Mechanical Vibrations

INTRODUCTION

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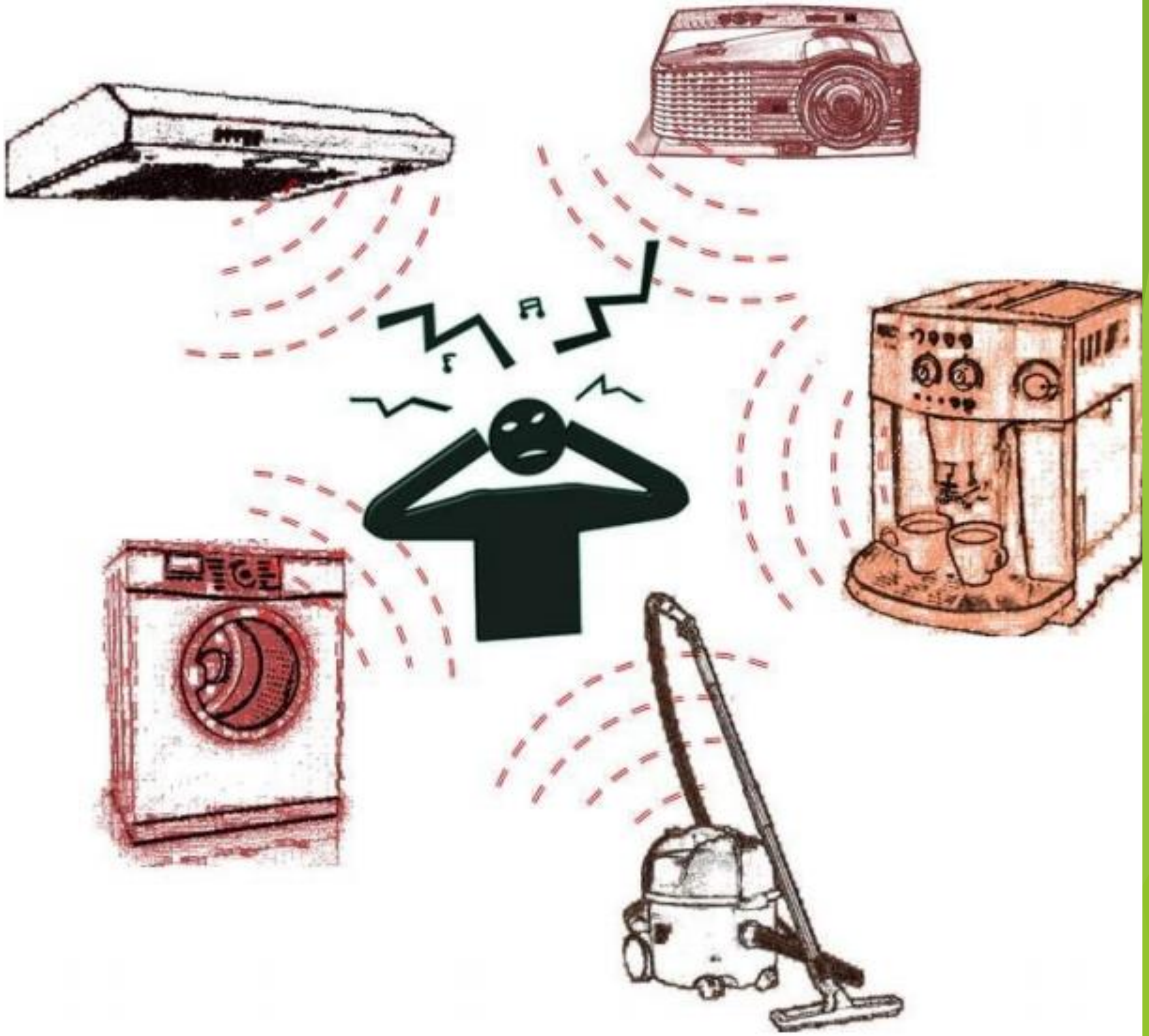
Outlines

1. Vibrations in our Life.
2. Mechanical Vibrations & Modeling of Dynamic Systems
3. Vibration Terminologies.
4. Course Contents.

