**Fundamentals of Linear Vibrations**

1. Single Degree-of-Freedom Systems
2. Two Degree-of-Freedom Systems
3. Multi-DOF Systems

4. Continuous

**Single Degree-of-Freedom Systems**

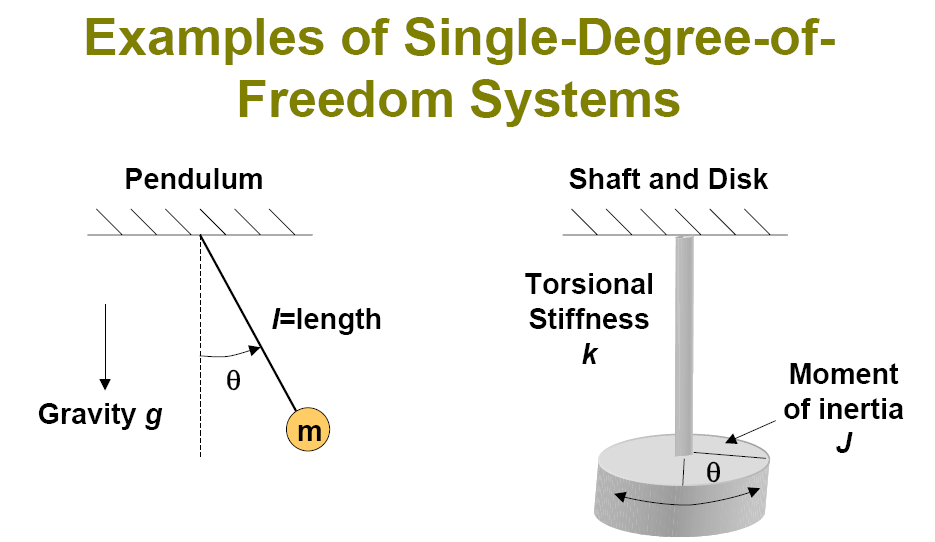
A spring-mass system

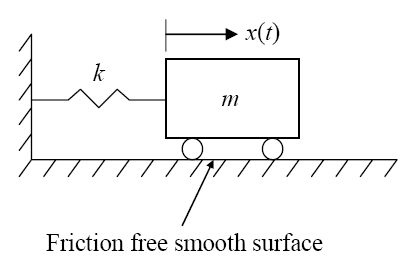
1- Newton law

* + General solution for any simple oscillator

1. Equivalent springs
   * Spring in series and in parallel
2. Energy Methods
   * Strain energy & kinetic energy (Work-energy statement)

**Undamped Free Vibrations of Single Degree of Freedom Systems :**





Or, in another form:

Equation of Motion:

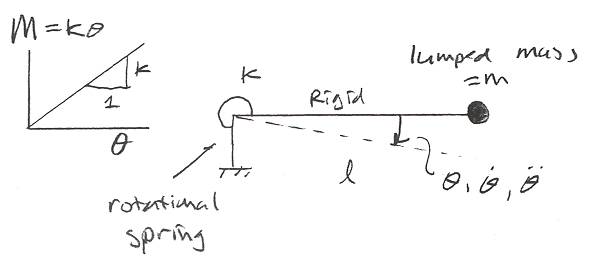


General approach:

1. Select coordinate system
2. Apply small displacement
3. Draw FBD
4. Apply Newton’s Laws:

**Any simple oscillator**

**Simple oscillator – Example 1**



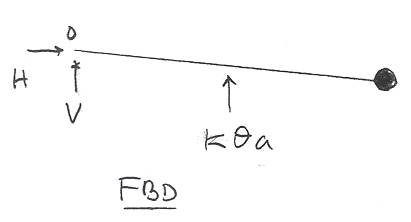
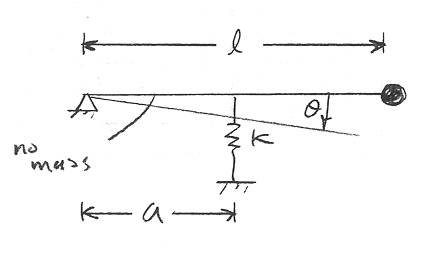








Simple oscillator – Example 2



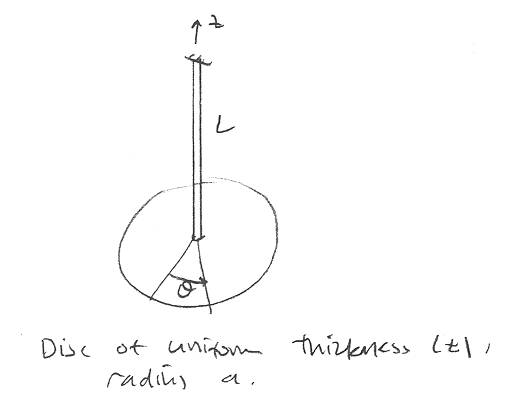
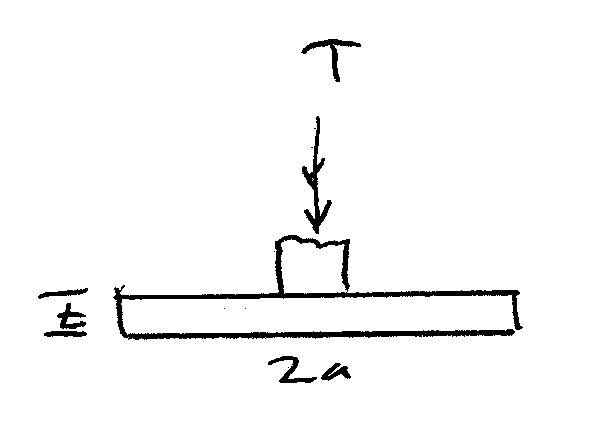


