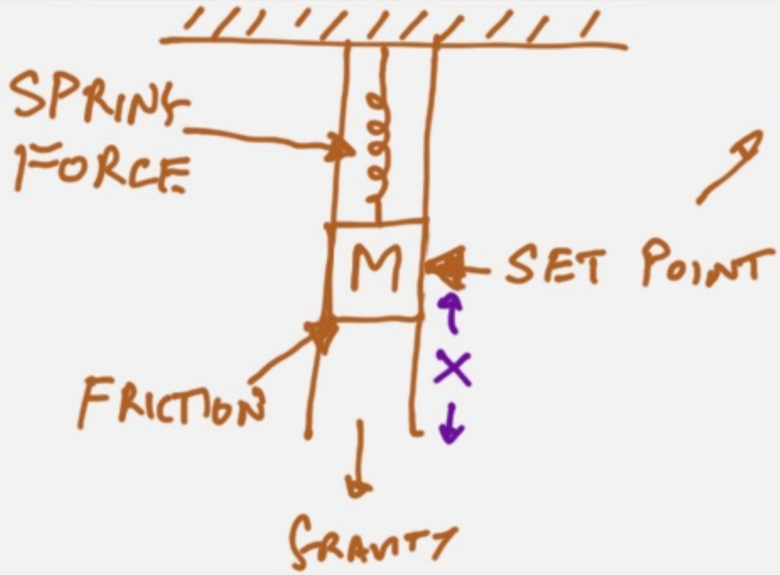


ANY ATTEMPT TO CHANGE THE SET POINT WILL RESULT IN OSCILLATION

UNLESS THE FRICTION IS ENOUGH TO STOP IT

DISPLACEMENT (x)

VELOCITY $\frac{dx}{dt} = \dot{x}$

ACCELERATION $\frac{d^2x}{dt^2} = \ddot{x} = \frac{dv}{dt}$

MASS

SPRING CONSTANT

$$M\ddot{x} + \cancel{b\dot{x}} + kx = F(t)$$

FRICTION COEFF. (DAMPER)

INPUT FORCING FUNCTION

$$M\ddot{x} + b\dot{x} + kx = F(t)$$

SECOND DERIVATIVE

LINEAR SECOND ORDER DIFFERENTIAL EQUATION WITH CONSTANT COEFFICIENTS

THIS IS WHAT ALLOWS US TO USE LAPLACE

LAPLACE TRANSFORMATION

$$x(t) \longrightarrow X(s)$$

$$\dot{x}(t) \longrightarrow sX(s)$$

$$\ddot{x}(t) \longrightarrow s^2 X(s)$$

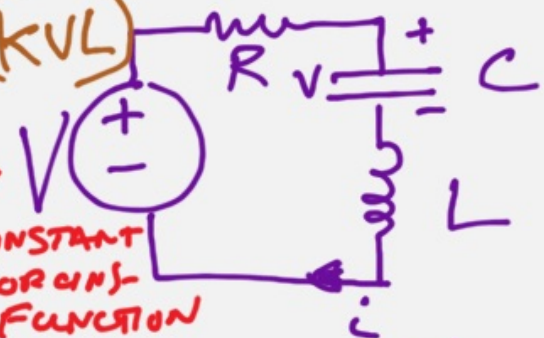
$$Ms^2X(s) + bsX(s) + kX(s) = F(s)$$

$$Ms^2 X(s) + bs X(s) + k X(s) = F(s)$$

IF THE INITIAL CONDITIONS ARE ZERO

$$X(s)\left[Ms^2 + bs + k\right] = F(s)$$

$$Ri + \underbrace{\left[\frac{1}{C}\int_0^\tau i\,d\tau\right]}_{v} + L\frac{di}{d\tau} = V$$ (KVL)



CONSTANT FORCING FUNCTION

$$R\frac{di}{d\tau} + \frac{i}{C} + L\frac{d^2 i}{d\tau^2} = \frac{dV}{d\tau}$$

$$L\frac{d^2 i}{dt^2} + R\frac{di}{d\tau} + \frac{i}{C} = 0$$

$v = V$ (AT THE END)

$i = 0$

$$L s^2 i(s) + R s\, i(s) + \frac{1}{C} i(s) = 0$$

SOLUTION FOR WHAT HAPPENS TO $i(s)$

$$\boxed{Ls^2 + Rs + \frac{1}{C} = 0}$$

THAT SOLUTION FOR $i(s)$
HAS 3 POSSIBLE OUTCOMES

1. OSCILLATORY (UNDER DAMPED)
2. CRITICALLY DAMPED
3. OVERDAMPED