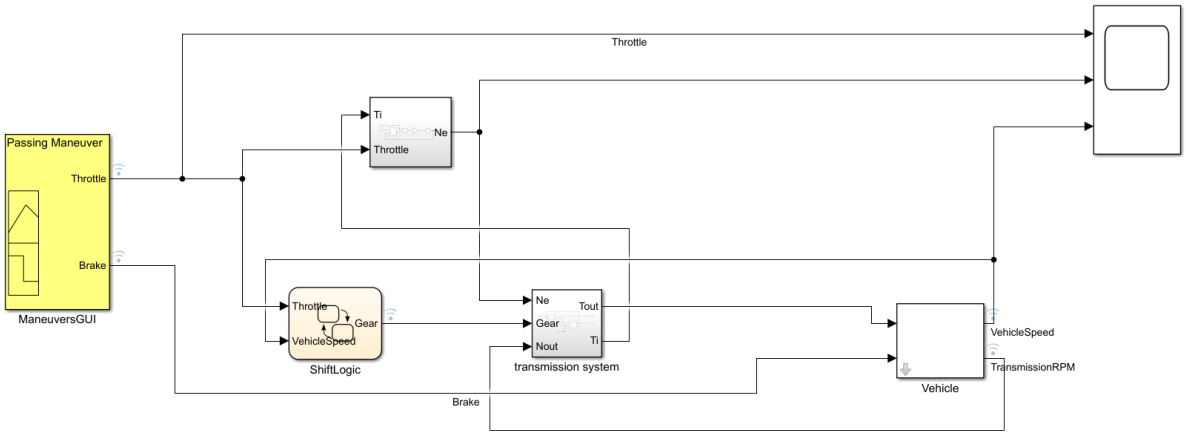
Report on MBD milestone Week 3 question 3

Topic: Automatic Gear Transmission control

Done by: Ashwini Mandare (unique ID: 2005458)

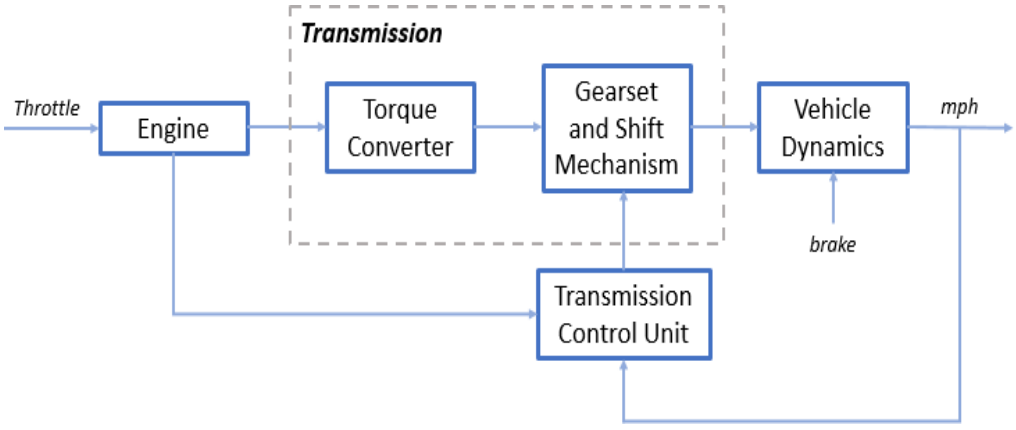
Introduction

In this project **Automatic Gear Transmission control** is designed. Here the gear shift occurs according to the change in vehicle speed from a specific threshold. This system contains various blocks in it. The following figure gives an idea of the same.



Block diagram

The block diagram of the system includes following: -



Equations of system: -

The following are equations used in the system.

$$I_{ei}\dot{N}_e = T_e - T_i$$

N_e = engine speed(RPM)

I_{ei} = moment of inertia of the engine and the impeller

T_e, T_i = engine and impeller torque

$$T_i = \frac{N_e^2}{K^2}$$

$$K = f_2\frac{N_{in}}{N_e} = \text{K-factor (capacity)}$$

N_{in} = speed of turbine (torque converter output)

$$R_{TQ} = f_3\frac{N_{in}}{N_e} = \text{torque ratio}$$

$R_{TR} = f_4(gear)$ = transmission ratio

$T_{out} = R_{TR}T_{in}$

$N_{in} = R_{TR}N_{out}$

T_{in}, T_{out} = transmission input and output torques

N_{in}, N_{out} = transmission input and output speed (RPM)

$T_{load} = sgn(mph)(R_{load0} + R_{load2}mph^2 + T_{brake})$

R_{load0}, R_{load2} = friction and aerodynamic drag coefficients

T_{load}, T_{brake} = load and break torque

mph = vehicle linear velocity

$$I_v \dot{N}_w = R_{fd}(T_{out} - T_{load})$$

I_v = vehicle inertia

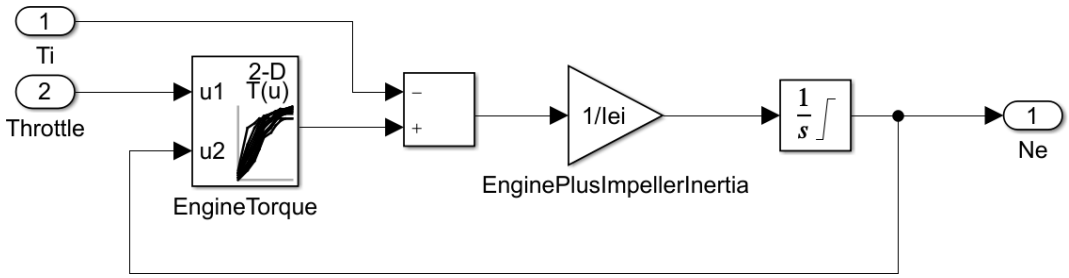
N_w = wheel speed(RPM)