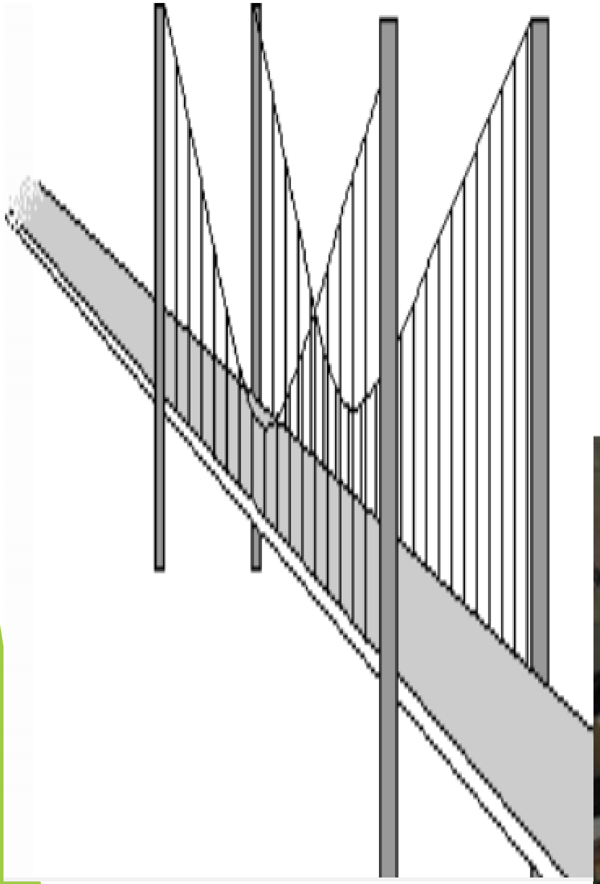
Vibrations in our Life

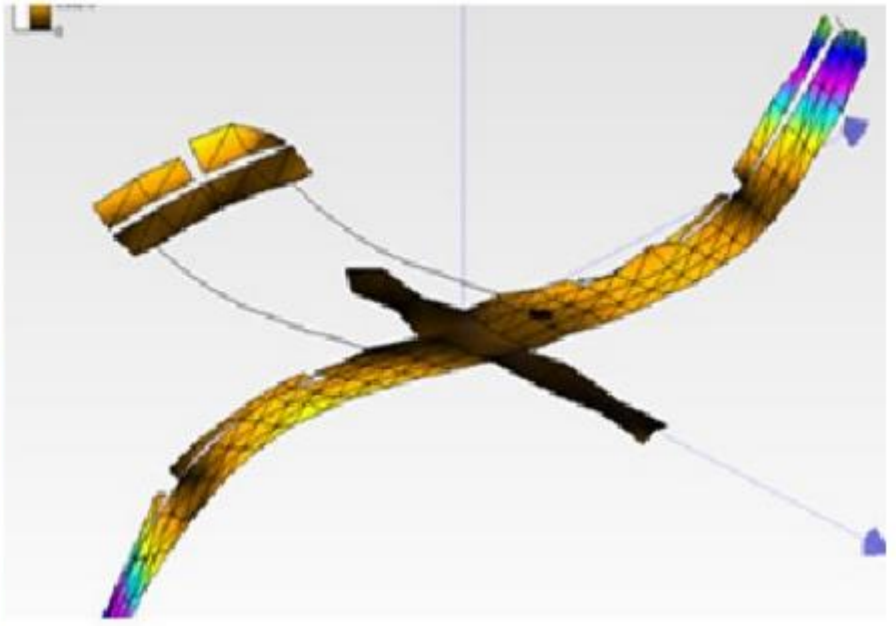
Good or Bad

- Conveyors
- Drills
- Washing Machine
- Mechanical Shaker
- Medical Applications



