Homework 3 - Problem 1

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```
clear;clc;
% Setup portion
    % Define necessary link parameters and link table
    syms m1 m2 L1 L2 theta1 thetaDot_1 thetaDotDot_1 theta2 thetaDot_2 thetaDotDot_2 g;
    linkTable = [0 0 0 theta1; pi/2 L1 0 theta2; 0 L2 0 0];

    % Generate transforms from link table
    T01 = functions.links.Link2Transform(linkTable(1,:));
    T12 = functions.links.Link2Transform(linkTable(2,:));
    T23 = functions.links.Link2Transform(linkTable(3,:));
    T03 = functions.links.Link2Transform(linkTable);

    % Pull and define rotations from transforms
    R01 = functions.transform.rotationFromTransform(T01);
    R12 = functions.transform.rotationFromTransform(T12);
    R23 = functions.transform.rotationFromTransform(T23);

    % Define position, centroid, inertial, and initial angular velocity/accel vectors
    P_01 = [0 0 0];
    P_12 = L1*[1 0 0];
    Pc_11 = L1*[1 0 0].';
    Pc_22 = L2*[1 0 0].';
    Ic_11 = 0;
    Ic_22 = 0;
    w_0 = 0;
    wDot_0 = 0;
    v0_dot = [0 0 g].';

% Velocity Propogation:
    % Define velocity conditions at first joint
    w_11 = functions.dynamics.omega_ip1ip1(R01.',w_0,thetaDot_1);
    wDot_11 = functions.dynamics.omegaDot_ip1ip1(R01.',wDot_0,w_0,thetaDot_1,thetaDotDot_1);
    vDot_11 = functions.dynamics.vDot_ip1ip1(R01.',wDot_0,P_01,w_11,v0_dot);
    vcDot_11 = functions.dynamics.vcDot_ip1ip1(wDot_11,Pc_11,w_11,vDot_11);

    % Define force and torque conditions at first joint
    F_11 = functions.dynamics.F_ip1ip1(m1,vcDot_11);
    N_11 = functions.dynamics.N_ip1ip1(wDot_11,w_11,Ic_11);

    % Define velocity conditions at second joint
    w_22 = functions.dynamics.omega_ip1ip1(R12.',w_11,thetaDot_2);
    wDot_22 = functions.dynamics.omegaDot_ip1ip1(R12.',wDot_11,w_11,thetaDot_2,thetaDotDot_2);
    vDot_22 = functions.dynamics.vDot_ip1ip1(R12.',wDot_11,P_12,w_11,vDot_11);
    vcDot_22 = functions.dynamics.vcDot_ip1ip1(wDot_22,Pc_22,w_22,vDot_22);

    % Define force and torque conditions at second joint
    F_22 = functions.dynamics.F_ip1ip1(m2,vcDot_22);
    N_22 = functions.dynamics.N_ip1ip1(wDot_22,w_22,Ic_22);

% Force Propogation:
    % Summarize force and torque conditions at second joint
    f_22 = F_22;
    n_22 = functions.dynamics.n_ii(N_22,R23,0,Pc_22,F_22,Pc_22,0);
    tau_2 = functions.dynamics.tau_i(n_22);

    % Summarize force and torque conditions at first joint
    f_11 = functions.dynamics.f_ii(R12,f_22,F_11);
    n_11 = functions.dynamics.n_ii(N_11,R12,n_22,Pc_11,F_11,P_12,0);
    tau_1 = functions.dynamics.tau_i(n_11);

% Cleanup tau_1 and tau_2 and display
    syms c1 c2 s1 s2;
    tau_1 = subs(tau_1,[cos(theta1),cos(theta2),sin(theta1),sin(theta2)],[c1,c2,s1,s2]);
    tau_2 = subs(tau_2,[cos(theta1),cos(theta2),sin(theta1),sin(theta2)],[c1,c2,s1,s2]);
    display(tau_1);
    display(tau_2);
```

```
tau_1 =

L1^2*m1*thetaDotDot_1 + L2*c2*m2*(L1*thetaDotDot_1 + L2*(c2*thetaDotDot_1 - s2*thetaDot_1*thetaDot_2) - L2*s2*thetaDot_1*thetaDot_2)


tau_2 =

L2*m2*(L2*thetaDotDot_2 + c2*g + L1*s2*thetaDot_1^2 + L2*c2*s2*thetaDot_1^2)
```

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