

# Scientific Methods & Models of Science and Technology Development and Its Applications



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# Scientific Method

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Facts (Confirmed Observations)

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Hypothesis (Educated Guess)

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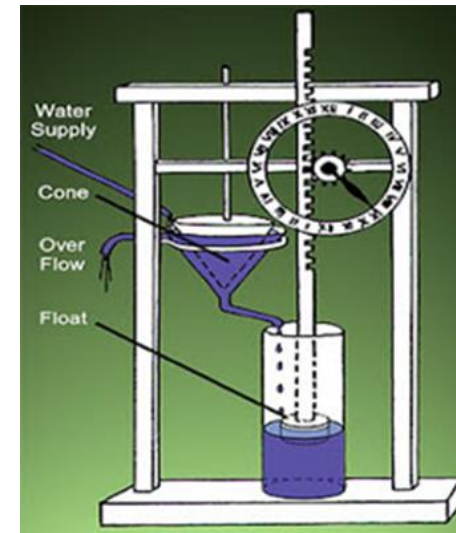
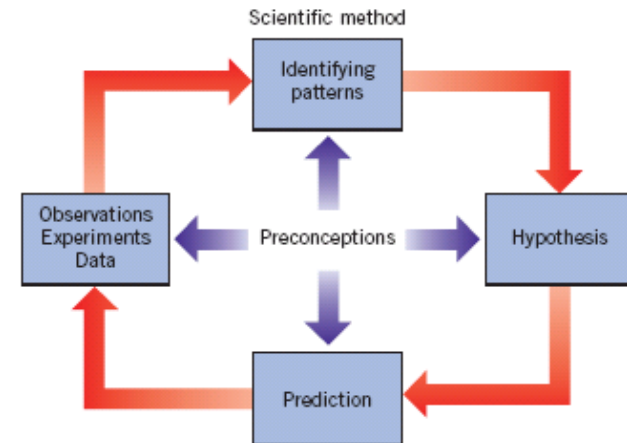
Laws (Mathematical  
Description of Nature)

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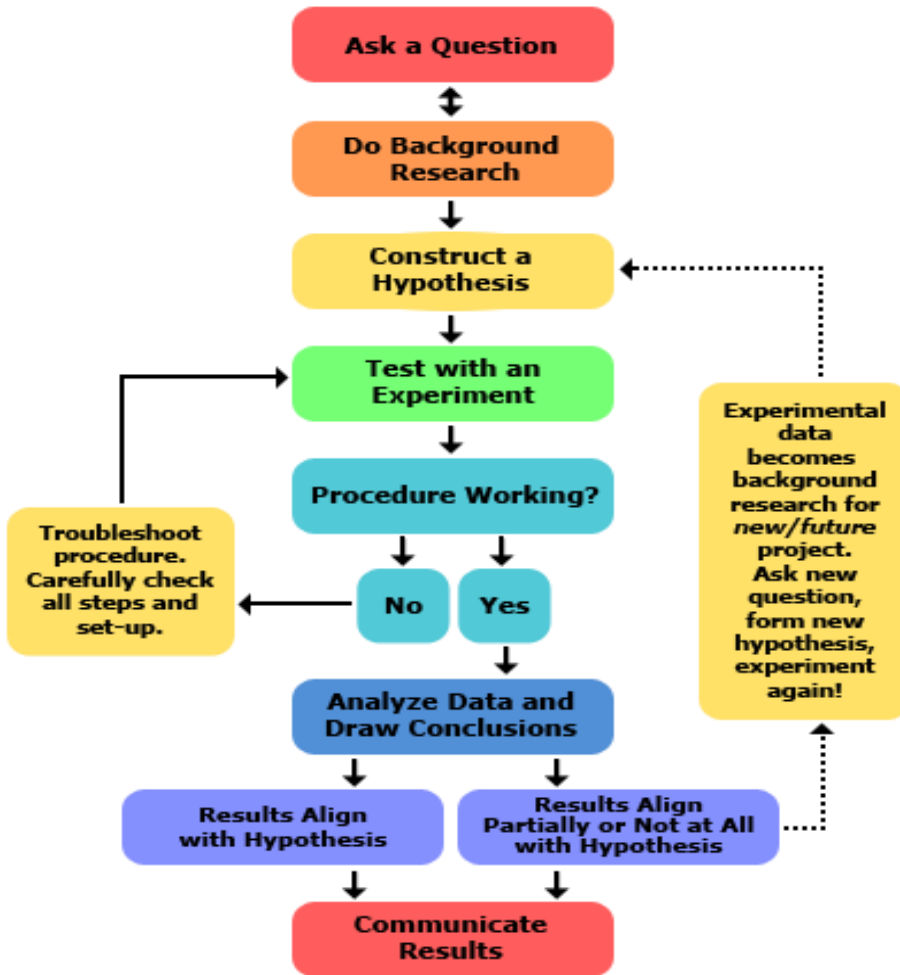
Theories (Well Established  
Explanation of Nature)