The importance of the study of Vibration





Mechanical Vibrations & Modeling of Dynamic Systems

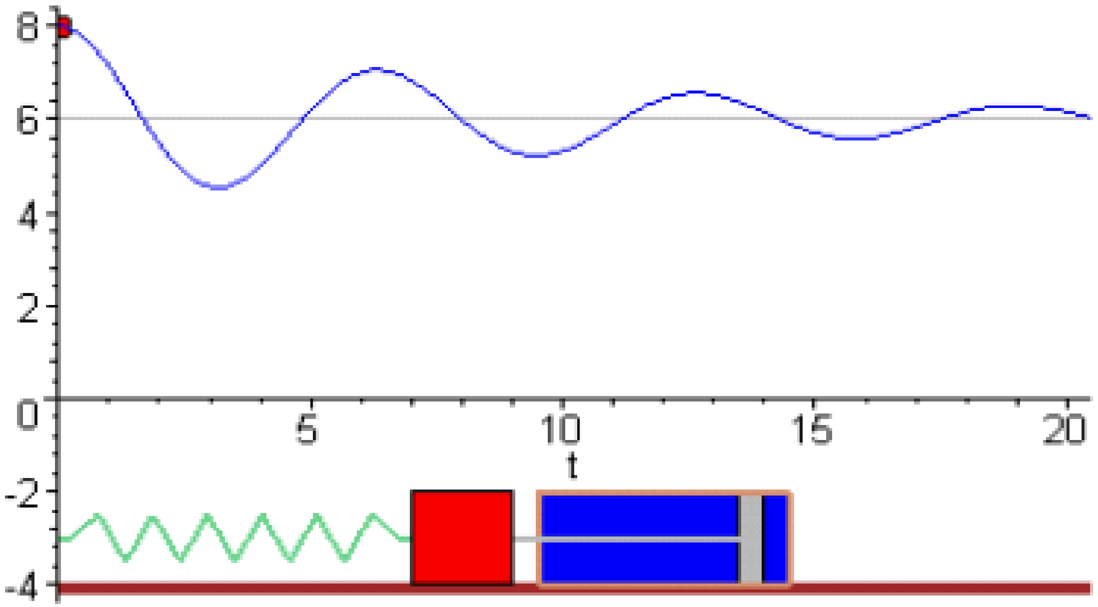
Vibrations of dynamic systems:

Consists of:

1. **Mass**

1. **Spring.**

1. **Damper.**



Vibrations Analysis

Vibration Analysis Procedure

Step 1: Mathematical Modelling

Step 2: Derivation of Governing Equations

Step 3: Solution of the Governing Equations

Step 4: Interpretation of the Results

An equation is a statement of an equality containing one or more variables. Solving the equation consists of determining which values of the variables make the equality true. The value(s) of the variable(s) (or unknown(s)) which satisfy the equality is/are called the solution(s) of the equation.

A model

is a description of a system using mathematical concepts and language. A model may help to explain a system and to study the effects of different components, and to make predictions about the behavior of a system in some circumstance. The process developing a model is termed as modelling. A model can take many forms such as statistical models, game theoretic models etc. but in general, mathematical models may include logical models. In many cases, the quality of a scientific field depends on how well the mathematical models developed on the theoretical side agree with results of repeatable experiments. Lack of agreement between theoretical mathematical models and experimental measurements often leads to important advances as better theories are developed.

The traditional models include four major elements

- **Governing Equations**: describe how the values of the unknown (dependent) variables will change w.r.t independent variables *for e.g.* v = (d/dt)s so velocity is a derivative of displacement w.r.t. time. where ***v***-> velocity, ***s***-> displacement, ***t***->time
- **Defining Equations**: They define new quantities in terms of base quantities *for e.g.* Red, Blue and Green are defined as primary colors and all other colors may be created taking a certain combination of these three colors
- **Constitutive Equations**: They define relation amongst two physical quantities that is specific to a material or substance *for e.g.* response of a crystal to an electric field, flow of liquid in a pipe etc.
- **Constraints**: They are the set of one or more predefined conditions which the solution must satisfy

So models are usually composed of **relationships** (operators - algebraic, functions, differential etc.)

Modeling of Dynamic Systems

Vibration is the repetitive motion of the system relative to a stationary frame of reference or nominal position.

