% MATLAB Code Implementation: Anti-lock Braking System (ABS) based on Novel Methodologies

% This code focuses on implementing fuzzy logic control and PID control for ABS,

% incorporating variation in road conditions (friction coefficient) and dynamic simulation.

% Simulation Parameters

m = 1500; % Vehicle mass (kg)

g = 9.81; % Acceleration due to gravity (m/s^2)

R = 0.3; % Wheel radius (m)

Iz = 300; % Moment of inertia of wheel (kg.m^2)

Vx0 = 30; % Initial velocity (m/s)

% Road Conditions (Variable friction)

mu\_dry = 0.9;

mu\_wet = 0.6;

mu\_ice = 0.2;

road\_condition = 'wet';

switch road\_condition

case 'dry'

mu = mu\_dry;

case 'wet'

mu = mu\_wet;

case 'ice'

mu = mu\_ice;

end

% Time Settings

dt = 0.001;

t\_end = 5;

t = 0:dt:t\_end;

% Initialization

vx = Vx0; % Vehicle velocity

vw = Vx0/R; % Wheel angular velocity

slip = 0;

slip\_desired = 0.2;

% Controller Parameters

Kp = 100;

Ki = 10;

Kd = 1;

integral = 0;

prev\_error = 0;

% Fuzzy Controller Setup

fis = readfis('fuzzyABS'); % Assume fuzzy controller file is defined

% Logging Variables

vx\_log = zeros(size(t));

slip\_log = zeros(size(t));

vw\_log = zeros(size(t));

brake\_force\_log = zeros(size(t));

for i = 1:length(t)

% Slip Calculation

if vx > 0

slip = (vx - R \* vw) / vx;

else

slip = 0;

end

% PID Control

error = slip\_desired - slip;

integral = integral + error \* dt;

derivative = (error - prev\_error) / dt;

u\_pid = Kp \* error + Ki \* integral + Kd \* derivative;

prev\_error = error;

% Fuzzy Control

u\_fuzzy = evalfis(fis, [slip vx]);

% Combine both control actions

brake\_force = max(0, min(mu \* m \* g, u\_fuzzy + u\_pid));

% Dynamics Update

Fx = mu \* m \* g;

ax = brake\_force / m;

vx = max(0, vx - ax \* dt);

Tw = brake\_force \* R;

alpha\_w = Tw / Iz;

vw = max(0, vw - alpha\_w \* dt);

% Logging

vx\_log(i) = vx;

vw\_log(i) = vw;

slip\_log(i) = slip;

brake\_force\_log(i) = brake\_force;

end

% Plotting Results

figure;

subplot(3,1,1);

plot(t, vx\_log);

title('Vehicle Speed'); ylabel('m/s'); grid on;

subplot(3,1,2);

plot(t, slip\_log);

title('Slip Ratio'); ylabel('Slip'); grid on;

subplot(3,1,3);

plot(t, brake\_force\_log);

title('Brake Force'); ylabel('N'); xlabel('Time (s)'); grid on;