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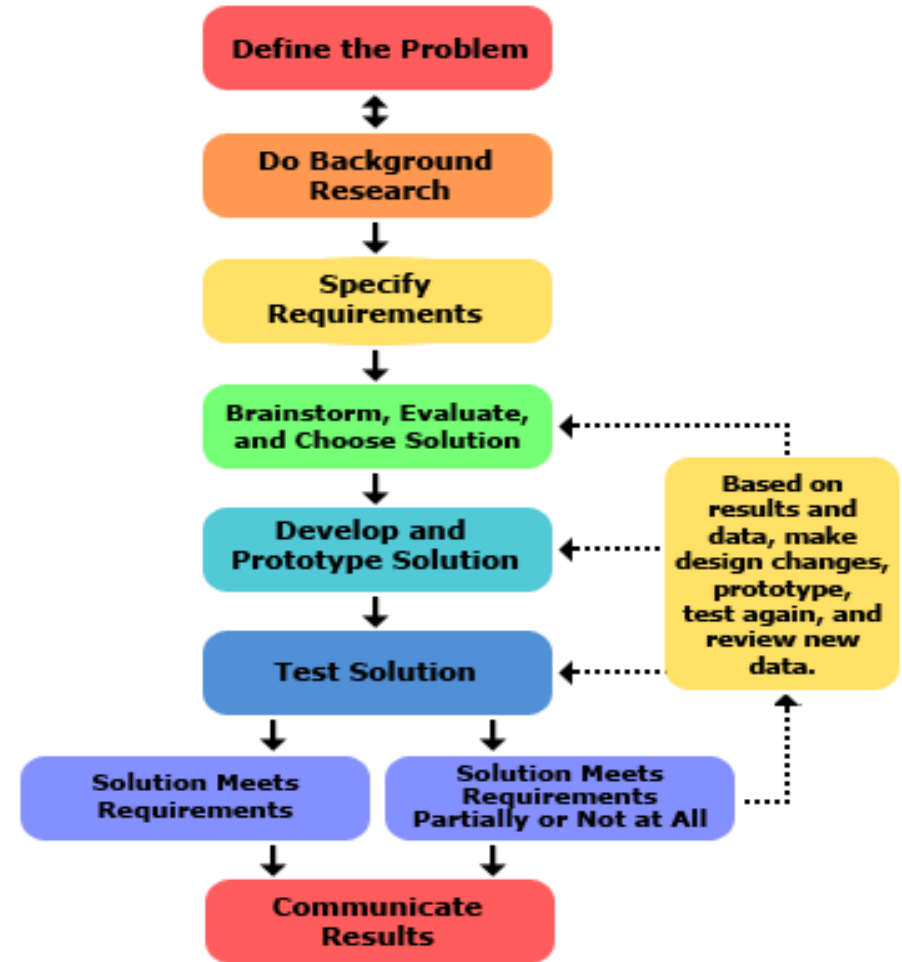