R_{fd} = final drive ratio

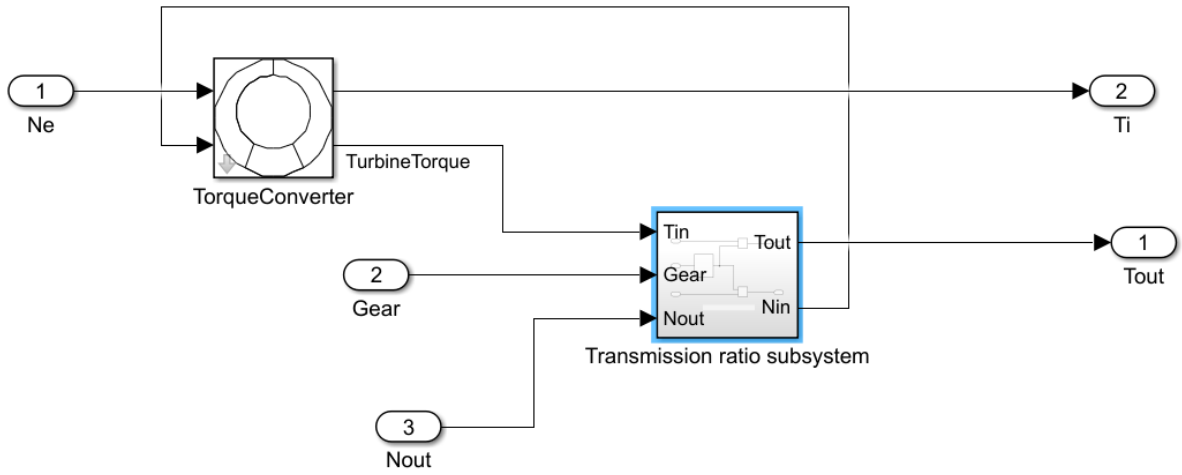
$T_{load} = f_s(N_w)$ = load torque

Subsystems used in model: -

1. Engine Subsystem

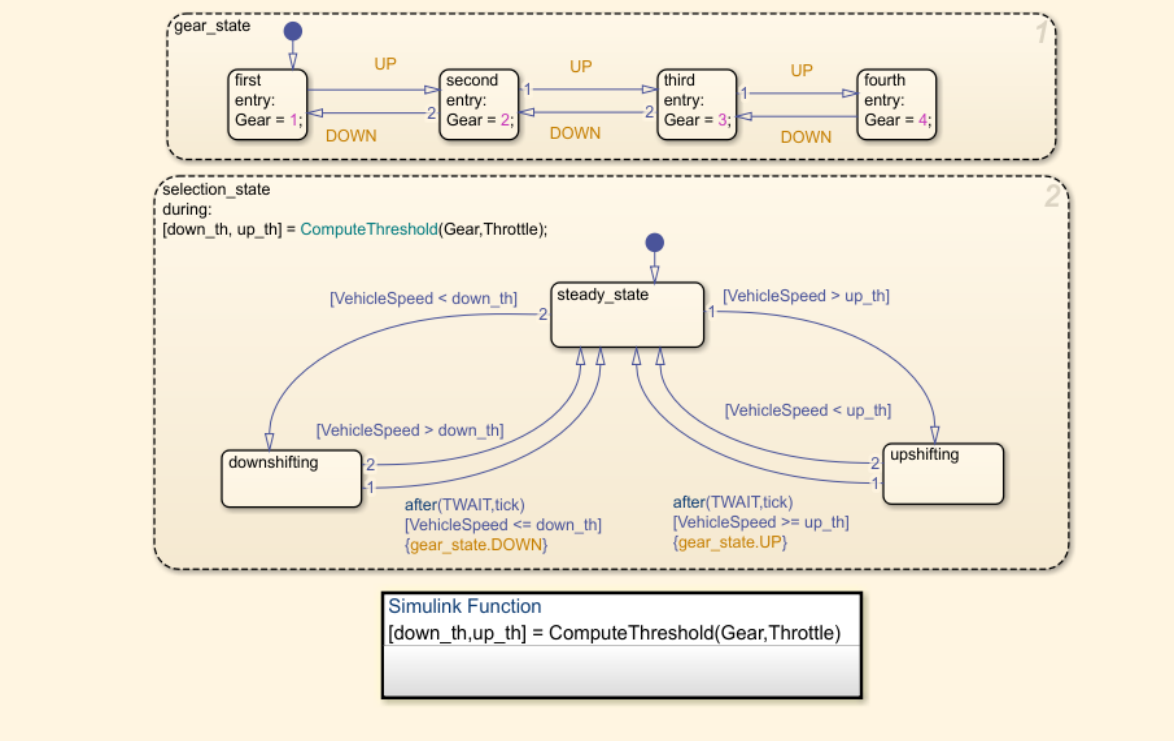


2. Transmission subsystem



Shift logic chart: -

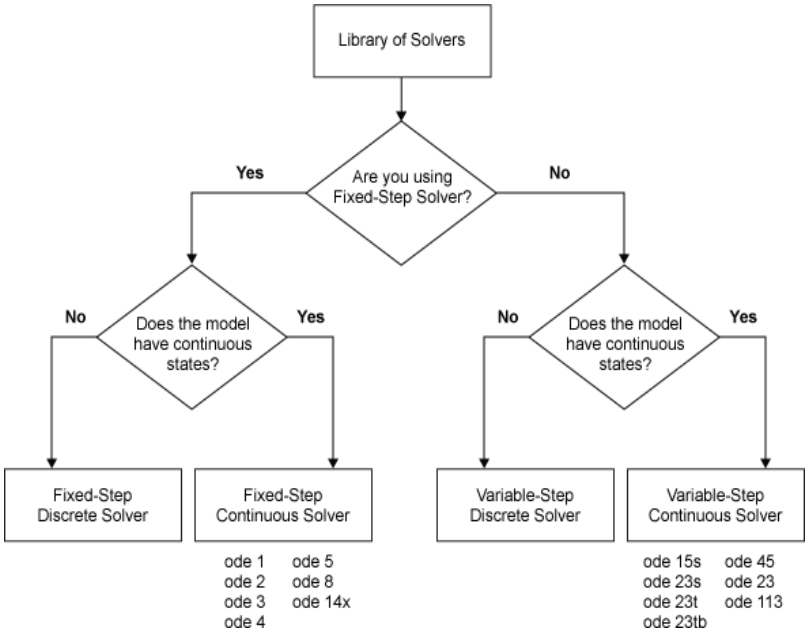
The shift logic chart is the logic for the