TTK 4130 MODELING & SIMULATION | ASSIGNMENT 9

ODIN A. SEVERINSEN

MTTK

$\boxed{1}$ a) See attached code

b) The IRK-method is very close to the exact solution

c) The IRK-method ~~does not~~ become ~~sg~~ unstable as long as the actual system is stable. This was tested up to $\lambda = -1400$

$\boxed{2}$ We have $\ddot{x} = -g\left(1 - \left(\frac{x_d}{x}\right)^{\kappa}\right)$, $E = \frac{mg}{\kappa-1} \frac{x_d^{\kappa}}{\underbrace{x^{\kappa-1}}_{x^{-(\kappa-1)} = x^{-\kappa+1}}} + mgx + \frac{1}{2}m\dot{x}^2$

and $\dot{E} = 0$

$$\Rightarrow \frac{dE}{dt} = \frac{\partial E}{\partial x} \cdot \dot{x} + \frac{\partial E}{\partial \dot{x}} \cdot \ddot{x}, \quad \frac{\partial E}{\partial x} = -mg\left(\frac{x_d}{x}\right)^{\kappa} + mg$$

$$\frac{\partial E}{\partial \dot{x}} = m\dot{x}$$

Scanned with CamScanner

$$\Rightarrow \quad \dot{E} = \underbrace{\left(-mg\left(\frac{x_d}{x}\right)^{k} + mg\right)}_{\partial E/\partial x}\underbrace{\dot{x}}_{\dot{x}} + \underbrace{m\dot{x}}_{\partial E/\partial \dot{x}}\underbrace{\left(-g\left(1-\left(\frac{x_d}{x}\right)^{k}\right)\right)}_{\ddot{x}}$$

$$= -mg\dot{x}\cancel{\left(\frac{x_d}{x}\right)^{k}} + \cancel{m\dot{x}g} - \cancel{m\dot{x}g} + m\dot{x}g\cancel{\left(\frac{x_d}{x}\right)^{k}}$$

$$= \underline{\underline{0}}$$

q.e.d.

b) See attached code. We ~~[illegible]~~ probably have energy loss because machine precision, so the derivative of E is not perfect 0.