

```
>> Dynamic_Result
```

```
R1 =
```

```
[ cos(t1), 0, sin(t1)]  
[ sin(t1), 0, -cos(t1)]  
[      0, 1,      0]
```

```
R2 =
```

```
[ cos(t1)*cos(t2), -cos(t1)*sin(t2), sin(t1)]  
[ cos(t2)*sin(t1), -sin(t1)*sin(t2), -cos(t1)]  
[      sin(t2),      cos(t2),      0]
```

```
R3 =
```

```
[ cos(t2 + t3)*cos(t1), -sin(t2 + t3)*cos(t1), sin(t1)]  
[ cos(t2 + t3)*sin(t1), -sin(t2 + t3)*sin(t1), -cos(t1)]  
[      sin(t2 + t3),      cos(t2 + t3),      0]
```

```
R4 =
```

```
[ cos(t1), sin(t1), 0]  
[ sin(t1), -cos(t1), 0]  
[      0,      0, -1]
```

```
R5 =
```

```
[ cos(t1)*cos(t5) + sin(t1)*sin(t5), cos(t5)*sin(t1) - cos(t1)*sin(t5), 0]  
[ cos(t5)*sin(t1) - cos(t1)*sin(t5), -cos(t1)*cos(t5) - sin(t1)*sin(t5), 0]  
[      0,      0, -1]
```

```
pc1 =
```

```
0  
0  
lc1
```

```
pc2 =
```

```
lc2*cos(t1)*cos(t2)  
lc2*cos(t2)*sin(t1)  
l1 + lc2*sin(t2)
```

pc3 =

```
cos(t1)*(lc3*cos(t2 + t3) + l2*cos(t2))
sin(t1)*(lc3*cos(t2 + t3) + l2*cos(t2))
    l1 + lc3*sin(t2 + t3) + l2*sin(t2)
```

pc4 =

```
cos(t1)*(l3*cos(t2 + t3) + l2*cos(t2))
sin(t1)*(l3*cos(t2 + t3) + l2*cos(t2))
l1 - lc4 + l3*sin(t2 + t3) + l2*sin(t2)
```

pc5 =

```
cos(t1)*(l3*cos(t2 + t3) + l2*cos(t2))
sin(t1)*(l3*cos(t2 + t3) + l2*cos(t2))
l1 - lc5 + l3*sin(t2 + t3) + l2*sin(t2)
```

Jv1 =

```
[ 0, 0, 0, 0, 0]
[ 0, 0, 0, 0, 0]
[ 0, 0, 0, 0, 0]
```

Jv2 =

```
[ -lc2*cos(t2)*sin(t1), -lc2*cos(t1)*sin(t2), 0, 0, 0]
[  lc2*cos(t1)*cos(t2), -lc2*sin(t1)*sin(t2), 0, 0, 0]
[                      0,          lc2*cos(t2), 0, 0, 0]
```

Jv3 =

```
[ -sin(t1)*(lc3*cos(t2 + t3) + l2*cos(t2)), -cos(t1)*(lc3*sin(t2 + t3) + l2*sin(t2))✗
-lc3*sin(t2 + t3)*cos(t1), 0, 0]
[  cos(t1)*(lc3*cos(t2 + t3) + l2*cos(t2)), -sin(t1)*(lc3*sin(t2 + t3) + l2*sin(t2))✗
-lc3*sin(t2 + t3)*sin(t1), 0, 0]
[                      0,          lc3*cos(t2 + t3) + l2*cos(t2)✗
lc3*cos(t2 + t3), 0, 0]
```

Jv4 =

```
[ -sin(t1)*(l3*cos(t2 + t3) + l2*cos(t2)), -cos(t1)*(l3*sin(t2 + t3) + l2*sin(t2)),
l3*sin(t2 + t3)*cos(t1), 0, 0]
[ cos(t1)*(l3*cos(t2 + t3) + l2*cos(t2)), -sin(t1)*(l3*sin(t2 + t3) + l2*sin(t2)),
l3*sin(t2 + t3)*sin(t1), 0, 0]
[
0, 13*cos(t2 + t3) + l2*cos(t2)
l3*cos(t2 + t3), 0, 0]
```

Jv5 =

```
[ -sin(t1)*(l3*cos(t2 + t3) + l2*cos(t2)), -cos(t1)*(l3*sin(t2 + t3) + l2*sin(t2)),
l3*sin(t2 + t3)*cos(t1), 0, 0]
[ cos(t1)*(l3*cos(t2 + t3) + l2*cos(t2)), -sin(t1)*(l3*sin(t2 + t3) + l2*sin(t2)),
l3*sin(t2 + t3)*sin(t1), 0, 0]
[
0, 13*cos(t2 + t3) + l2*cos(t2)
l3*cos(t2 + t3), 0, 0]
```