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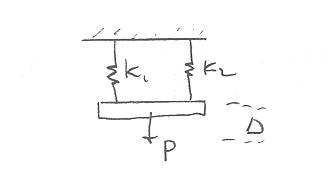
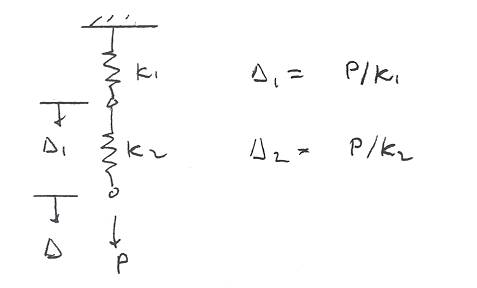
**Simple oscillator – Example 3**





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Springs in series:

same force - flexibilities add

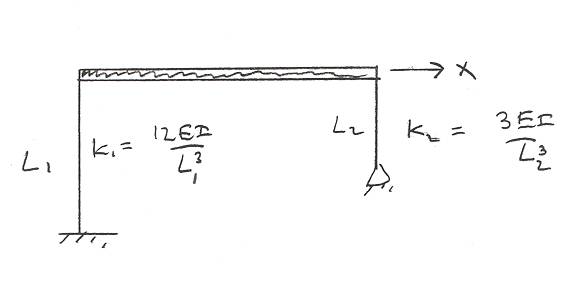
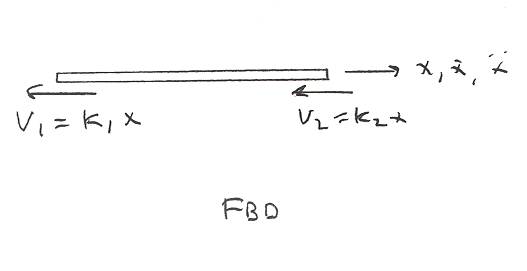
Springs in parallel:

same displacement - stiffnesses add



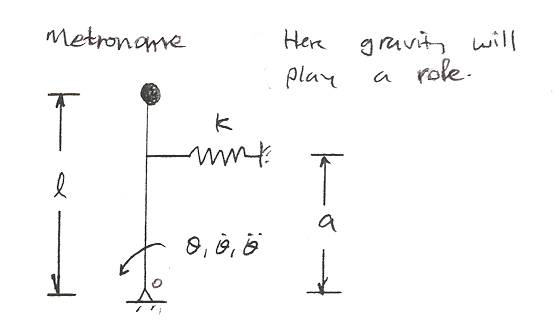
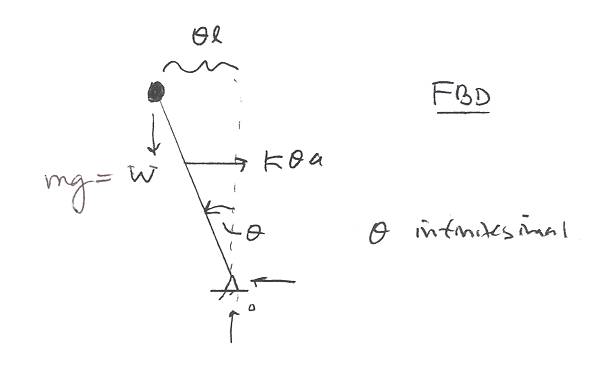






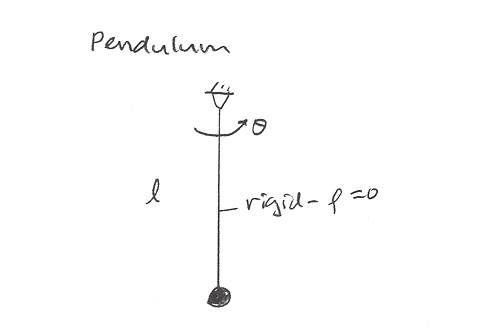
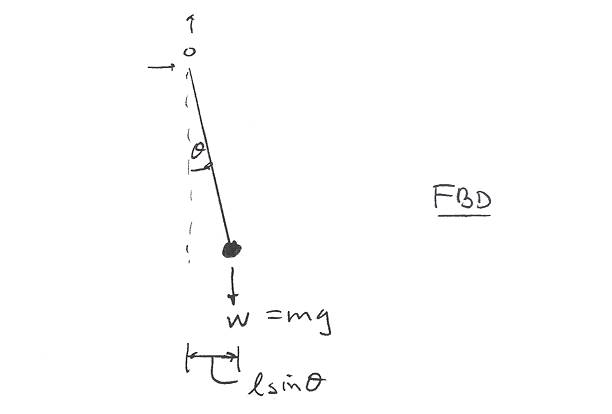
Equivalent springs – Example 4

Example 5 :



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Example 6 :



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We cannot define *ωn*

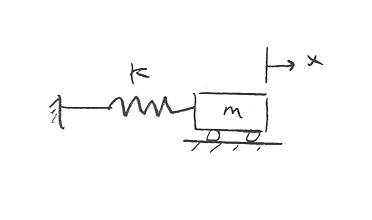
since we have *sinθ* term

If *θ < < 1, sinθ ≈ θ* :



Work-Energy principles

Energy methods



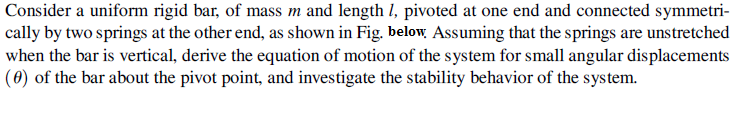


Work-energy principles have many uses, but one of the most useful is

to derive the equations of motion.

Conservation of energy: E = const.





Sol:

