MODEL BASED DEVELOPMENT (CA 2)

11/26/2018

Objective:

The objective of our second assignment for Model Based Development is to develop a State Controller to implement an Automatic Gearbox. This gearbox will be use on the current Vehicle Plant Model we have implemented in class.

The Gearbox will take inputs such as speed, throttle and gradient, based on these inputs the Automatic Gearbox pick the appropriate gear. We will also implement extra features such as Modes.

We are asked to develop a state chart to describe the operation and test our controller model, clearly documenting each test. All to be done within Simulink.

Theory:

The way the gears are arranged varies from one car to another, knowing how the gears are arranged, including how to put the car into reverse, before you move off is vital.

Choosing the wrong gear can

- make the car accelerate too slowly or too quickly
- make it difficult to control the car effectively
- increase fuel consumption and wear and tear on the car.

Travelling in the highest suitable gear will help you save fuel and reduce wear on the engine.

Gear	Speed (mph)	Gradient (%)
1st Gear	From 0 to 20	From -20 to 20
2nd Gear	From 20 to 40	From -15 - 15
3rd Gear	From 40 to 60	From -10 - 10
4th Gear	From 60 to 80	From -5 - 5

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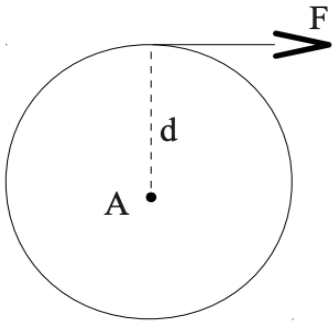
Torque:

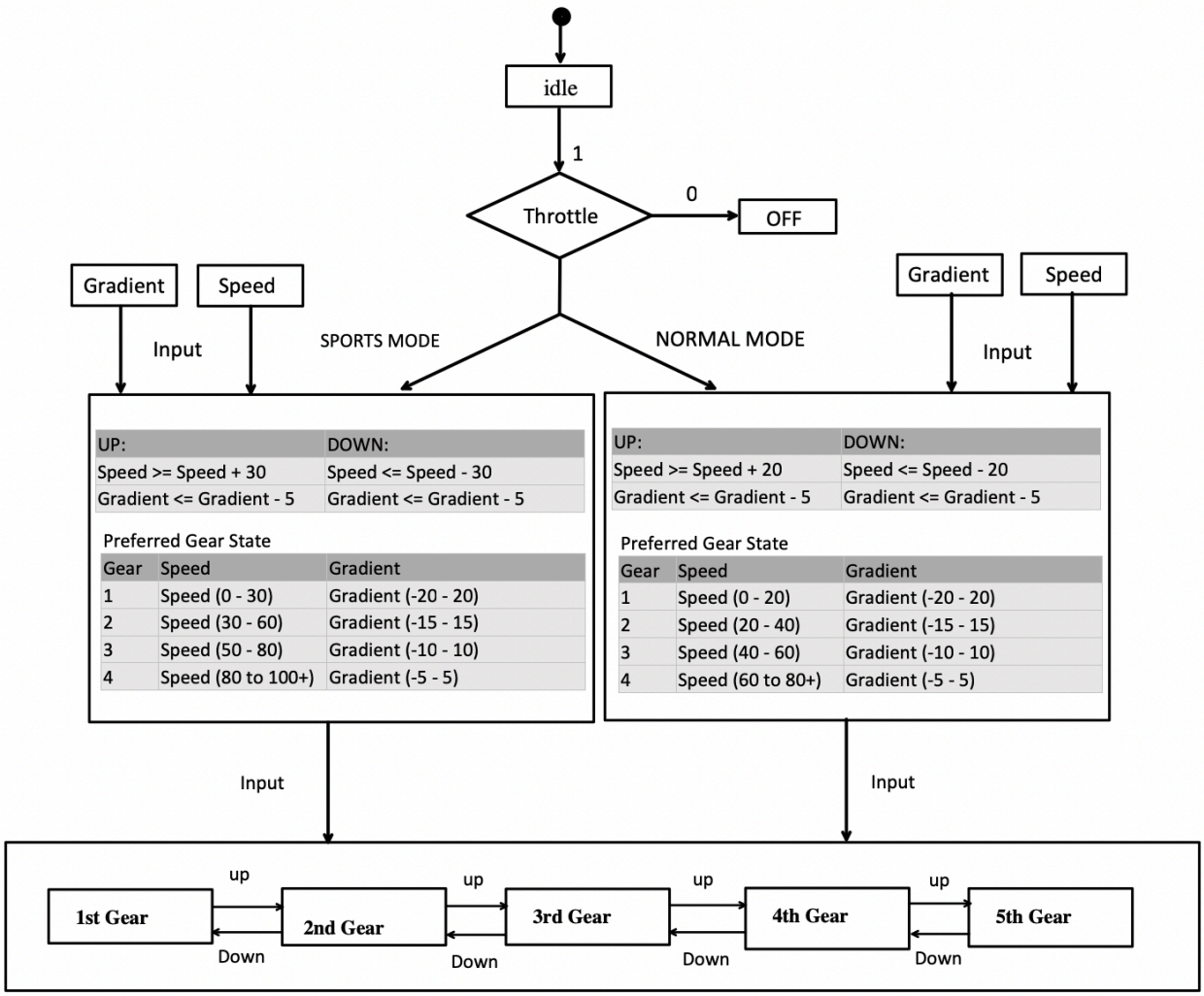
Torque is a measure of the tendency of a force to rotate an object about some axis. In the following diagram, the circle represents a gear of radius d. The dot in the centre represents the axle (A). A force F is applied at the edge of the gear, tangentially.



