16 - 748 Problem set 4

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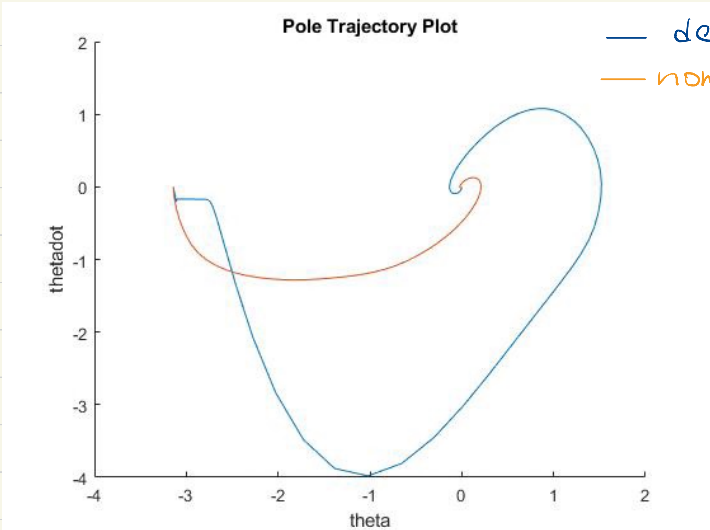
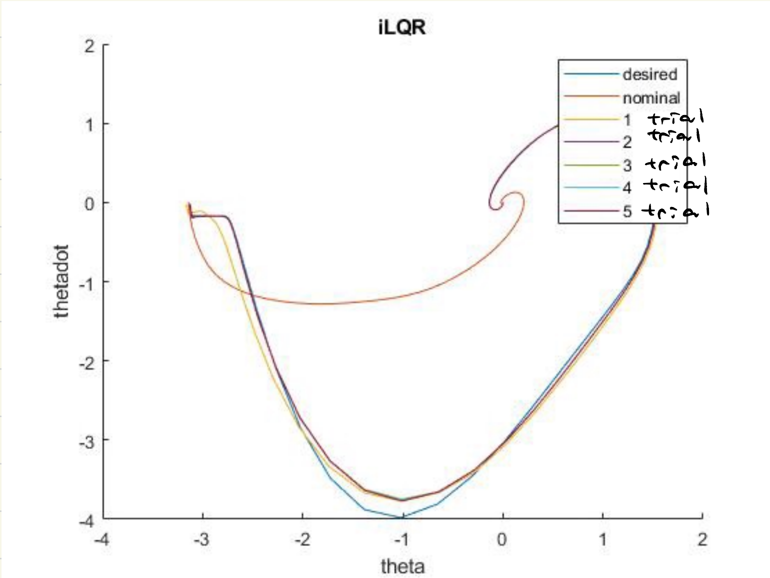
Problem 1.

a) b)



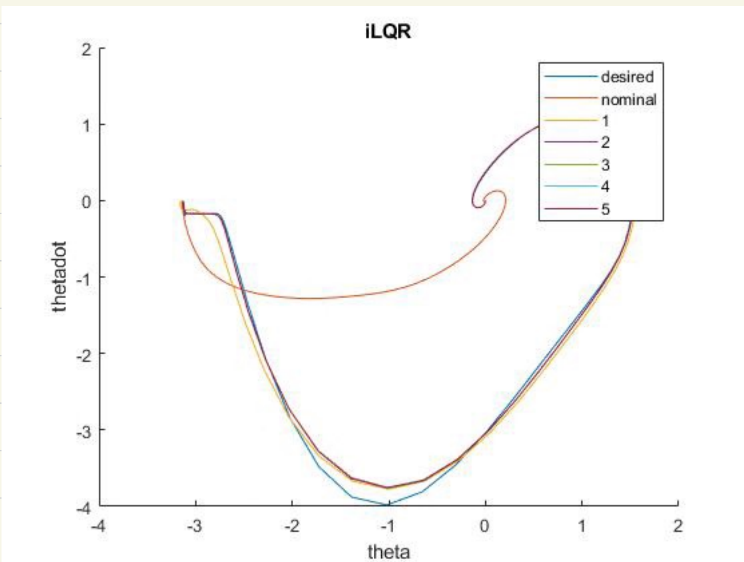
— desired
— nominal

c)


iLQR
desired
nominal
1 trial
2 trial
3 trial
4 trial
5 trial
thetadot
theta
2
1
0
-1
-2
-3
-4
-4
-3
-2
-1
0
1
2