Principles of Motion → Vibration Modeling

Math → Vibration Analysis

Modeling of Dynamic Systems

Spring-Mass Model

Mechanical Energy = Potential + Kinetic

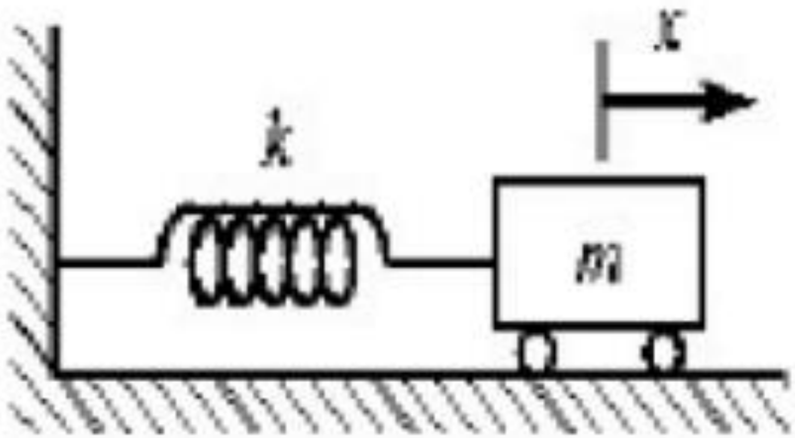
From the energy point of view, vibration is caused by the exchange of potential and kinetic energy.

When all energy goes into PE, the motion stops.
When all energy goes into KE, max velocity happens.

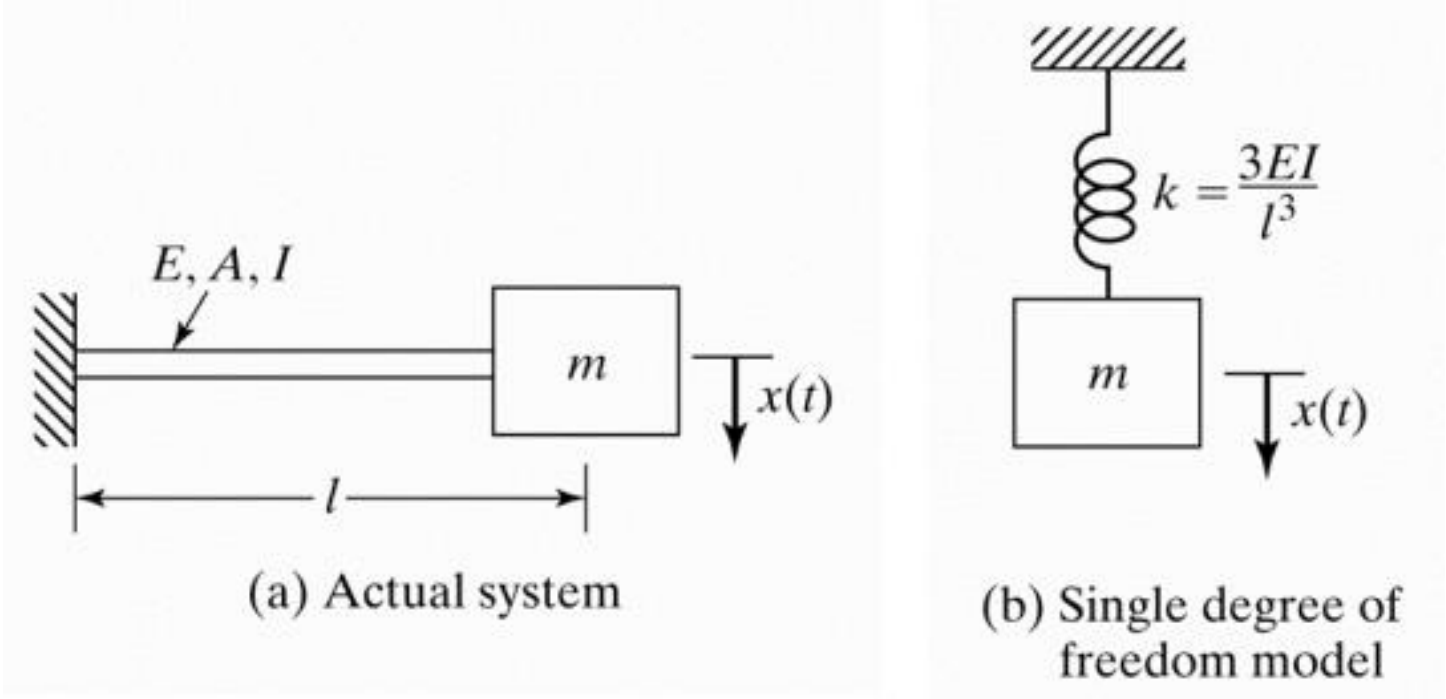
Spring stores potential energy by its deformation ($kx^2/2$).
Mass stores kinetic energy by its motion ($mv^2/2$).