In this example, the radius of the gear is the moment arm. The force is acting along a tangent to the gear, so it is perpendicular to the radius. The amount of torque at A about the gear axle is defined as (F x d)

State Chart:

I made a simple state chart to visually show the process of my Automated Gear Box



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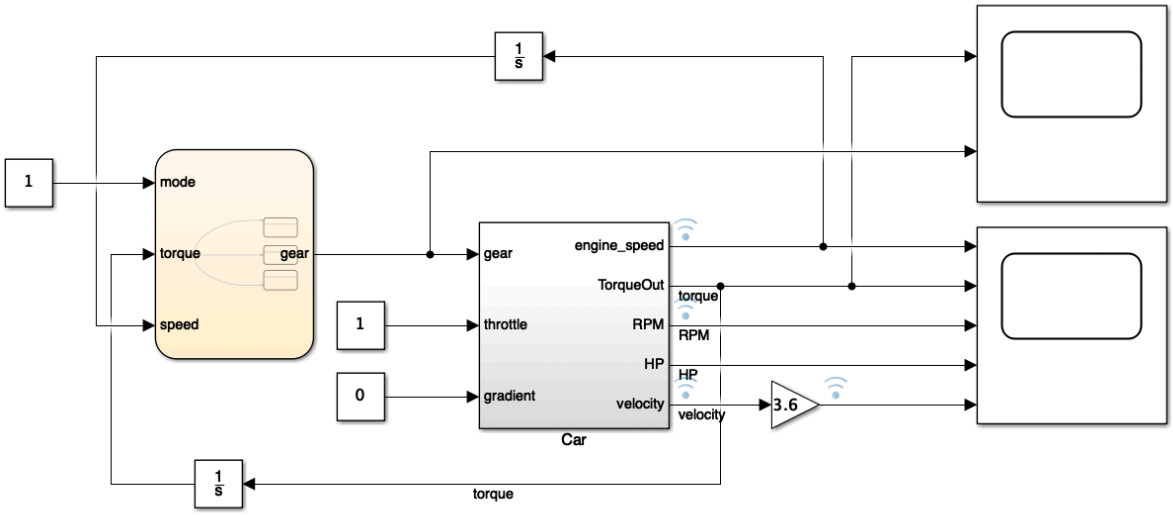
Plant Model

Final Plant Model:

- has three inputs to the state flowchart:
  - mode: there are 3 modes, each mode can be selected by assigning (1 – 3). Each mode has different ratios which is used to assign gears to be used.
  - Torque: this input is a feedback from the torque about with time delay.
  - Speed: this input is a feedback to the speed result.
- Results can be seen through the scope which takes in 5 inputs.



Up Function:

I have tried playing using functions, I wasn't able to get any results from my functions and always returns error.