1d)

ud = 0


iLQR
desired
nominal
1
2
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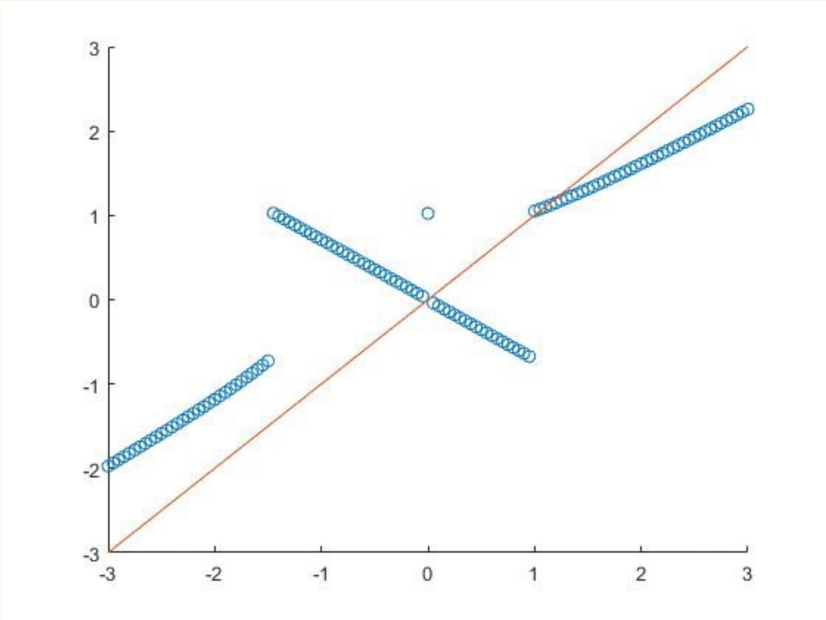
5
thetadot
theta
2
1
0
-1
-2
-3
-4
-4
-3
-2
-1
0
1
2

2 a)



2b)

forward walking occurs when $\dot{\theta}(0^+) > \omega_1$

$\omega_1 = \sqrt{2\frac{g}{l}(1-\cos(\gamma-\alpha))}$

the sysem has enough kinetic energy to go forward

when $\dot{\theta} < \omega_2$ it will rotate in the opposite direction

where $\omega_2 = -\sqrt{2\frac{g}{l}(1-\cos(\alpha+\gamma))}$

when $\omega_1 < \dot{\theta} < \omega_2$, collision

$$\dot{\theta}^+_{n+1} = -\dot{\theta}^+_n \cos(2\alpha)$$

$$\therefore \dot{\theta}^+_{n+1} = \begin{cases} \cos(2\alpha)\sqrt{(\dot{\theta}_n^+)^2 + 4\frac{g}{l}\sin\alpha\sin\gamma} & \dot{\theta}_n^+ \geq \omega_1 \\ -\dot{\theta}_n^+\cos(2\alpha) & \omega_2 < \dot{\theta}_n^+ < \omega_1 \\ -\cos(2\alpha)\sqrt{(\dot{\theta}_n^+)^2 - 4\frac{g}{l}\sin\alpha\sin\gamma} & \dot{\theta}_n^+ \leq \omega_2 \end{cases}$$

$\Uparrow$

$P(x)$

$$\therefore \frac{\partial P}{\partial \dot{\theta}_n} = \begin{cases} \cos(2\alpha)\sqrt{\dot{\theta}^2 + \frac{4g\sin(\alpha)\sin(\gamma)}{l}} & \dot{\theta}_n^+ \geq \omega_1 \\ -\cos(2\alpha) & \omega_2 < \dot{\theta}_n^+ < \omega_1 \\ -\cos(2\alpha)\sqrt{\dot{\theta}^2 - \frac{4g\sin(\alpha)\sin(\gamma)}{l}} & \dot{\theta}_n^+ \leq \omega_2 \end{cases}$$

$\therefore$ newton's method

$$x_{i+1} = x_i - \frac{xP(x)}{\partial xP(x)}$$

$$xP(x) = x - P(x)$$

$$dxP(x) = I - \frac{\partial P(x)}{\partial x}$$

$$\uparrow$$

$$\begin{bmatrix} 1 & 0 \\ 0 & \end{bmatrix}$$

Plug into matlab

fixpoints are $\boxed{[-0.3127 \quad 1.0950]}$

$[-0.3127 \quad 0]$

$\because \theta = 0$

doesn't count

$$\boxed{\begin{array}{l} \text{the eigenvalues of } dxP(x) \text{ are} \\ 0.5000 \ \& \ 1.000 \quad \leq 1 \\ \text{thus it is stable I.S.L} \end{array}}$$