Motor bike- Clutch working

GROUP-I

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Introduction

A **clutch** is a mechanical device that engages and disengages the power transmission, especially from driving shaft to driven shaft.

Without the clutch, the only way to stop the wheels from turning would be to turn off the engine -- an impractical solution in any kind of motorized vehicle.

The clutch is a series of spring-loaded plates that, when pressed together, connect the transmission to the crankshaft. When a rider wants to shift gears, he uses the clutch to disconnect the transmission from the crankshaft. Once the new gear is selected, he uses the clutch to re-establish the connection.

Multi plate Clutch system of motorcycle:

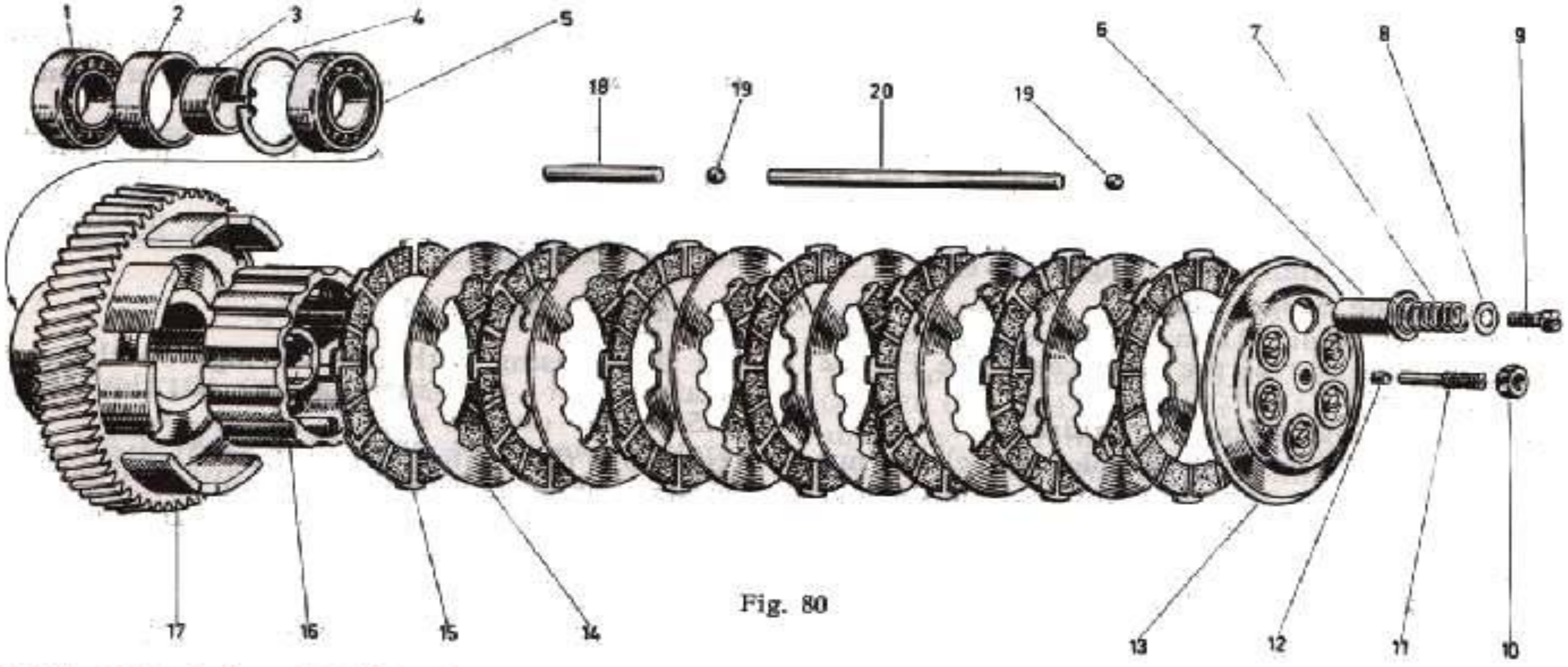
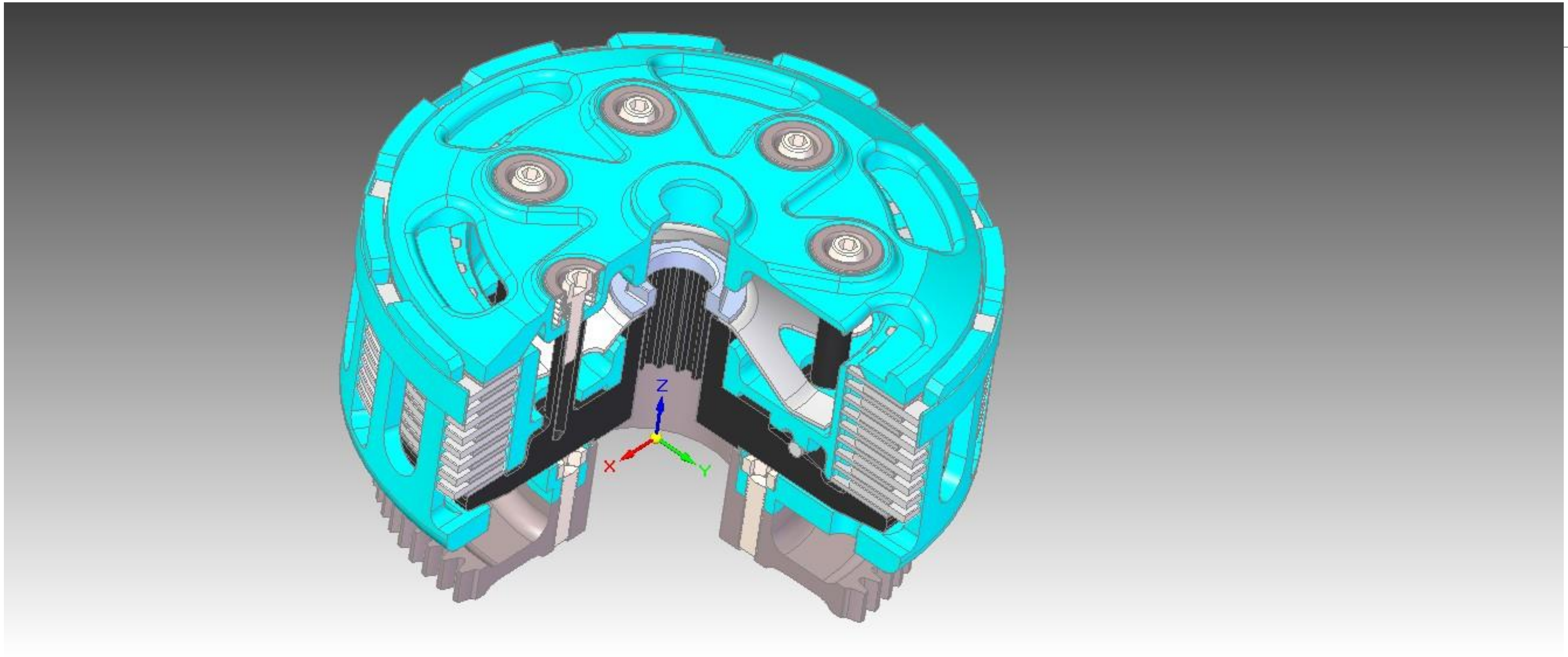