Modeling of Dynamic Systems

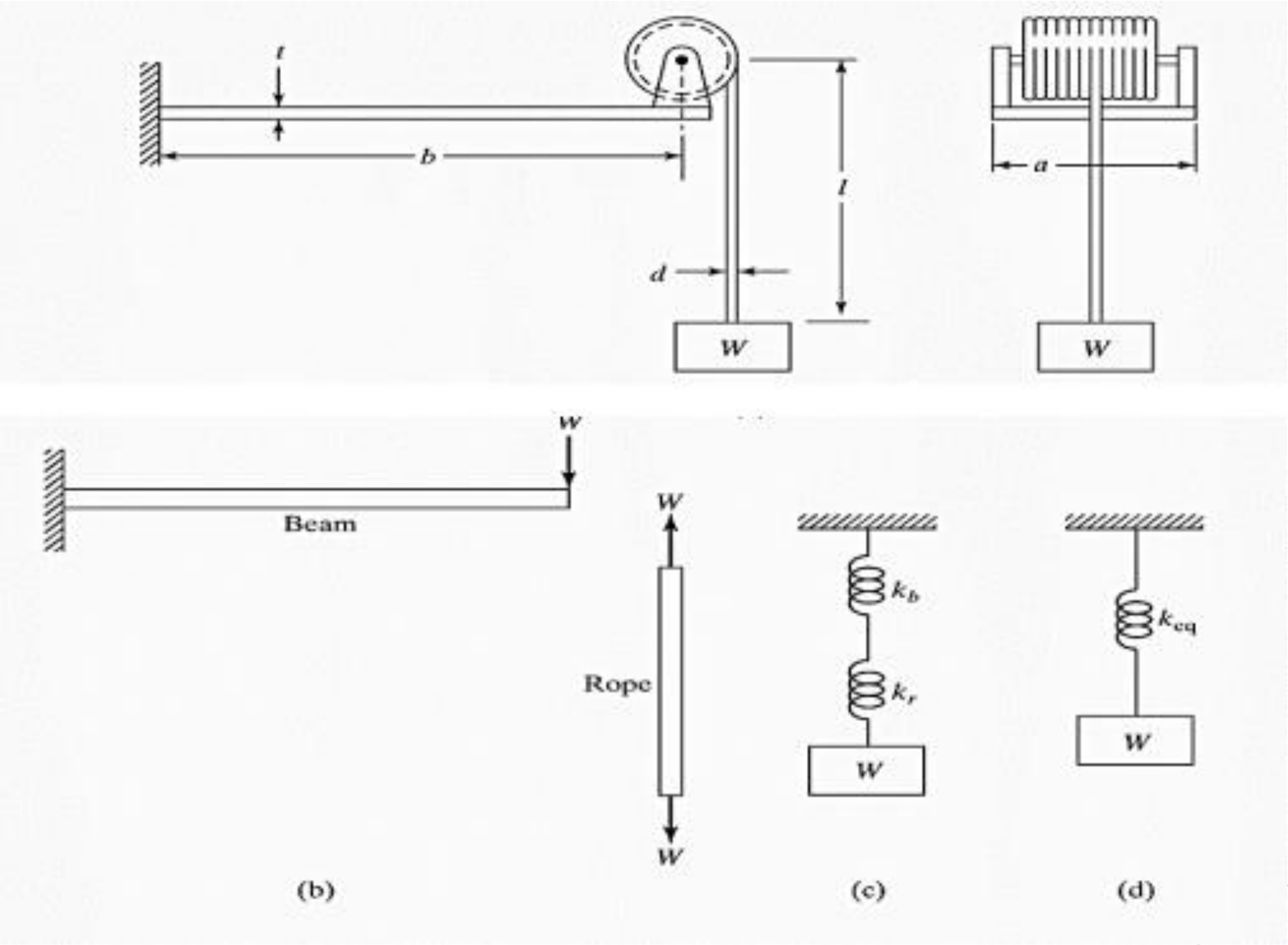
Springs and Masses connection as the way to model the vibrating system.