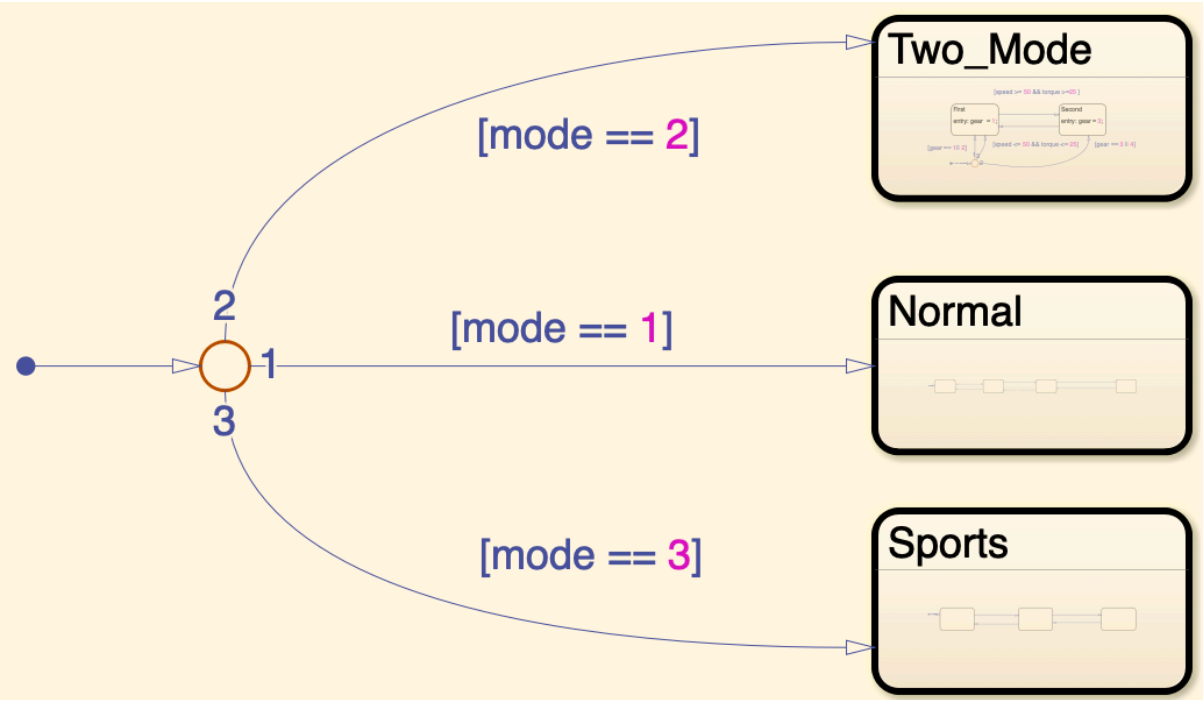
I tried using the if-else state which to do the up action (Gear + 1).

```
function status = up(t)

% Up (Gear + 1)
[Speed >= Speed + 20 || Gradient <= Gradient - 5]
1
2
{gear = gear;}
{gear = gear + 1;}
```

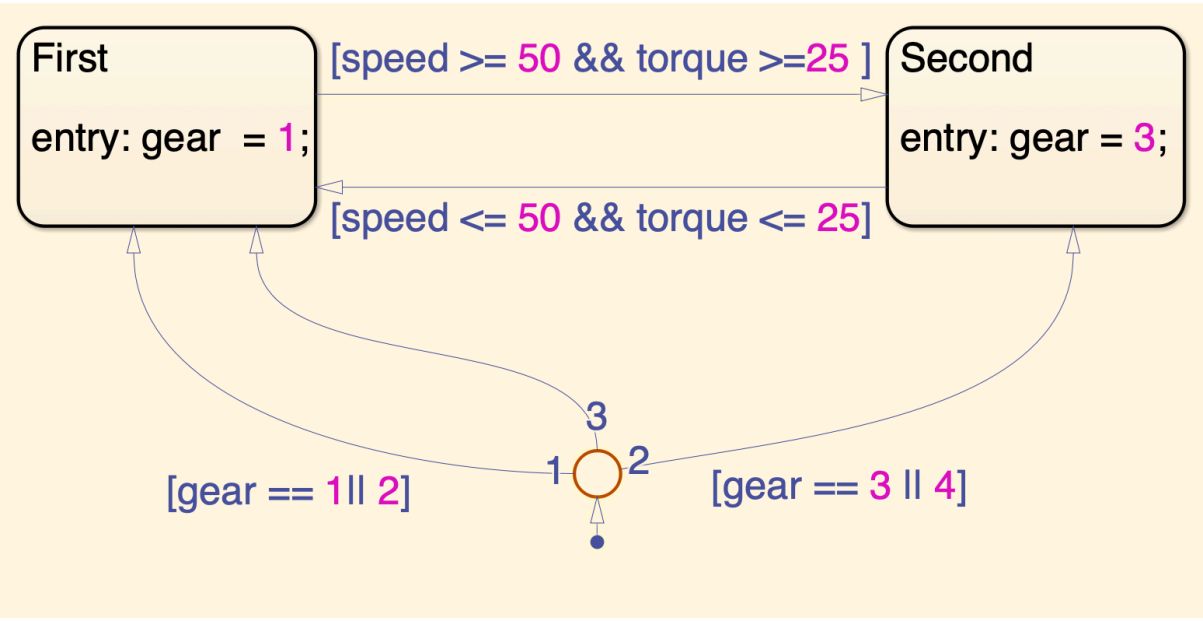
State Flow Chart:

Contains three modes, Winter, Normal and Sports. It has a junction which allows user to select the mode the want to be on which can be done by setting the mode input.



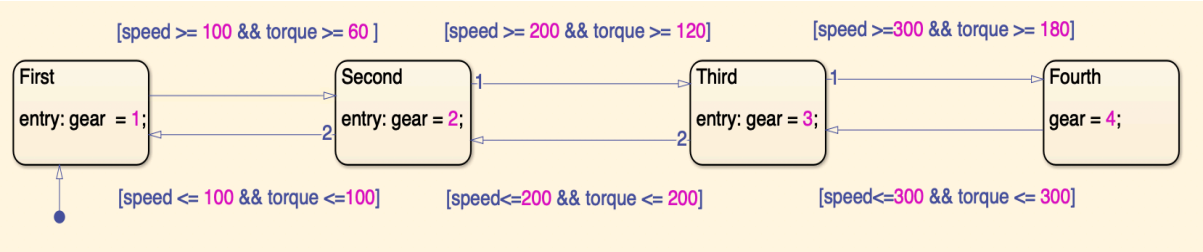
Two gear mode:

In this mode we only used two gears, gear 1 and 3. It also contains a junction which checks the current gear of vehicle just in case we want to use a set time and change mode.



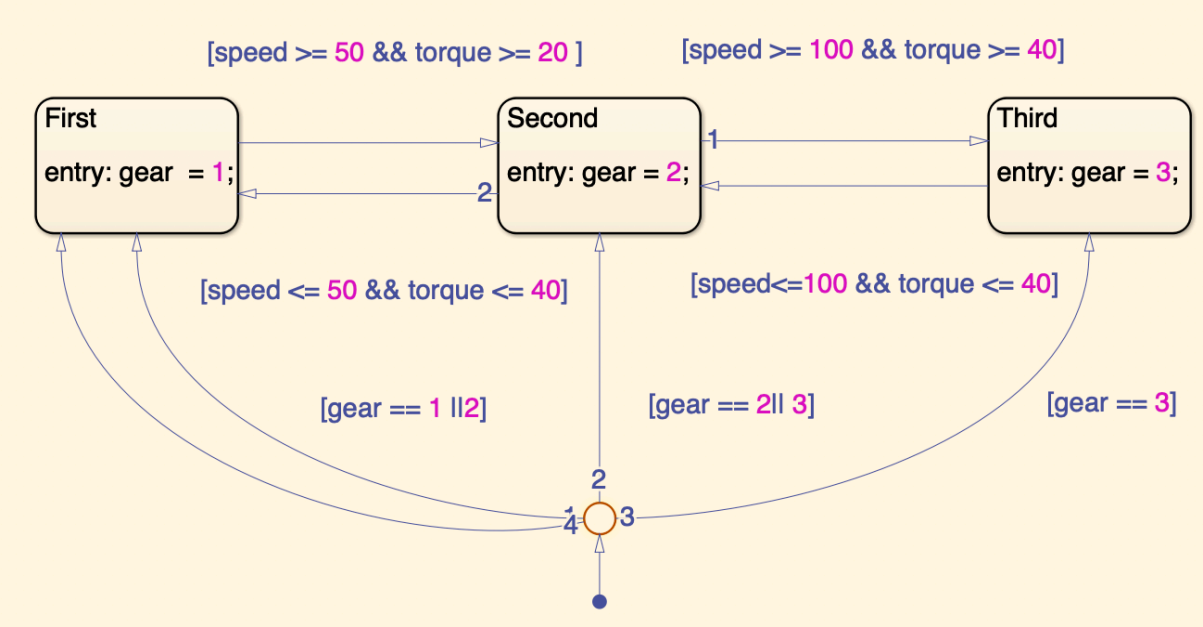
Normal Mode:

This is the normal mode which has an initial state at gear 1. I have put statements when met at certain gear will automatically move up or down. It has a maximum of four gears. It uses the speed and torque inputs in statements to decide when to move up or down.