Fig. 80

List of parts of the clutch housing.

1 Bearing.
2 Spacer.
3 Spacer.
4 Seeger ring.
5 Bearing.
6 Spring retainer.
7 Clutch spring.
8 Washer.
9 Screw TC.
10 Hexagon nut.
11 Clutch adjusting screw.
12 Roller.
13 Pressure plate.
14 Driven plate.
15 Driving plate.
16 Clutch drum.
17 Clutch housing.
18 Clutch peg.
19 Ball (2).
20 Clutch operating rod.

CLUTCH : solid edge model



Physics:

T_{in} = input (engine) torque;

F_n = normal force between friction plates;

I_e, I_v = moments of inertia for the engine and for the transmission/vehicle;

b_e, b_v = damping rates at the engine and transmission/vehicle sides of the clutch;

μ_k, μ_s = kinetic and static coefficients of friction;

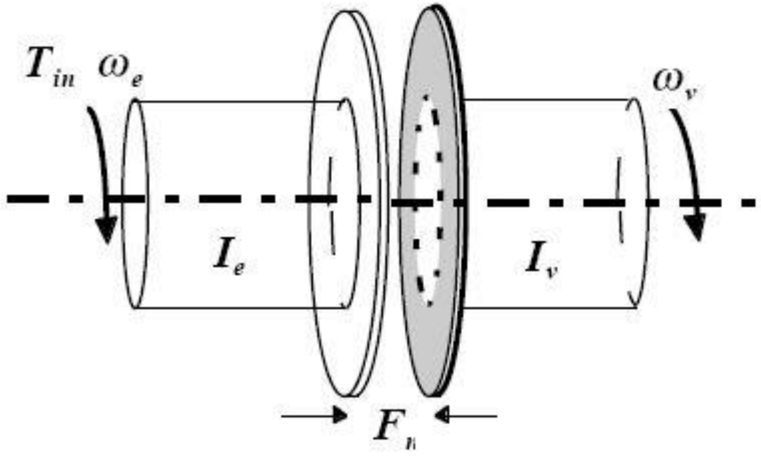
ω_e, ω_v = angular speeds of the engine and transmission input shafts;

r_1, r_2 = inner and outer radii of the clutch plate friction surfaces;

R = equivalent net radius;

T_{cl} = torque transmitted through the clutch;

T_l = friction torque required of the clutch to maintain lockup;



Distinct modes of operation

1) slipping - the two plates have differing angular velocities

2) lockup - the two plates rotate together.

Equations :

Equation 1:The state equations for the coupled system are:

$$I_e\dot{\omega}_e = T_{in} - b_e\omega_e - T_d$$

$$I_v\dot{\omega}_v = T_d - b_v\omega_v$$

Equ 2 : The torque capacity of the clutch is a function of its size friction characteristics, and the normal force that is applied are

$$(T_f)\max = \int\int_A \frac{r \times F_f}{A} da = \frac{F_n\mu}{\pi(r_2^2 - r_1^2)} \int_{r_1}^{r_2} \int_0^{2\pi} r^2 dr d\theta = \frac{2}{3} R F_n \mu$$

$$R = \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}$$

Equ 3 : When the clutch is slipping, the model uses the kinetic coefficient of friction and the full capacity is available, in the direction that opposes slip.

$$T_{fmaxk} = \frac{2}{3} R F_n \mu_k$$

$$T_d = sgn(\omega_e - \omega_v) T_{fmaxk}$$

Equ 4 : When the clutch is locked, the angular velocities of the engine and transmission input shafts are the same, and the system torque acts on the combined inertia as a single unit. So, we combine the differential equations (Equation 1) into a single equation for the locked state.

$$\omega_e = \omega_v = \omega$$

$$(I_e + I_v)\dot{\omega} = T_{in} - (b_e + b_v)\omega$$

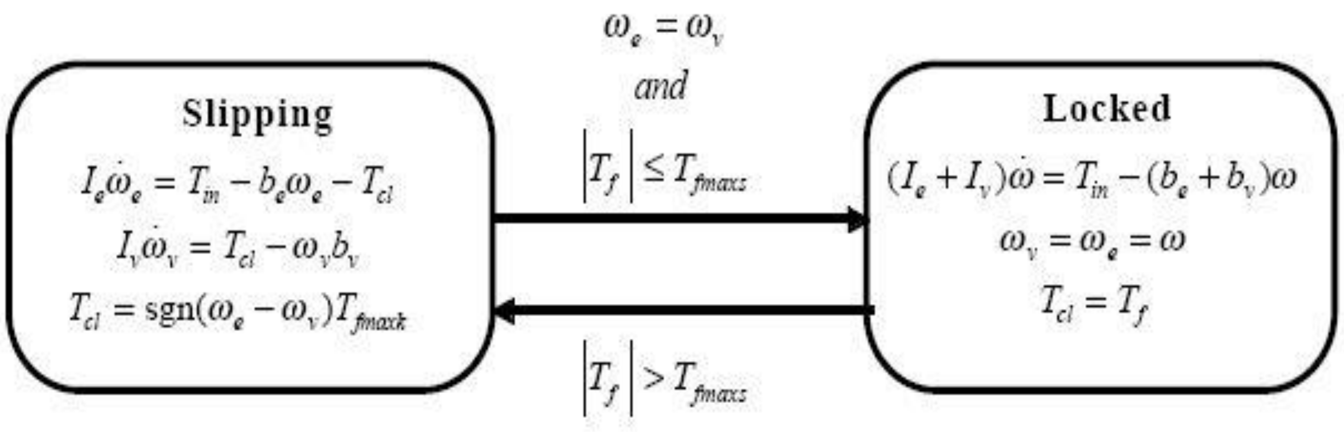
Equ 5 :Solving Equation 1 and Equation 4, the torque transmitted by the clutch while locked is:

$$T_c = T_f = \frac{I_v T_{in} - (I_v b_e - I_e b_v)\omega}{I_v + I_e}$$

The clutch remains locked unless the magnitude of Tf exceeds the static friction capacity

$$T_{fmaxs} = \frac{2}{3} R F_n \mu_s$$

Overall behavior of the clutch.



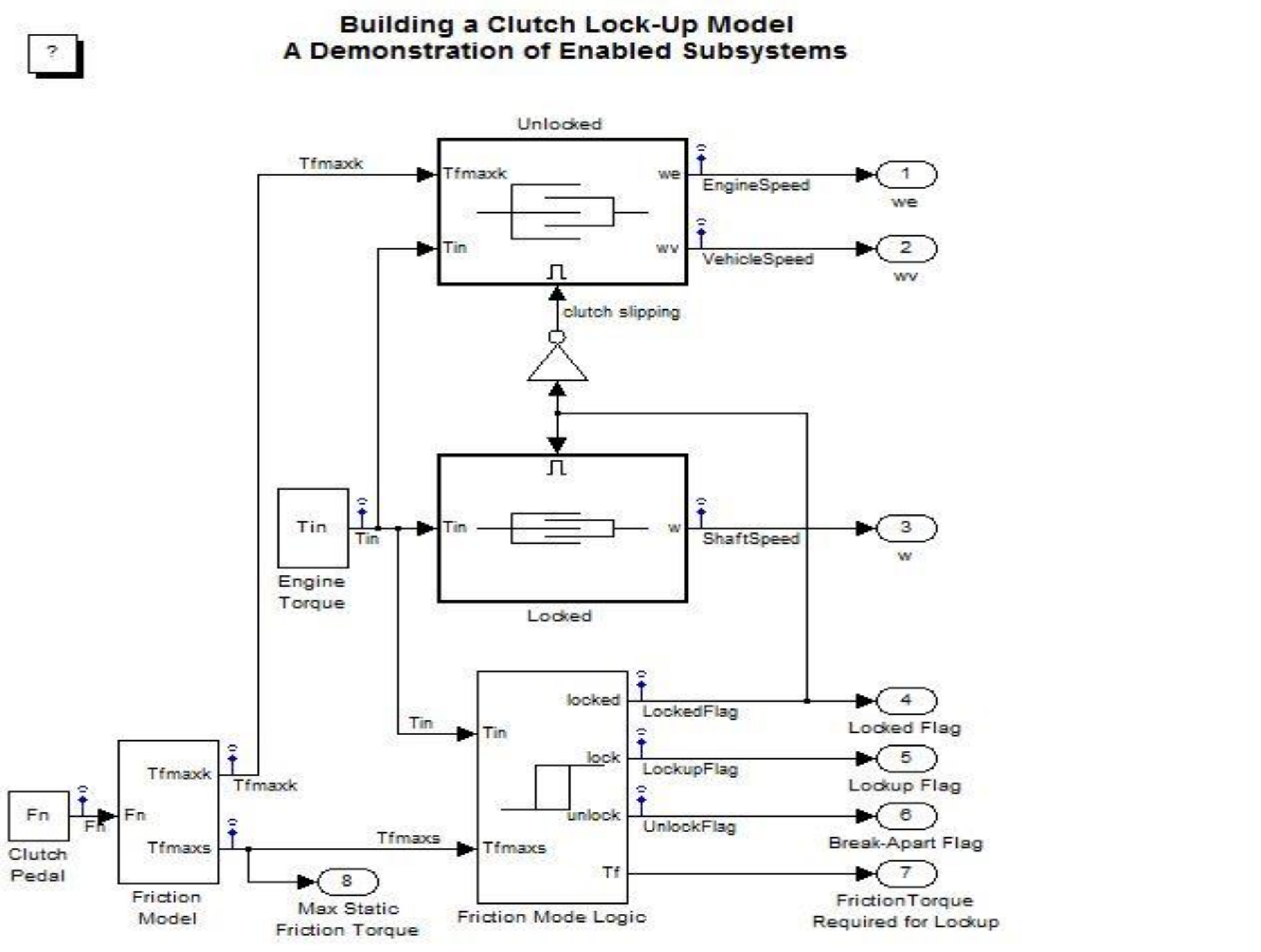
Modelling

There are two methods for solving this type of problem:

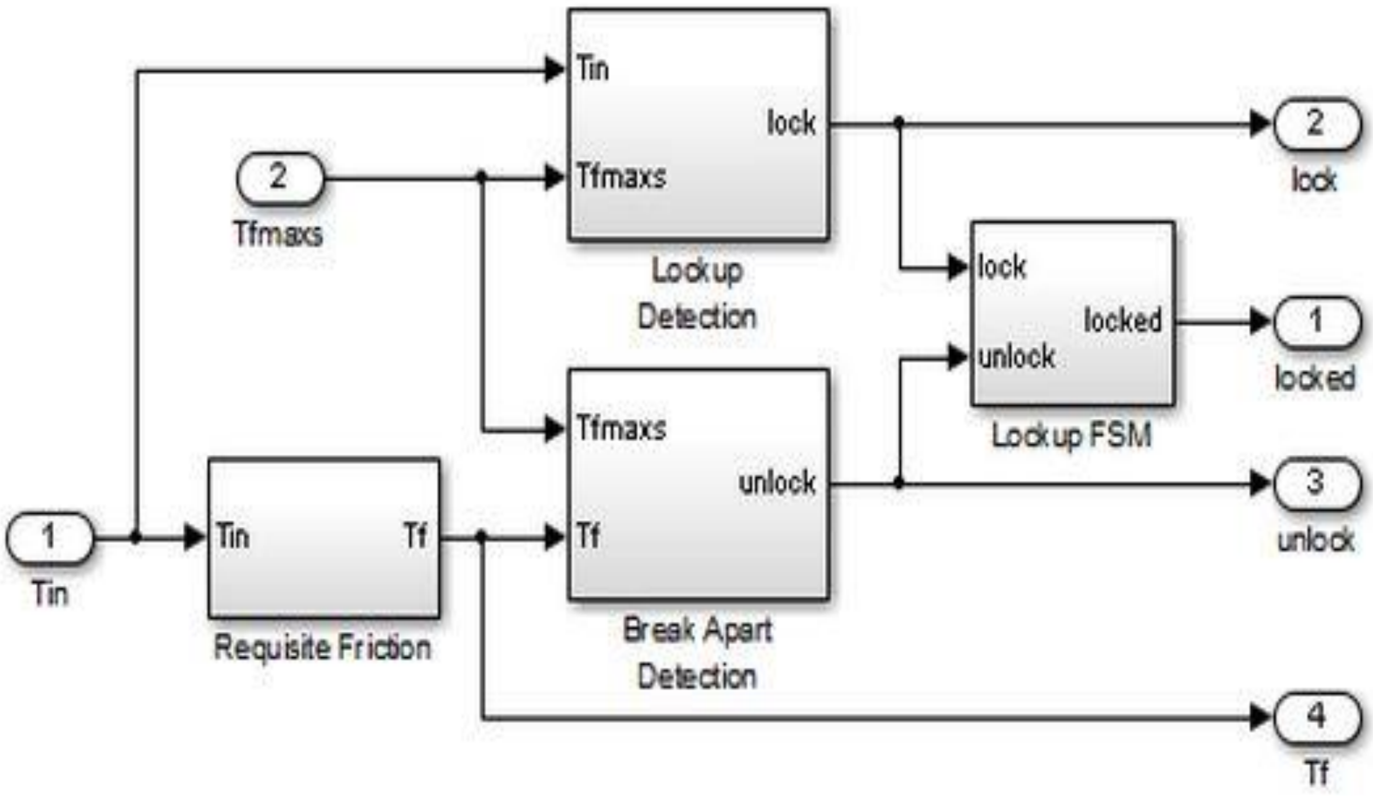
1) Compute the clutch torque transmitted at all times, and employ this value directly in the model

2) Use two different dynamic models and switch between them at the appropriate times