m =

```
m1
m2
m3
m4
m5
```

ans =

```
Iyy1 + Izz5 + Iyy2*cos(conj(t2))*cos(t2) + Iyy3*cos(conj(t2) + conj(t3))*cos(t2 + t3)
+ m4*cos(conj(t1))*cos(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj
(l3))*(l3*cos(t2 + t3) + l2*cos(t2)) + m5*cos(conj(t1))*cos(t1)*(cos(conj(t2))*conj
(l2) + cos(conj(t2) + conj(t3))*conj(l3))*(l3*cos(t2 + t3) + l2*cos(t2)) + m3*cos
(conj(t1))*cos(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj(lc3))*
(lc3*cos(t2 + t3) + l2*cos(t2)) + m4*sin(conj(t1))*sin(t1)*(cos(conj(t2))*conj(l2)
cos(conj(t2) + conj(t3))*conj(l3))*(l3*cos(t2 + t3) + l2*cos(t2)) + m5*sin(conj(t1)
*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj(l3))*(l3*cos(t2
t3) + l2*cos(t2)) + m3*sin(conj(t1))*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2)
conj(t3))*conj(lc3))*(lc3*cos(t2 + t3) + l2*cos(t2)) + lc2*m2*cos(conj(t1))*cos(conj
(t2))*conj(lc2)*cos(t1)*cos(t2) + lc2*m2*cos(conj(t2))*sin(conj(t1))*conj(lc2)*co
(t2)*sin(t1)
```

ans =

```
Iyy2*sin(conj(t1))*sin(conj(t2))*cos(t1)*cos(t2) - Iyy2*cos(conj(t1))*sin(conj(t2)
*cos(t2)*sin(t1) - m4*cos(conj(t1))*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2)
conj(t3))*conj(l3))*(l3*sin(t2 + t3) + l2*sin(t2)) + m4*sin(conj(t1))*cos(t1)*(co
(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj(l3))*(l3*sin(t2 + t3) + l2*si
```

```
(t2)) - m5*cos(conj(t1))*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*
*conj(l3))*(l3*sin(t2 + t3) + l2*sin(t2)) + m5*sin(conj(t1))*cos(t1)*(cos(conj(t2))*
*conj(l2) + cos(conj(t2) + conj(t3))*conj(l3))*(l3*sin(t2 + t3) + l2*sin(t2)) +
m3*cos(conj(t1))*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj
(lc3))*(lc3*sin(t2 + t3) + l2*sin(t2)) + m3*sin(conj(t1))*cos(t1)*(cos(conj(t2))*conj
(l2) + cos(conj(t2) + conj(t3))*conj(lc3))*(lc3*sin(t2 + t3) + l2*sin(t2)) - Iyy3*cos
(conj(t1))*sin(conj(t2) + conj(t3))*cos(t2 + t3)*sin(t1) + Iyy3*sin(conj(t1))*sin
(conj(t2) + conj(t3))*cos(t2 + t3)*cos(t1) - lc2*m2*cos(conj(t1))*cos(conj(t2))*conj
(lc2)*sin(t1)*sin(t2) + lc2*m2*cos(conj(t2))*sin(conj(t1))*conj(lc2)*cos(t1)*sin(t2)
```

```
ans =
```

```
Iyy3*sin(conj(t1))*sin(conj(t2) + conj(t3))*cos(t2 + t3)*cos(t1) - Iyy3*cos(conj(t1))*
*sin(conj(t2) + conj(t3))*cos(t2 + t3)*sin(t1) - l3*m4*cos(conj(t1))*sin(t2 + t3)*sin
(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj(l3)) + l3*m4*sin(conj
(t1))*sin(t2 + t3)*cos(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj
(l3)) - l3*m5*cos(conj(t1))*sin(t2 + t3)*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj
(t2) + conj(t3))*conj(l3)) + l3*m5*sin(conj(t1))*sin(t2 + t3)*cos(t1)*(cos(conj(t2))*
*conj(l2) + cos(conj(t2) + conj(t3))*conj(l3)) - lc3*m3*cos(conj(t1))*sin(t2 + t3)*
*sin(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*conj(lc3)) + lc3*m3*sin
(conj(t1))*sin(t2 + t3)*cos(t1)*(cos(conj(t2))*conj(l2) + cos(conj(t2) + conj(t3))*
*conj(lc3))
```

```
ans =
```

```
0
```

```
ans =
```

```
-Izz5
```

```
q_d =
```

```
t1_d
t2_d
t3_d
t4_d
t5_d
```

```
q =
```

```
t1
t2
t3
```

t4
t5

gT =

0 0 -9.8000

G1 =

0

G2 =

$(49*m4*(13*\cos(t2 + t3) + 12*\cos(t2)))/5 + (49*m5*(13*\cos(t2 + t3) + 12*\cos(t2)))/5$ ✖
 $(49*m3*(1c3*\cos(t2 + t3) + 12*\cos(t2)))/5 + (49*1c2*m2*\cos(t2))/5$

G3 =

$(49*13*m4*\cos(t2 + t3))/5 + (49*13*m5*\cos(t2 + t3))/5 + (49*1c3*m3*\cos(t2 + t3))/5$

G4 =

0

G5 =

0

G =

✖
 0
 $(49*m4*(13*\cos(t2 + t3) + 12*\cos(t2)))/5 + (49*m5*(13*\cos(t2 + t3) + 12*\cos(t2)))/5$ ✖
 $+ (49*m3*(1c3*\cos(t2 + t3) + 12*\cos(t2)))/5 + (49*1c2*m2*\cos(t2))/5$
 ✖
 $(49*\cos(t2 + t3)*(13*m4 + 13*m5 + 1c3*m3))/5$
 ✖
 0
 ✖
 0

>>