gear changing mechanism.



Solver selection

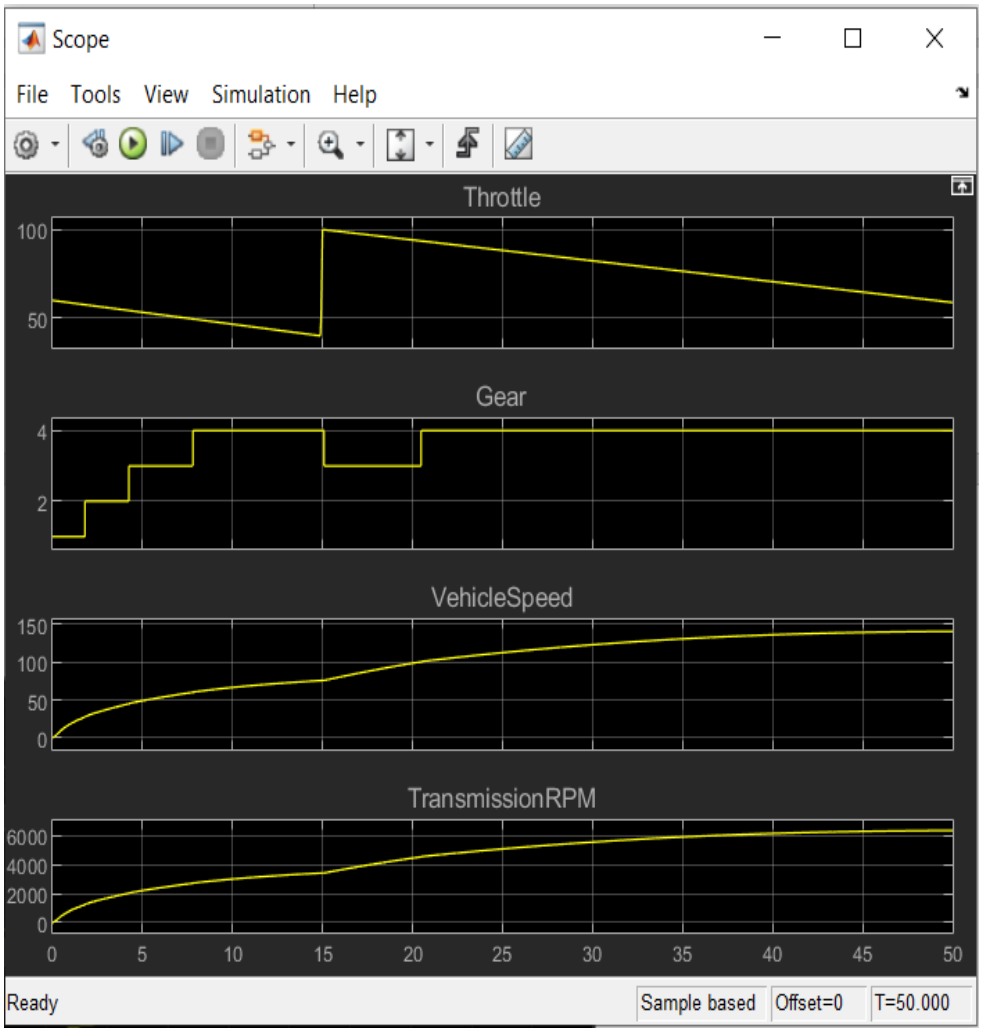
The appropriate solver for simulating a model depends on these characteristics:

- System dynamics
- Solution stability
- Computation speed
- Solver robustness



According to the above figure, this system does not contain any discrete blocks, so continuous solvers need to be selected. Fixed Step Solver is used because it took least number of steps to simulate compared to variable step solvers. variable step solvers took 1258 steps to completed the simulation. But fixed step solvers took only 1251 steps to complete the simulation. These step difference does not make any difference in the stability. So, fixed step solvers are selected. Fixed step size of 0.04 is taken because 0.04 sampletime is chosen for the shift logic chart. So, in order to simulate the system step size should be either 0.04 or in multiples of 0.04 which is lesser than 0.04. Since, taking the step size below 0.04 would increase simulation time. So, taking 0.04 step size is optimal.

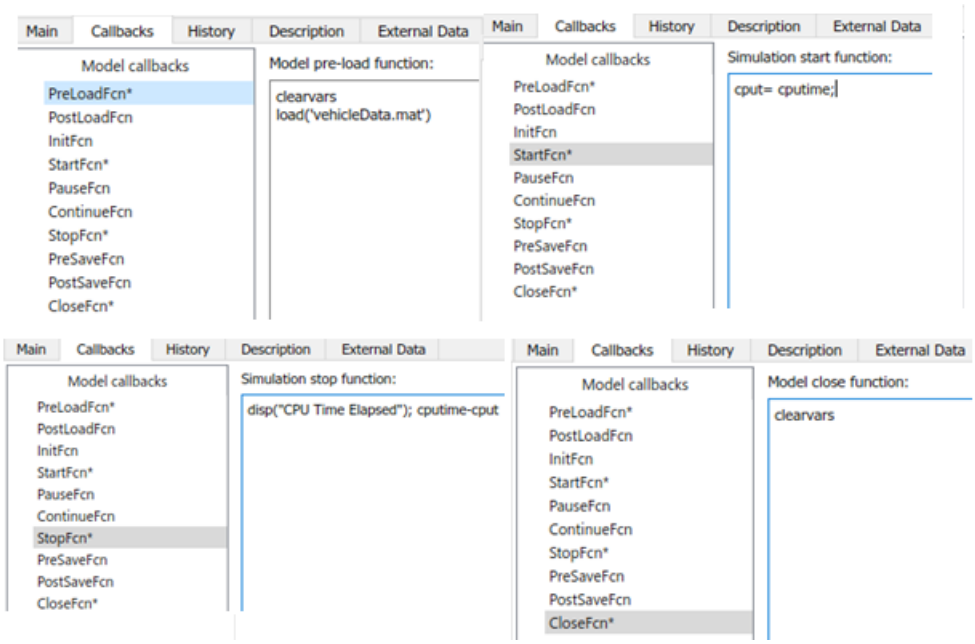
Output: -



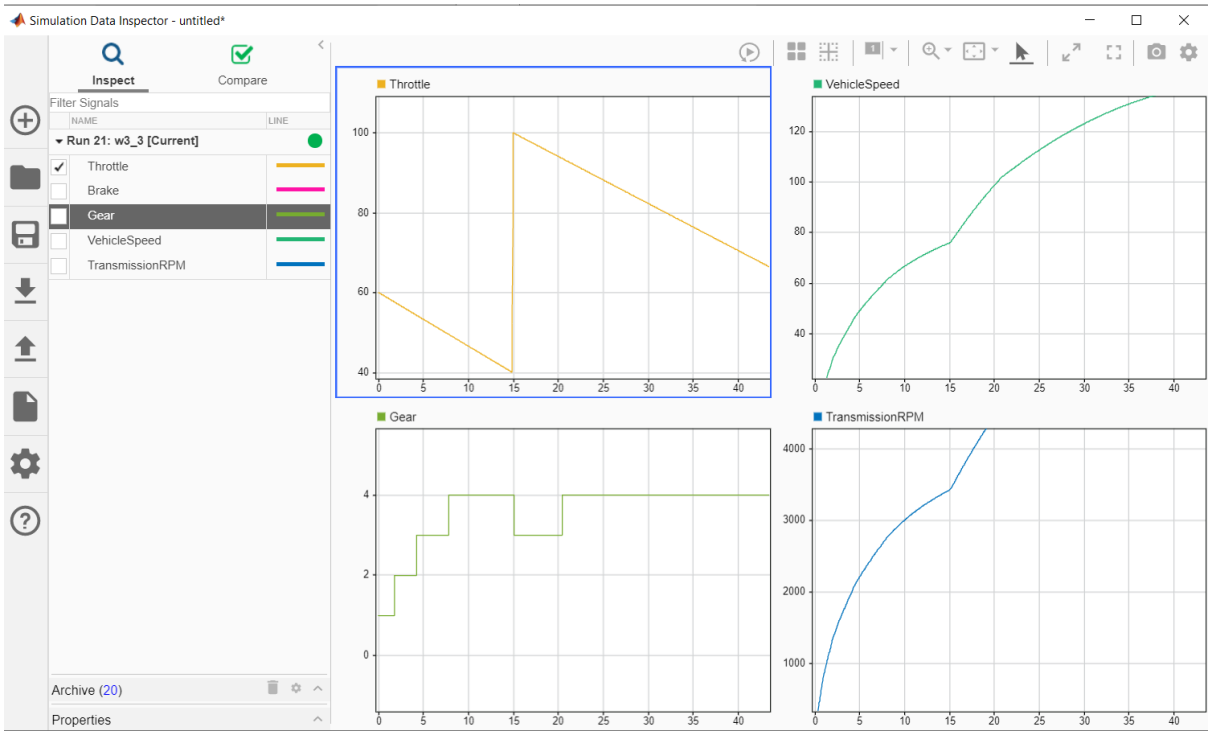
Skills: -

Callbacks

- Preload function is used to clear variables in base workspace and load the vehicle data file.
- Start call back function, which is implemented to capture the CPU time at the start of the simulation.
- Stop call back function, which is implemented to capture the CPU time at the stop of the simulation.
- Close call back function which is used to clear the base workspace after closing the model.