Model and Running the Simulation



Clutch friction mode logic



Parameters used

Ie = 1kg.m2

Iv= 5kg.m2

Be = 2Nm/rad/sec

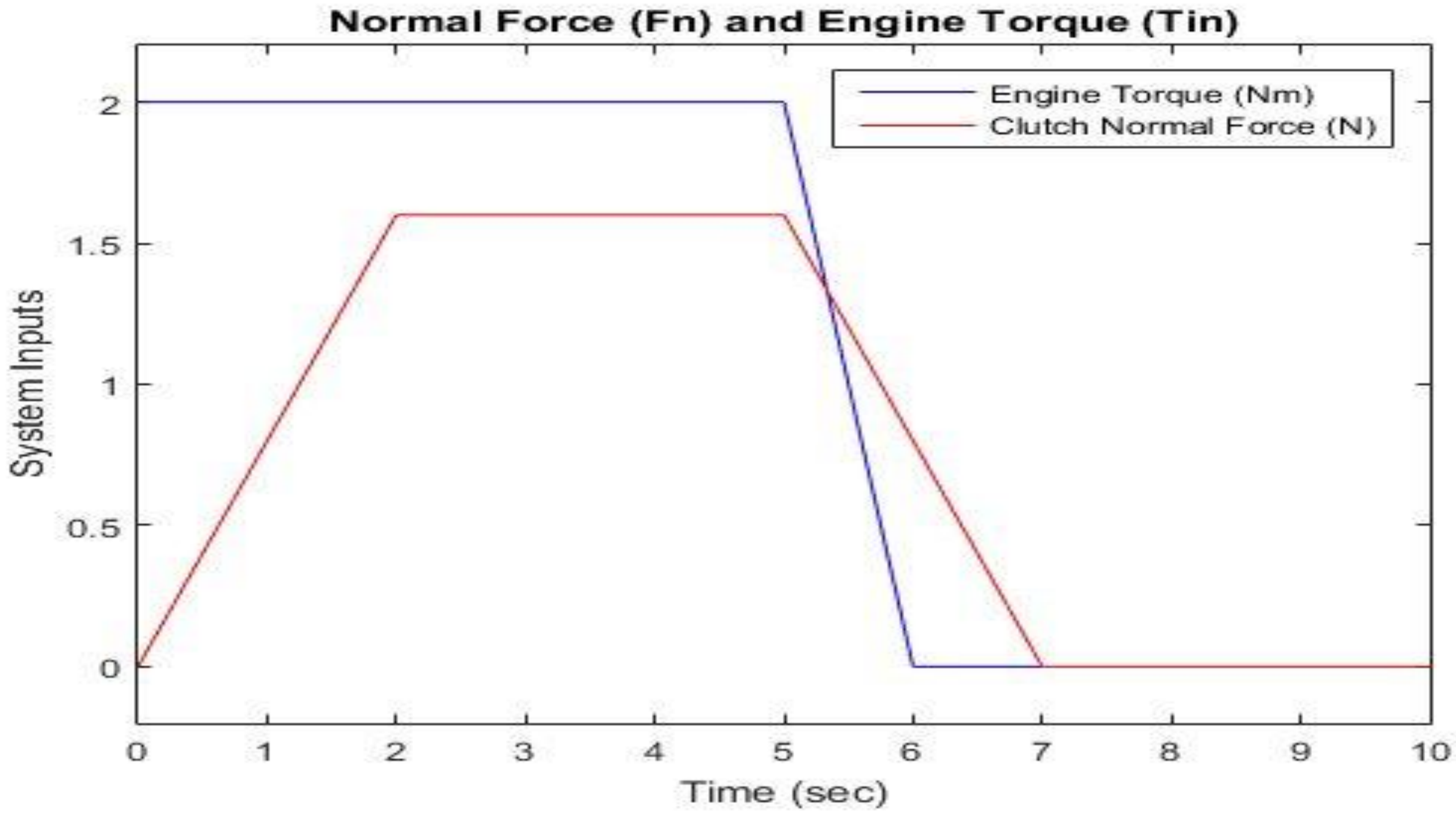
Bv =1Nm/rad/sec

Mu k = 1

Mu s = 1.5

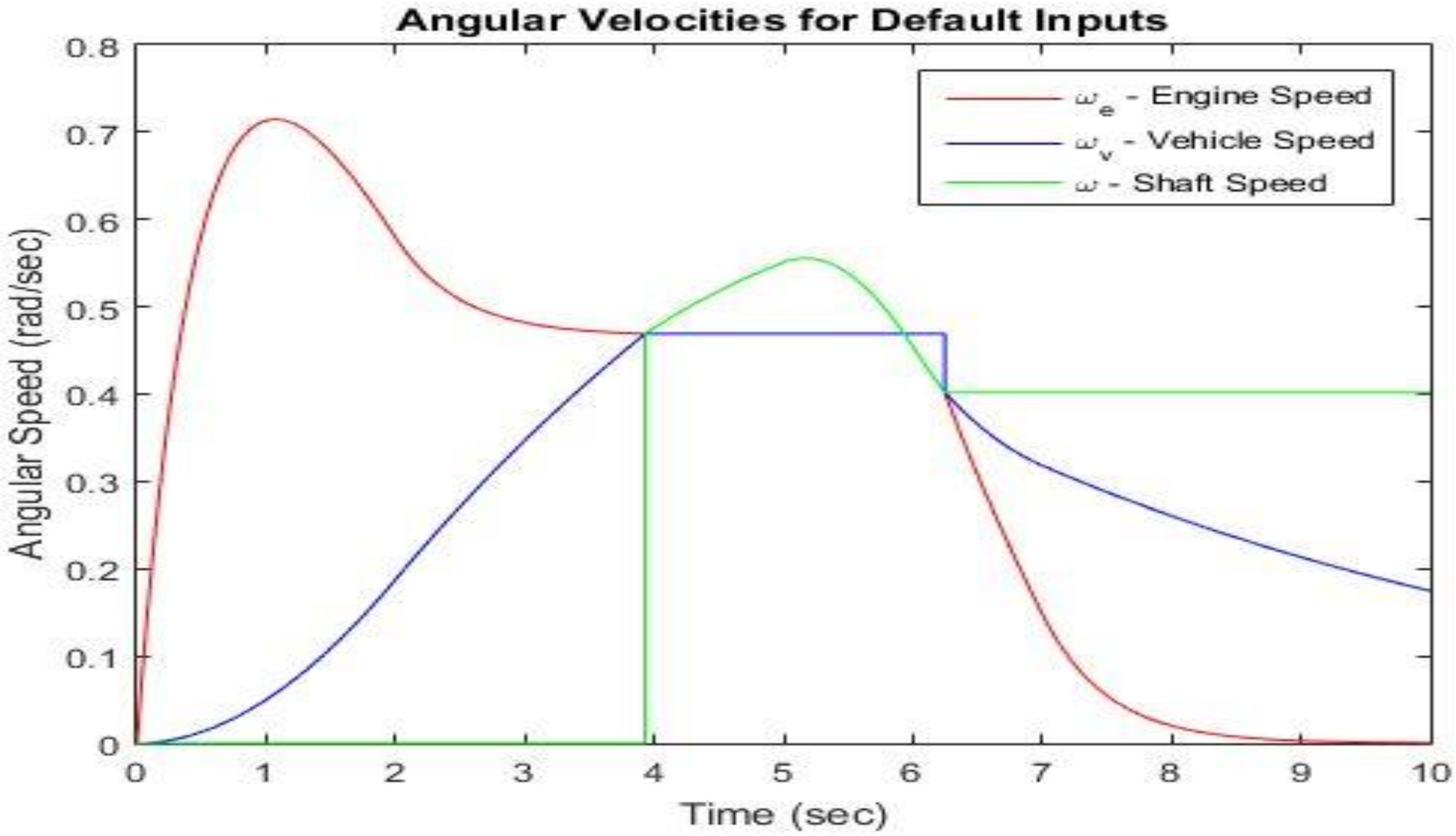
R= 1m

Plots :



Normal Force (Fn) and Engine Torque (Tin)
Engine Torque (Nm)
Clutch Normal Force (N)
System Inputs
0
0.5
1
1.5
2
0
1
2
3
4
5
6
7
8
9
10
Time (sec)

Plots:



Angular Velocities for Default Inputs
ωe - Engine Speed
ωv - Vehicle Speed
ω - Shaft Speed
Angular Speed (rad/sec)
Time (sec)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
7
8
9
10

Thank you