LAMPIRAN

LAMPIRAN A

LAMPIRAN BAB IV

1. **4.6 MATLAB *M-files Input***

```
%% Half car model
% Simulation and animation of a half car model.
%
%%

clear ; close all ; clc

%% Parameters

% Vehicle
m   = 835;      % Half of body mass                    [kg]
m1  = 28;       % Mass of a front unsprung mass        [kg]
m2  = 28;       % Mass of a front unsprung mass        [kg]
J   = 418;      % Half of body moment of inertia     [kg.m2]
l1  = 1.35;     % Distance of CG from front axle         [m]
l2  = 1.40;     % Distance of CG from rear axle          [m]
k3  = 25000;    % Spring constant suspension front     [N/m]
k4  = 20000;    % Spring constant suspension rear      [N/m]
k1  = 200000;   % Spring constant tire front           [N/m]
k2  = 180000;   % Spring constant tire rear            [N/m]
b1  = 1500;     % Damping constant suspension front  [N.s/m]
b2  = 1200;     % Damping constant suspension rear   [N.s/m]


% Video
playback_speed = 1;             % Speed of playback
tF    = 2;                      % Final time             [s]
fR    = 300/playback_speed;      % Frame rate           [fps]
dt    = 1/fR;                   % Time resolution        [s]
time  = linspace(0,tF,tF*fR);   % Time                   [s]

%% Road
% Stretch 1
x_r_1_total = 5;    % Distance of the first stretch      [m]
dx_r_1 = 0.1;       % resolution                         [m]
x_r_1 = 0:dx_r_1:x_r_1_total;
z_r_1 = zeros(1,length(x_r_1));

% Stretch 2
R_r = 0.2;              % Radius                         [m]
th_r = 0:0.01:pi;
x_r_2 = -R_r*cos(th_r) + x_r_1_total+R_r;
z_r_2 = R_r*sin(th_r);

% Stretch 3
x_r_3_total = 15;       % Distance of the last stretch   [m]
```

```
dx_r_2 = 0.1;           % resolution                    [m]
x_r_3 =
x_r_1_total+2*R_r:dx_r_2:x_r_1_total+2*R_r+x_r_3_total;
z_r_3 = zeros(1,length(x_r_3));


% Concatenating
X_r = [x_r_1 x_r_2(2:end) x_r_3(2:end)];
Z_r = [z_r_1 z_r_2(2:end) z_r_3(2:end)];

figure
hold on ; box on ; grid on ; axis equal
plot(x_r_1,z_r_1)
plot(x_r_2,z_r_2)
plot(x_r_3,z_r_3)
xlabel('Distance x [m]')
ylabel('Distance z [m]')
legend('Jarak Tempuh Awal','Road Disturbance','Jarak Tempuh
Akhir')
title('Road Disturbance (Input)')

%% Simulation
% States
% x3    - Body vertical motion coordinate
% theta - Body pitch motion coordinate
% u1    - Front wheel vertical motion coordinate
% u2    - Rear wheel vertical motion coordinate
% M \ddot{x} + C \dot{x} + K x = F u

M = [   m   0   0   0   ;
        0   J   0   0   ;
        0   0   m1  0   ;
        0   0   0   m2  ];
b = [   b1+b2          l2*b2-l1*b1        -b1         -b2    ;
        l2*b2-l1*b2    b1*l1^2+b2*l2^2    l1*b1       -l2*b2 ;
        -b1            l1*b1              b1          0      ;
        -b2            l2*b2              0           b2    ];
K = [   k3+k4          l2*k4-l1*k3        -k3          -k4   ;
        l2*k4-l1*k3    k3*l1^2+k4*l2^2    l1*k3        -l2*k4;
        -k3            l1*k3              k3+k1       0      ;
        -k4            -l2*k4             0            k4+k2];
F = [   0       0   ;
        0       0   ;
        k1     0    ;
        0       k2 ];

% State space model
A = [   zeros(4,4)      eye(4,4)    ;
        -M\K          -M\b    ];
B = [   zeros(4,2)  ;
        M\F      ];
```

```
C = [   1 0 0 0 0 0 0 0 ;
        0 1 0 0 0 0 0 0 ;
        0 0 1 0 0 0 0 0 ;
        0 0 0 1 0 0 0 0 ;
        0 0 0 0 0 0 0 0 ;
        0 0 0 0 0 0 0 0 ;
        0 0 0 0 0 0 0 0 ;
        0 0 0 0 0 0 0 0 ];
D = zeros(8,2);

sys = ss(A,B,C,D);

% Input
vel = 5.667  ;          % Longitudinal speed of the car [m/s]
lon_pos_1 = vel*time + l1+l2;

% Longitudinal position of the front axle   [m]
lon_pos_2 = vel*time;

% Longitudinal position of the rear axle    [m]
%
u1 = interp1(X_r,Z_r,lon_pos_1);
u2 = interp1(X_r,Z_r,lon_pos_2);

figure
hold on ; grid on ; box on
plot(time,u1)
plot(time,u2)
xlabel('Time [s]')
ylabel('Distance z [m]')
title('Road Disturbance (Input)')
legend('Front Wheel Disturbance','Rear Wheel Disturbance')

u_vet = [u1' u2'];
[y,time,x] = lsim(sys,u_vet,time);

x3     = y(:,1); % Body vertical motion coordinate      [m]
theta  = y(:,2); % Body pitch motion coordinate       [rad]
u1     = y(:,3); % Frontwheel vertical motion coordinat [m]
u2     = y(:,4); % Rearwheel vertical motion coordinate [m]

figure
hold on ; grid on ; box on
plot(time,x3)
plot(time,u1)
plot(time,u2)
plot(time,theta)
xlabel('Time [s]')
ylabel('Vertical Displacement [m]')
legend('Vehicle Chassis','Front Wheel','Rear Wheel','Chasis
(rotational)')
```

2. **Gambar 4.7** Model Diagram Blok MATLAB