

التحكم بالروبوت - معادلات الحركة (لاغرانج)

التمرين الأول: أوجد المصفوفات D , H , G لمعادلات الحركة الخاصة بالمنظومة التالية باستخدام MATLAB.

$$\mathcal{L} = k_1 \dot{\theta}_1^2 + (k_2 + k_3 \cos(\theta_2))(\dot{\theta}_1 + \dot{\theta}_2)^2 - p_1 \sin(\theta_1) - p_2 \sin(\theta_1 + \theta_2)$$

```
clear; clc;
```

```
% Define symbolic variables
syms th1(t) th2(t) k1 k2 k3 p1 p2
dth1 = diff(th1,t);
dth2 = diff(th2,t);
```

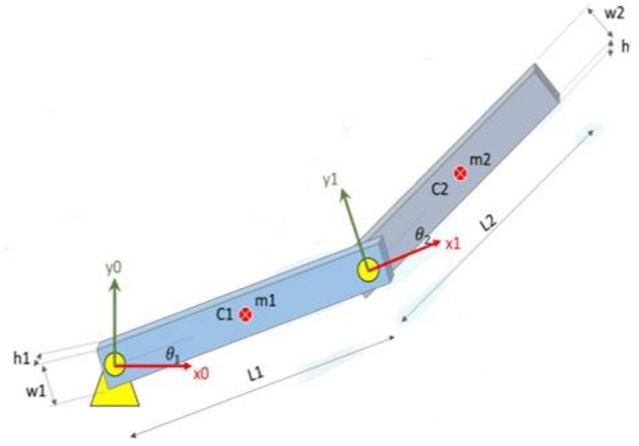
```
% Lagrangian
L = k1*dth1^2 + (k2 +
k3*cos(th2))*(dth1 + dth2)^2 -
p1*sin(th1) - p2*sin(th1 + th2)
```

```
% Equations of motion
Taw = simplify(functionalDerivative(-L, [th1, th2]))
```

```
% Substitute derivatives
syms dth1 dth2 d2th1 d2th2
oldt={'diff(th1(t), t)', 'diff(th2(t), t)', 'diff(th1(t), t, t)',
'diff(th2(t), t, t)'};
newt={ dth1 dth2 d2th1 d2th2};
Taws=subs(Taw,oldt,newt);
```

```
% Mass matrix (D)
D = equationsToMatrix(Taws, [d2th1; d2th2])
```

```
% Coriolis/centrifugal (H) and gravity (G) terms
temp = Taws - D*[d2th1; d2th2];
G = simplify(subs(temp, {dth1,dth2}, {0, 0}))
H=simplify(temp-G)
```



التمرين الثاني: اكتب برنامج بلغة MATLAB لإيجاد الصيغة المصفوفاتية D, H, G لمعادلات الحركة المشتقة من تابع لاغرانج الآتي:

$$\mathcal{L} = 0.1\dot{\theta}_1^2 + (0.2 + 0.05 \cos(\theta_2))(\dot{\theta}_1 + \dot{\theta}_2)^2 - 5 \sin(\theta_1) - 0.6 \sin(\theta_1 + \theta_2)$$

```
clear; clc;
```

```
% Define symbolic variables
```

```
syms th1(t) th2(t) k1 k2 k3 p1 p2
```

```
dth1 = diff(th1,t);
```

```
dth2 = diff(th2,t);
```

```
% Lagrangian
```

```
L = 0.1*dth1^2 + (0.2 + 0.05*cos(th2))*(dth1 + dth2)^2 - 5*sin(th1) -  
0.6*sin(th1 + th2)
```

```
% Equations of motion
```

```
Taw = simplify(functionalDerivative(-L, [th1, th2]))
```

```
% Substitute derivatives
```

```
syms th1 th2 dth1 dth2 d2th1 d2th2
```

```
oldt={ 'diff(th1(t), t)', 'diff(th2(t), t)', 'diff(th1(t), t, t)',  
'diff(th2(t), t, t)'};
```

```
newt={ dth1 dth2 d2th1 d2th2};
```

```
Taws=subs(Taw, str2sym(oldt), newt);
```

```
% Mass matrix (D)
```

```
D = equationsToMatrix(Taws, [d2th1; d2th2])
```

```
% Coriolis/centrifugal (H) and gravity (G) terms
```

```
temp = Taws - D*[d2th1; d2th2];
```

```
G = simplify(subs(temp, {dth1,dth2}, {0, 0}))
```

```
H=simplify(temp-G)
```

التمرين الثالث: أوجد المصفوفات D , H , G لمعادلات الحركة الخاصة بالمنظومة التالية باستخدام MATLAB.

$$\mathcal{L} = (0.05 + 10d^2)\dot{\theta}^2 + 5\dot{d}^2 + 100d\sin(\theta)$$

```
clear; clc;
```

```
% Define symbolic variables
```

```
syms d(t) th(t)
```

```
dd = diff(d,t);
```

```
dth = diff(th,t);
```

```
% Lagrangian
```

```
L = (0.05 + 10*d^2)*dth^2 + 5*dd^2 + 100*d*sin(th)
```

```
% Equations of motion
```

```
Taw = simplify(functionalDerivative(-L, [d, th]))
```

```
% Substitute derivatives
```

```
syms dd dth d2d d2th
```

```
oldt={'diff(d(t), t)', 'diff(th(t), t)', 'diff(d(t), t, t)', 'diff(th(t), t, t)'};
```

```
newt={dd dth d2d d2th};
```

```
Taws=subs(Taw, oldt, newt);
```

```
% Mass matrix (D)
```

```
D = equationsToMatrix(Taws, [d2d; d2th])
```

```
% Coriolis/centrifugal (H) and gravity (G) terms
```

```
HG = Taws - D*[d2d; d2th];
```

```
G = simplify(subs(HG, {dd,dth}, {0, 0}))
```

```
H=simplify(HG-G)
```