Sports Mode:

Sports mode uses three gears, the speed statements are a lot higher because in sports mode the vehicle is able to run faster on every gear compare to normal mode. It also contains a junction similar to winter mode which checks the current gear.



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Test

Test 1: Running Gear Automation in Normal Mode

Gradient: 0

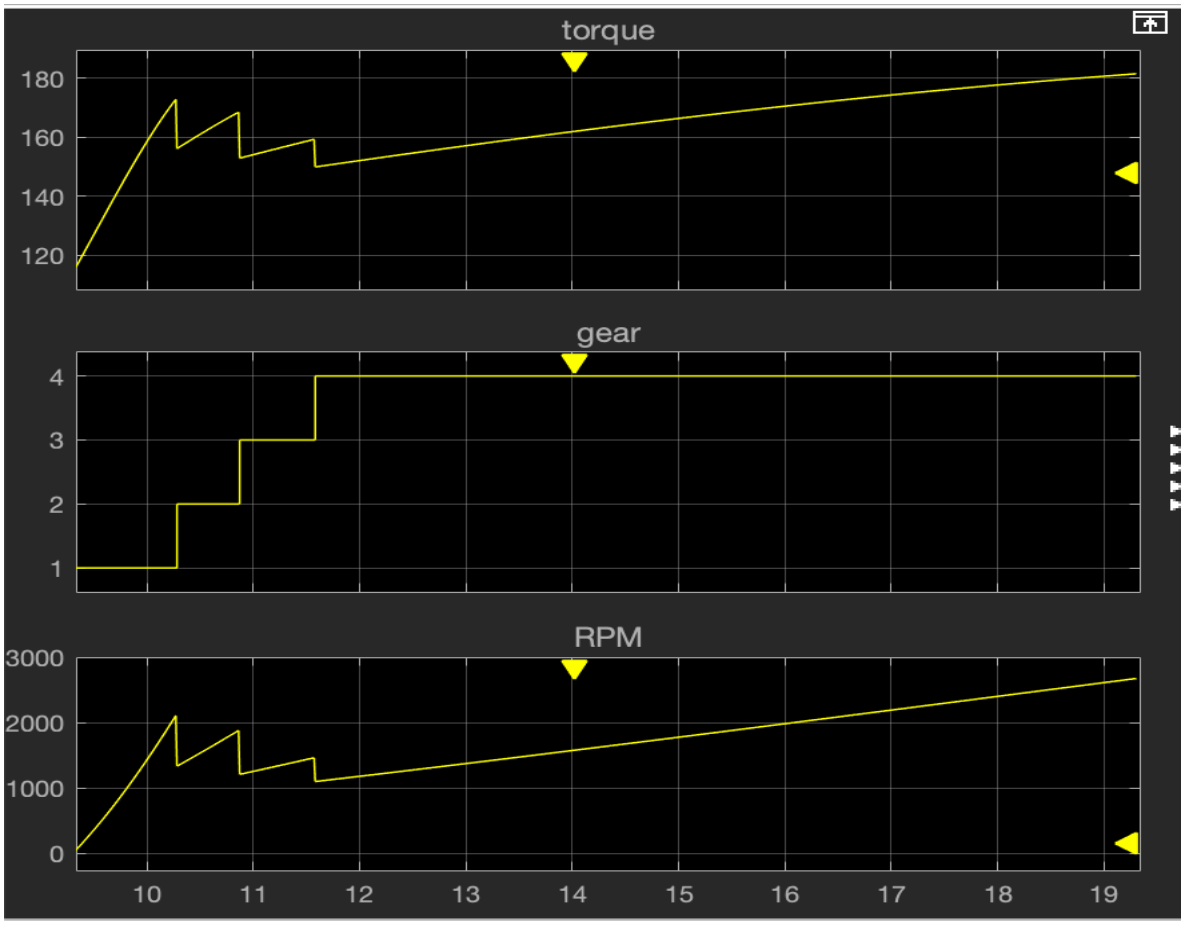
Mode: 1

Expected Result:

Gear graph should show a change in gears. Increasing gear by one at every max point of the torque. Gear graph should show max at four.

Obtained Result:

I used 10 simulation run time.



