MAE 2030 Lecture #6: 2/19/21

Today: ① Theorems review
② Harmonic Demo
③ ODE improving solver

Review: Theorems:

→ Impulse-momentum

$p = \Delta L$ ($L = mv$)

*always applies $\int F \cdot dt$

→ Power

*always applies $P = \dot{E}_k$

$F \cdot v$ $\quad \frac{1}{2}mv^2 = E_k$

→ Conservation of Energy

$E_k + E_p = \text{constant}$

$\frac{1}{2}mv^2$ $\quad -\int F \cdot dx$

*only true if F is a conservative force

1D → $F = F(x)$

2D/3D → F = conservative force field (read about in math text)

*demo: hammer & nail in wood

ex) $\dot{z} = f(t, z)$

$\ddot{x} + \dot{x} + x = \sin(t)$

define $v = \dot{x}$

$x = v$

$\dot{v} = \sin(t) - x - v$

dots ← ! → no dots

ex) $\dddot{x} + \ddot{x} + \dot{x} = \sin(t)$

$v = \dot{x}$

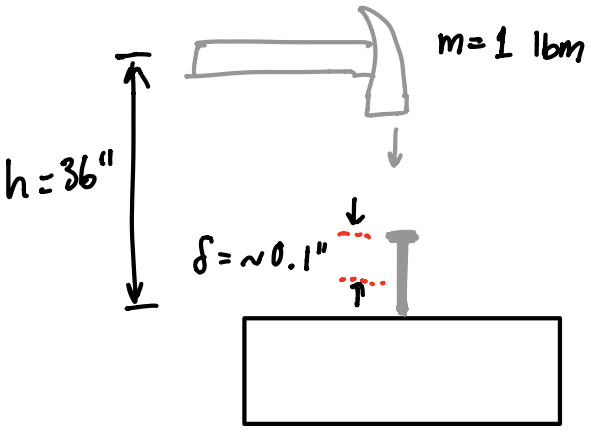
$w = \dot{v}$

$\dot{x} = v$ (z)

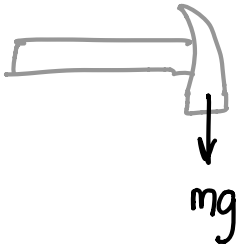
$\dot{v} = w$

$\dot{z}$ $\dot{w} = \sin(t) - v - w$

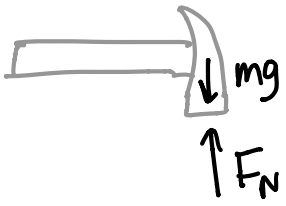
ex) hammer falls on nail in wood



FBDs: falling



hitting nail



Instead of solving ODEs:

Shortcut! $W = \Delta E_K$

$$W_{fall} + W_{nail} = E_{K_i} - E_{K_e}$$

$$mg(h+\delta) - F_N\delta = 0 - 0$$

$$F_N = \frac{mg(h+\delta)}{\delta} = \frac{1\ \text{lbm} \cdot 36''}{0.1''} g$$

$$F_N = 360\ \text{lbm} \cdot g = 360\ \text{lbf}$$

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* demo: MATLAB ODE solver → ODE45