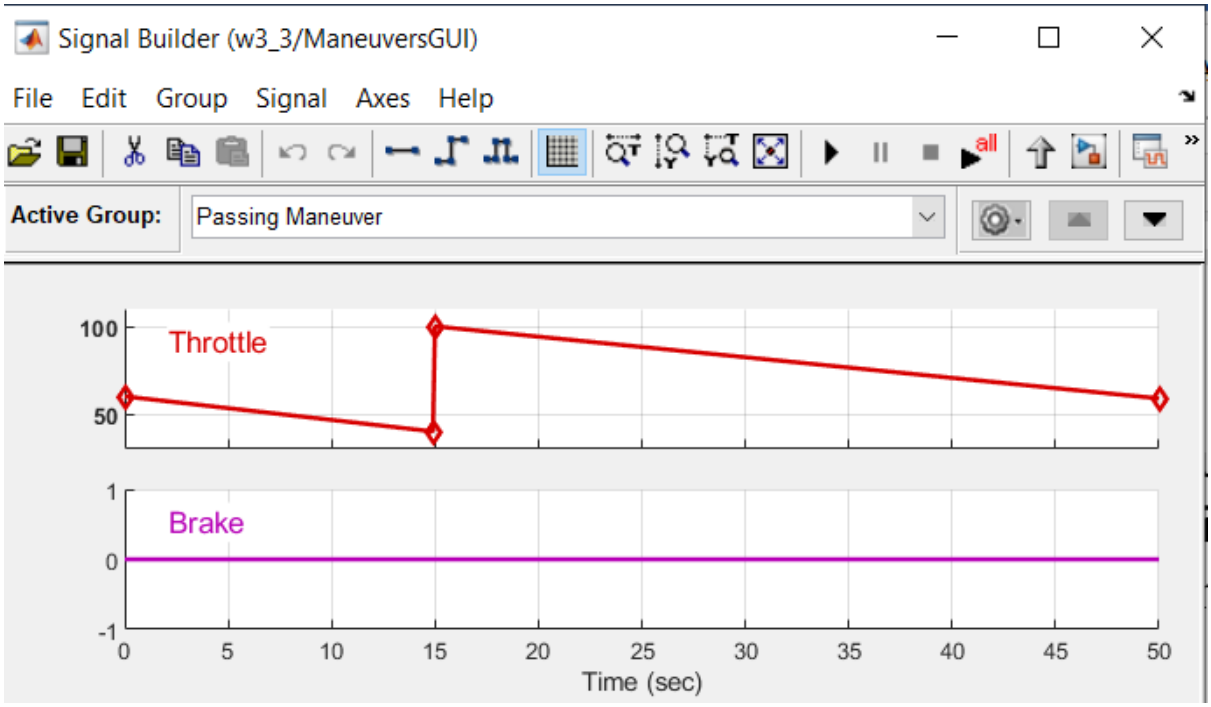


Data inspector



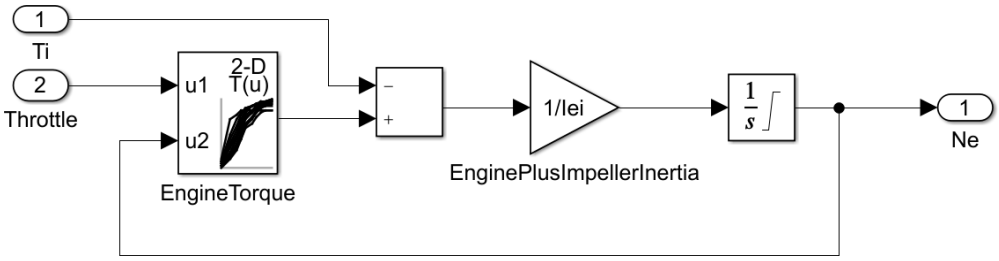
Signal builder

Signal builder is used to inputs throttle position and brake position to the vehicle

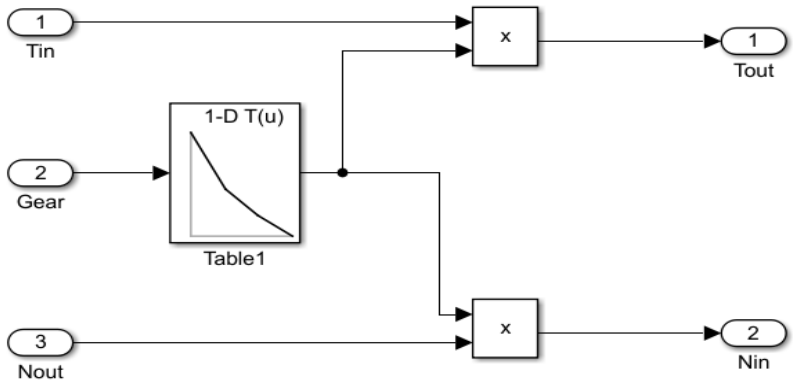


Lookup table

2D Look up table is used to calculate the engine torque map, and torque converter characteristics used in the simulations.



Two 1D look up table is used to calculate the gear ratio.



Transmission Gear Ratio