Peter Racioppo
Robotics and Automation
Homework 6

In[6865]:=
```
(* Qs 2 *)
ClearAll["Global`*"]

v1 = LC1 * θ1'[t];
I1 = (1 / 3) * m1 * L1^2;

T1 = 0.5 * m1 * (v1)^2 + 0.5 * I1 * (θ1'[t])^2;
U1 = m1 * g * LC1 * Sin[θ1[t]];

m2s = (m2 + M);
LC2s = (LC2 * m2 + L2 * M) / (m2 + M);
I2s = ((1 / 3) * m2s * (LC2s)^2);
(* V2squared=L1^2*(θ1'[t])^2+LC2s^2*(θ1'[t]+θ2'[t])^2+
    2*L1*LC2s*(Sin[θ1[t]]*Sin[θ1[t]+θ2[t]]+Cos[θ1[t]]*Cos[θ1[t]+θ2[t]])*
     θ1'[t]*(θ1'[t]+θ2'[t]); *)
V2squared = L1^2 * (θ1'[t])^2 + LC2s^2 * (θ1'[t] + θ2'[t])^2 +
    2 * L1 * LC2s * (Cos[θ2[t]]) * θ1'[t] * (θ1'[t] + θ2'[t]);

T2 = 0.5 * m2s * V2squared + 0.5 * I2s * (θ1'[t] + θ2'[t])^2;
U2 = m2s * g * L1 * Sin[θ1[t]] + LC2s * Sin[θ1[t] + θ2[t]];

LG = T1 + T2 - (U1 + U2);

T2a = Simplify[D[LG, θ1[t]]];
TA = D[LG, θ1'[t]];
T1a = Simplify[D[TA, t]];

T2b = D[LG, θ2[t]];
TB = D[LG, θ2'[t]];
T1b = Simplify[D[T4, t]];

tao1 = T1a - T2a;
tao2 = T1b - T2b;

Collect[tao1, {θ1''[t], θ2''[t]}];
Collect[tao2, {θ1'[t]}];

(*
Solve[{τ1== T1a-T2a,τ2== T1b-T2b},M];
Solve[T1a-T2a==τ1 ,M];
Solve[T1b-T2b==τ2 ,M];
Solve[T1a-T2a==τ1 ,θ1''[t]];
Solve[T1b-T2b==τ2 ,θ1''[t]];
*)

(* ------------------------------------------------- *)
(* Qs 3 *)
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ClearAll["Global`*"]
T01 = {{Cos[θ1], -Sin[θ1], 0, L1 * Cos[θ1]},
       {Sin[θ1], Cos[θ1], 0, L1 * Sin[θ1]},
       {0, 0, 1, 0},
       {0, 0, 0, 1}};
T12 = {{Cos[θ2], -Sin[θ2], 0, L2 * Cos[θ2]},
       {Sin[θ2], Cos[θ2], 0, L2 * Sin[θ2]},
       {0, 0, 1, 0},
       {0, 0, 0, 1}};

T02 = Simplify[T01.T12];
T02 // MatrixForm;

R01 = T01[[1 ;; 3, 1 ;; 3]];
R02 = T02[[1 ;; 3, 1 ;; 3]];

px = L1 Cos[θ1] + L2 Cos[θ1 + θ2];
py = L1 Sin[θ1] + L2 Sin[θ1 + θ2];

z00 = {0, 0, 1};
z01 = R01.{0, 0, 1};
z02 = R02.{0, 0, 1};

J0 = Simplify[{{D[px, θ1], D[px, θ2]}, {D[py, θ1], D[py, θ2]}}];
J0 // MatrixForm;

(* B. *)
fa = {0, -50};
(* ga=R02.{0,0}; *)

Fp = {fa[[1]], fa[[2]]};
Fp // MatrixForm;

τ = Simplify[Transpose[J0].Fp];
τ // MatrixForm
```

$$\begin{pmatrix} -50\,(\text{L1}\,\text{Cos}[\theta 1] + \text{L2}\,\text{Cos}[\theta 1 + \theta 2]) \\ -50\,\text{L2}\,\text{Cos}[\theta 1 + \theta 2] \end{pmatrix}$$

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(* ------------------------------------------------- *)
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