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% ECE 4560 - Homework 12.1
% Caitlyn Caggia
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```
%part a
```

```
syms l1 l2 l3 a1 a2 a3
```

```
g1 = [R(a1) [0;0]; 0 0 1];
g2 = [R(a2) [l1;0]; 0 0 1];
g3 = [R(a3) [l2;0]; 0 0 1];
g4 = [eye(2) [l3;0]; 0 0 1];
```

```
J1 = [0; 0; 1];
J2 = [0; 0; 1];
J3 = [0; 0; 1];
```

```
ad1 = [R(-a2-a3) [l2*sin(a3) + l1*sin(a2+a3);
    l3+l2*cos(a3)+l1*cos(a2+a3)]; 0 0 1];
ad2 = [R(-a3) [l2*sin(a3); l3+l2*cos(a3)]; 0 0 1];
ad3 = [eye(2) [0;l3]; 0 0 1];
```

```
Jb1 = ad1*J1;
Jb2 = ad2*J2;
Jb3 = ad3*J3;
```

```
Jbody = [Jb1 Jb2 Jb3]
```

```
%part b
```

```
ad1 = [R(a1) [0; 0]; 0 0 1];
ad2 = [R(a1+a2) [l1*sin(a1); l1*cos(a1)]; 0 0 1];
ad3 = [R(a1+a2+a3) [l1*sin(a1)+l2*sin(a1+a2); -l1*cos(a1)-
    l2*cos(a1+a2)]; 0 0 1];
```

```
Js1 = ad1*J1;
Js2 = ad2*J2;
Js3 = ad3*J3;
```

```
Jspatial = [Js1 Js2 Js3]
```

```
%part c
```

```
l1 = 1; l2 = 2/3; l3 = 1/2;
a1 = pi/3; a2 = -pi/4; a3 = pi/6;
adot = [-pi/12; pi/8; -pi/12];
```

```
ad1 = [R(-a2-a3) [l2*sin(a3) + l1*sin(a2+a3);
    l3+l2*cos(a3)+l1*cos(a2+a3)]; 0 0 1];
ad2 = [R(-a3) [l2*sin(a3); l3+l2*cos(a3)]; 0 0 1];
ad3 = [eye(2) [0;l3]; 0 0 1];
```

```
Jb1 = ad1*J1;
Jb2 = ad2*J2;
Jb3 = ad3*J3;
```

```

Jbody = [Jb1 Jb2 Jb3];

vbody = Jbody * adot

%part d
ad1 = [R(a1) [0; 0]; 0 0 1];
ad2 = [R(a1+a2) [l1*sin(a1); l1*cos(a1)]; 0 0 1];
ad3 = [R(a1+a2+a3) [l1*sin(a1)+l2*sin(a1+a2); -l1*cos(a1)-
l2*cos(a1+a2)]; 0 0 1];

Js1 = ad1*J1;
Js2 = ad2*J2;
Js3 = ad3*J3;

Jspatial = [Js1 Js2 Js3];

vspatial = Jspatial*adot

%part e
h = [0.25 0 0];
adj = [eye(2) [0; -0.25]; 0 0 1];
vtool = adj * vbody

Jbody =

[      l1*sin(a2 + a3) + l2*sin(a3),      l2*sin(a3),  0]
[ l3 + l1*cos(a2 + a3) + l2*cos(a3), l3 + l2*cos(a3), l3]
[                                1,                1,  1]

Jspatial =

[ 0, l1*sin(a1),      l2*sin(a1 + a2) + l1*sin(a1)]
[ 0, l1*cos(a1), - l2*cos(a1 + a2) - l1*cos(a1)]
[ 1,                1,                1]

vbody =

    0.1114
   -0.2428
   -0.1309

vspatial =

    0.0682
    0.4958
   -0.1309

vtool =

```

0.1114
 -0.2100
 -0.1309

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