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clc;
clear;

fprintf('Homework 2: Generalized-Alpha method\n');
fprintf('Name: Abdelrahman Fathy Abdelhaleem Aly Abdelrahman \n');
fprintf('Matr.-Nr.: 108023251500 \n \n');
fprintf('Start Task 3a (and Task 4): \n');

% Data Inputs
L = 1.0 ;
pA = 1.0 ;
EA = 500;
g = 9.8;
dt = 0.01;
t_f = 5;

% Linear Momentum
M = [(pA*L^3)/3 0; 0 (pA*L)/3];
fprintf('Mass Matrix: \n');
disp(M);
K = [(pA*g*L^2)/2 0; 0 EA/L];
fprintf('Stiffness Matrix: \n');
disp(K);

% Initial Conditions
u0 = [0; -L/5];
fprintf('Initial Displacement: [%f, %f] \n',u0(1),u0(2));
v0 = [sqrt(g/6*L); 0];
fprintf('Initial Velocity: [%f, %f] \n',v0(1),v0(2));

% Task 3a:
alpha_1 = 1;
alpha_2 = 0;
p_inf = 1;

[u, v, a, e_abs, eta, e_cum, t, t_steps] = newmark(M,K,alpha_1,alpha_2,p_inf,u0,v0,
t_f,dt);

% Create a figure for each plot and save it
% Define a directory to save the plots
outputDir = 'task3a_plots';
if ~exist(outputDir, 'dir')
    mkdir(outputDir);
end

% Plot u
figure;
plot(t, u(1, :), 'r', t, u(2, :), 'b');
xlabel('Time');
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ylabel('u');
title('u vs Time (3a)');
legend('\theta', 'u');
saveas(gcf, fullfile(outputDir, 'u_vs_time.png'));

% Plot v
figure;
plot(t, v(1, :), 'r', t, v(2, :), 'b');
xlabel('Time');
ylabel('v');
title('v vs Time (3a)');
legend('$\dot{\theta}$', '$\dot{u}$', 'Interpreter', 'latex');
saveas(gcf, fullfile(outputDir, 'v_vs_time.png'));

% Plot a
figure;
plot(t, a(1, :), 'r', t, a(2, :), 'b');
xlabel('Time');
ylabel('a');
title('a vs Time (3a)');
legend('$\ddot{\theta}$', '$\ddot{u}$', 'Interpreter', 'latex');
saveas(gcf, fullfile(outputDir, 'a_vs_time.png'));

% Plot e_abs
figure;
plot(t, e_abs, 'r');
xlabel('Time');
ylabel('e_abs', 'Interpreter', 'latex');
title('e_abs vs Time (3a)', 'Interpreter', 'latex');
saveas(gcf, fullfile(outputDir, 'e_abs_vs_time.png'));

% Plot eta
figure;
plot(t, eta, 'r');
xlabel('Time');
ylabel('$\eta$', 'Interpreter', 'latex');
title('$\eta$ vs Time (3a)', 'Interpreter', 'latex');
saveas(gcf, fullfile(outputDir, 'eta_vs_time.png'));

% Plot e_cum
figure;
plot(t, e_cum, 'r');
xlabel('Time');
ylabel('e_cum', 'Interpreter', 'latex');
title('e_cum vs Time (3a)', 'Interpreter', 'latex');
saveas(gcf, fullfile(outputDir, 'e_cum_vs_time.png'));

% Plot t_steps
figure;
plot(t, t_steps, 'r');
xlabel('Time');
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ylabel('t\_steps','Interpreter','latex');  
title('t\_steps vs Time (3a)','Interpreter','latex');  
saveas(gcf, fullfile(outputDir, 't_steps_vs_time.png'));  
  
% Close all figures  
close all;  
  
fprintf('Task 3a (and Task 4): plots is saved in [%s] folder \n', outputDir);
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