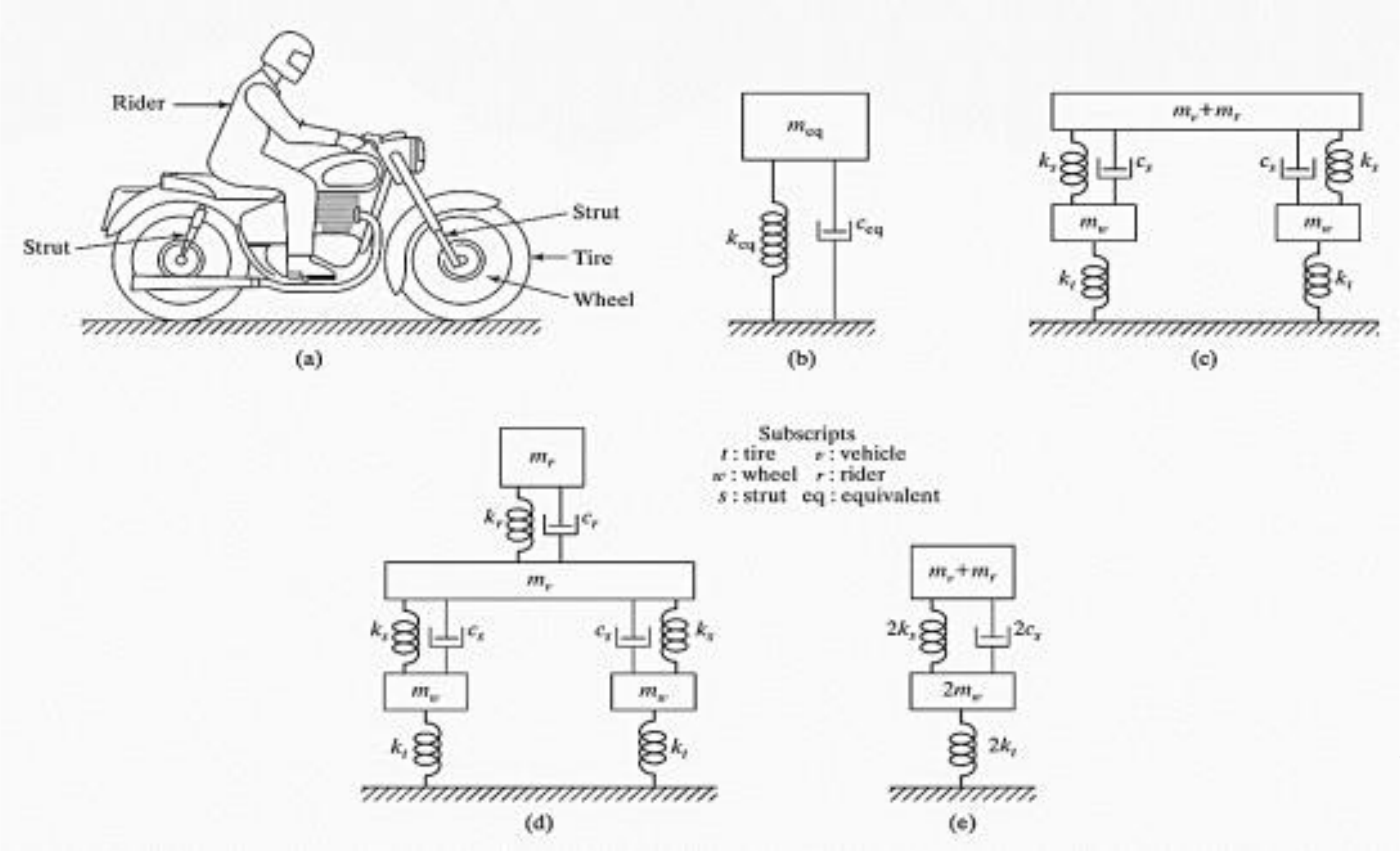
Modeling of Dynamic Systems



Modeling of Dynamic Systems



Modeling of Dynamic Systems



Thank you