAME	VALUE	
<div> Main </div>		
Parameterize by	Peak longitudinal force and corresponding slip ▾	
<div> Rated vertical load </div>	3500	N ▾
<div> Peak longitudinal force at rated load </div>	3000	N ▾
<div> Slip at peak force at rated load (percent) </div>	10	
<div> Geometry </div>		
<div> Rolling radius </div>	0.2596	m ▾
<div> Rolling Resistance </div>		
<div> Dynamics </div>		
Compliance	No compliance - Suitable for HIL simulation ▾	
Inertia	Specify inertia and initial velocity ▾	
<div> Tire inertia </div>	1	kg*m <sup>2</sup> ▾
<div> Initial velocity </div>	100/3.6/0.2596	107 rad/s ▾
<div> Advanced </div>		

Figure 4 Tire Settings


Block Parameters: Disc Brake4
✕

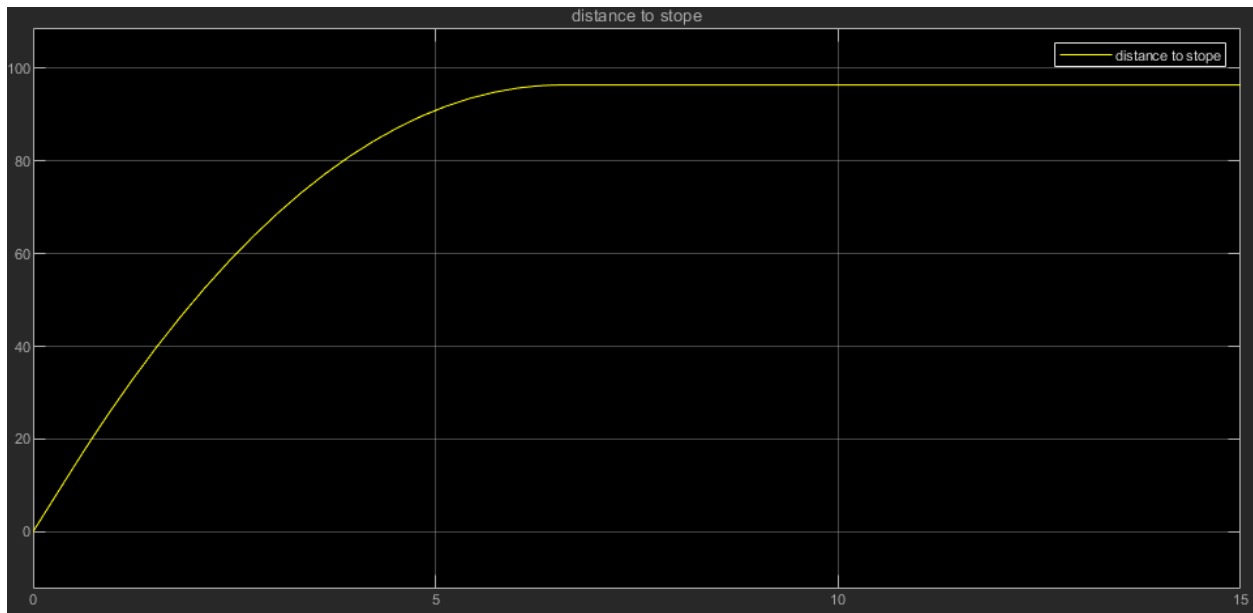
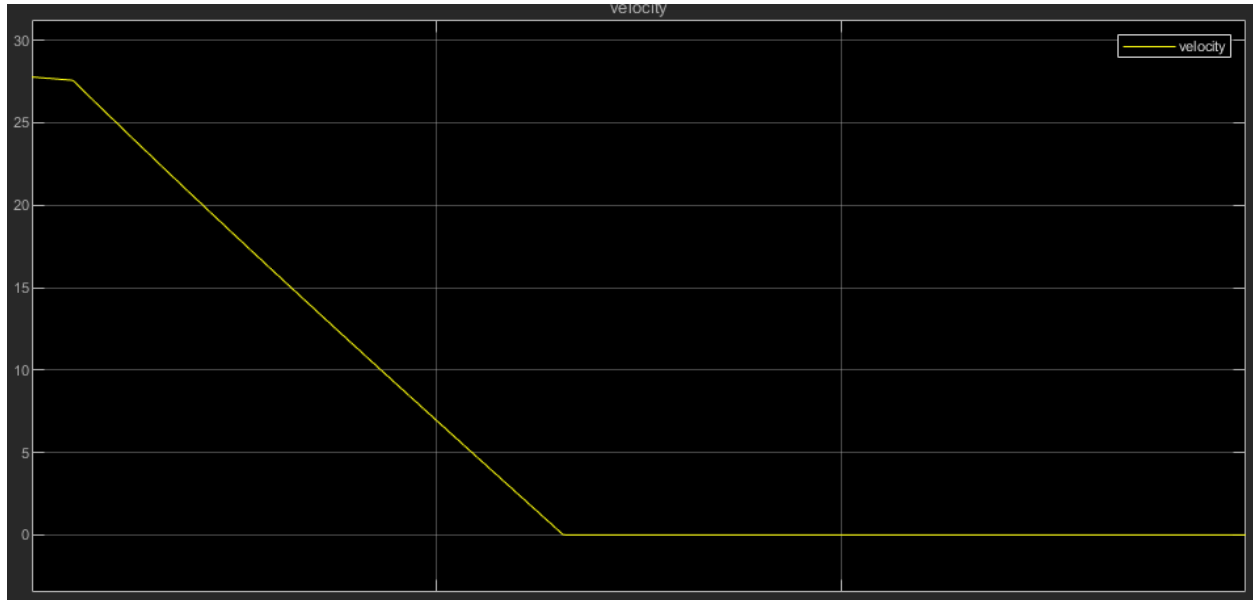
Disc Brake
☒ Auto Apply
?

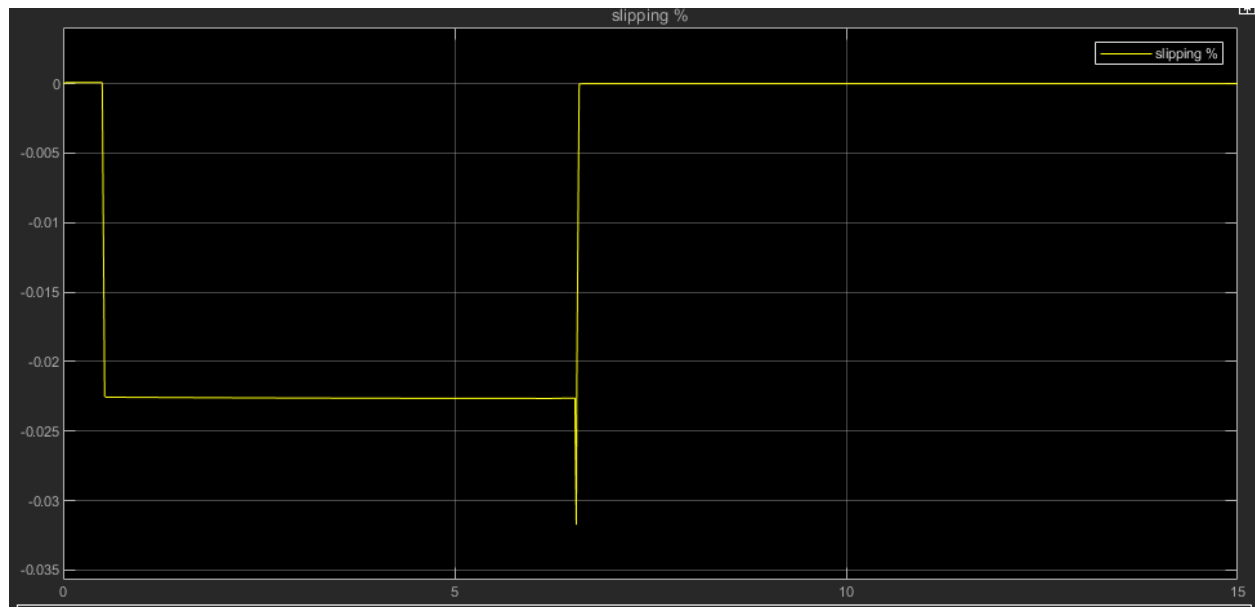
Settings
Description

NAME	VALUE		
<div> ▼ <b>Geometry</b> </div>			
<div> &gt; Mean pad radius </div>	189	mm	▼
<div> &gt; Cylinder bore </div>	11.11	mm	▼
<div> &gt; Number of brake pads </div>	2		
<div> ▼ <b>Friction</b> </div>			
Thermal port	Omit ▼		
<div> &gt; Static friction coefficient </div>	0.9		
<div> &gt; Coulomb friction coefficient </div>	0.7		
<div> &gt; Breakaway friction velocity </div>	0.1	rad/s	▼
<div> &gt; Viscous friction coefficient </div>	0	N*m*s/rad	▼
<div> &gt; <b>Faults</b> </div>			

*Figure 5 Disc Brake Settings*

## Results:





## Comments:

- No slipping occurs as the slipping% did not reach -1.
- The vehicle will take approximately 7 seconds to come to rest after the brakes are applied.