Test 2: Running Gear Automation in Two-Mode

Gradient: 0

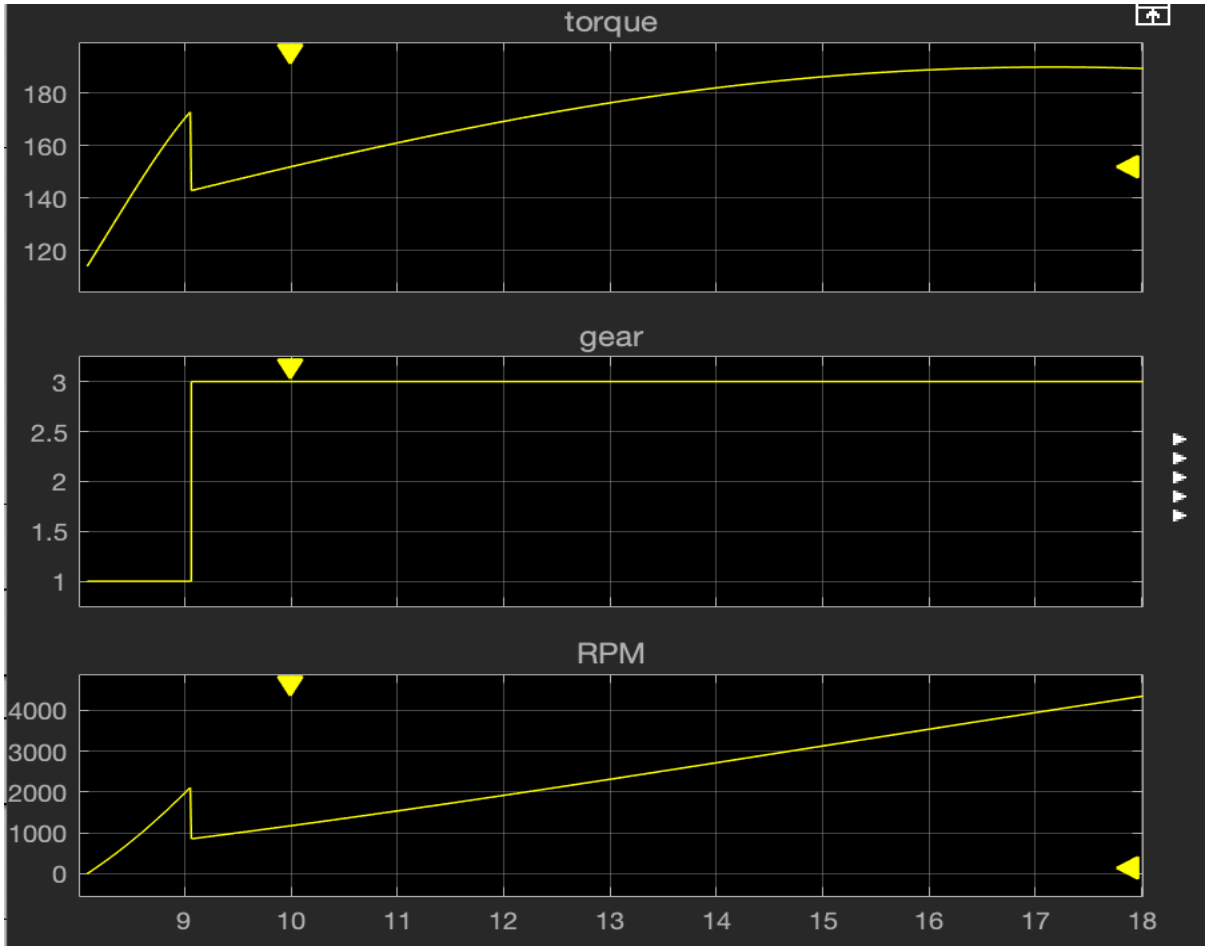
Mode: 2

Expected Result:

Gear graph should show a change in gears. Increasing gear by one at every max point of the torque. Gear graph should show max of three as the Two-Mode goes from gear one to gear three when speed and torque is greater than 100.

Obtained Result:

I used 10 simulation run time.



Test 3: Running Gear Automation in Sports Mode

Gradient: 0

Mode: 3

Expected Result:

Gear graph should show a change in gears. Increasing gear by one at every max point of the torque. Gear graph should show max of three as the Sport Mode goes from gear one to gear three step by step when speed and torque is greater than 400 and 600.

Obtained Result:

I used 10 simulation run time.