ME 3050 - Dynamic Modeling + Controls
Lecture Notes - Fall, 2013 - Steven R. Anton

Introduction

(1.1) **What is System Dynamics?**

→ The study of modeling and analysis of dynamical systems as a function of time.

System Dynamics

Modeling
- Differential Equations derived to describe time-varying behavior of the system
- Free Body Diagrams (FBDs)
- Newton's 2nd Law
- Energy Methods

Analysis
- Study of model to understand response of system
- Time-Domain analysis: examine how system responds in time to various inputs (Initial Conditions, Impulse, Step, etc.)
- Frequency-Domain analysis: examine system response when subject to sinusoidal inputs.

Dynamics vs. System Dynamics

Dynamics: find state of object at specific instant in time

System Dynamics: find state of system as a function of time

↳ leads to use of Differential Equations ex: $\dot{x} + ax = b$

$$\ddot{x} + a\dot{x} + bx = c$$

Important Background to Review

- Dynamics, FBDs, Equation of Motion (EOMs)
- Differential Equations, Laplace Transforms, Partial Fraction Expansions

Some Applications

- Response of car driving over bumpy road.
- Simulation + control of a robotic arm.
- Design of vibration sensors + vibration absorbers.
- Response of electric motors + circuits.

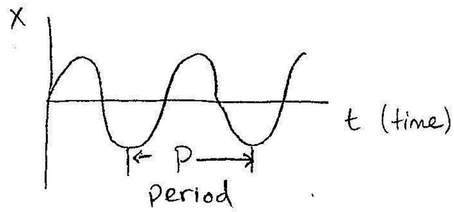
(1.2) Units

	SI	US (FPS - foot-pound-second)
Time	second (s)	second (sec)
Length	meter (m)	foot (ft)
Force	newton (N)	pound (lb)
Mass	Kilogram (kg)	slug
Energy	joule (J)	foot-pound (ft-lb)
Power	watt (W)	ft-lb/sec
Temp.	°C, °K	°F, °R

Note: $F = ma$
$W = mg$

$g = 9.81\ m/s^2$ or $32.2\ ft/s^2$

Oscillation Units



Frequency: f in cycles/second or Hz (1 Hz = 1 cps)

ω in radian/sec (angular frequency)

Conversion: $2\pi f = \omega$

Period: $P = \frac{1}{f} = \frac{2\pi}{\omega}$ (seconds)

RPM: $1\ RPM = \frac{2\pi}{60}$ rad/sec