# CompaConcepts Science Vs Technology Development

## Scientific Method



## Engineering Method



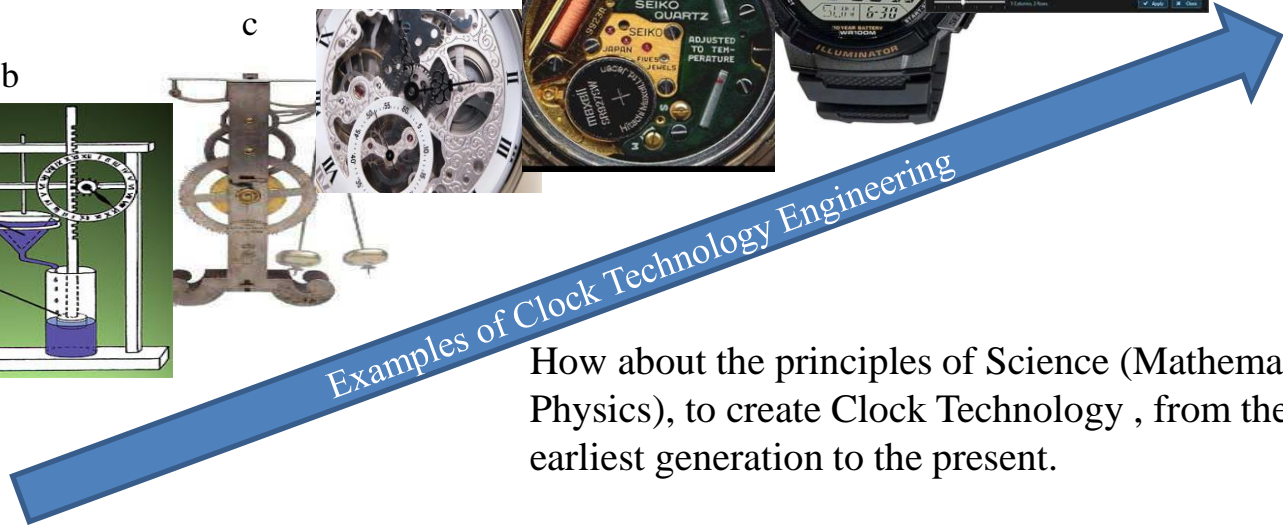
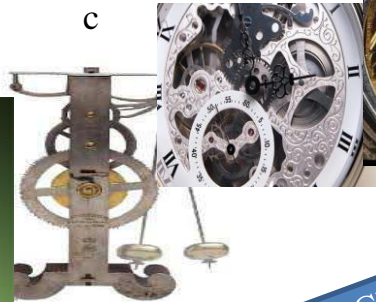
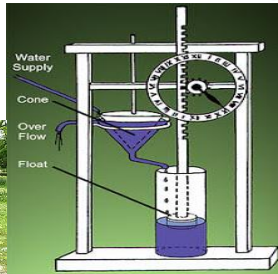
# Examples of Engineering Processes and Technology Development Results

# Introduction to Technology / Engineering Development (Concept-based)

## Case Examples of Clock Technology Development:

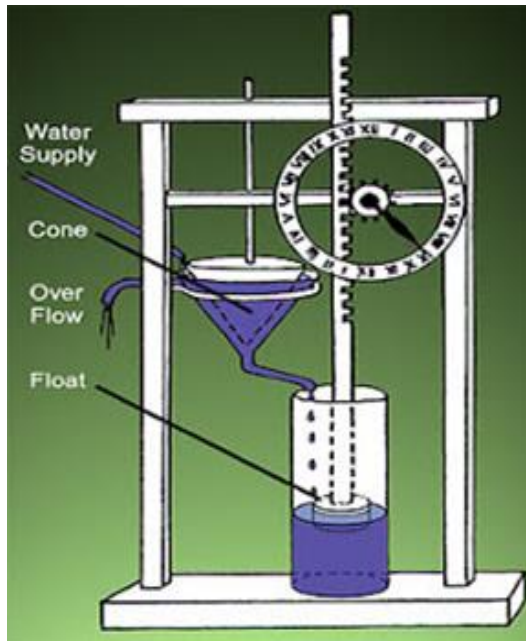
- a. Solarium
- b. Water Clock
- c. Pendulum Mechanical Clock (gravity)
- d. Spring Mechanical Clock
- e. Semi-Mechanical Clock (analog) - Battery Power
- f. Clock with Digital Technology (Hw / Sw)

Natural Clock  
(without engineering)



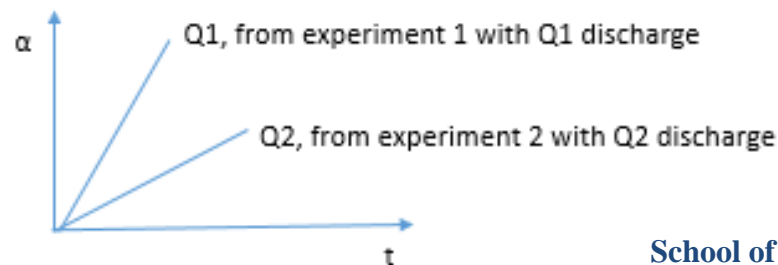
How about the principles of Science (Mathematics & Physics), to create Clock Technology , from the earliest generation to the present.

# Examples of Scientific Methods in Development for Water Clocks,



The Following Model:

- Mathematical formulation between the flow ( $Q$ ) of water with the movement of the rod and the rotation of the gear that will produce a clocking point or appointment.
- Clockwise angle ( $\alpha$ ) as a function of water discharge ( $Q$ )  $\alpha = f(Q)$



# Principles of Science Development and Application for Technology Development (Clock)

- Problem(Find Problem).....?
- Idea dan Solution idea.....?
- Scientific method/manipulation.....?
- The basics of Science.....?
  - Physics ..., according to the needs of engineering technology ...
  - Geometry : circles and angles, angular divisions...
  - Calculus, second hand speed, minute hand speed and clock speed...
- Engineering/Technology development...?
- Experiment & result .....
- reports : Paper, publications (a seminar, a journal, HAKI, PATENT)

## ASSIGNMENT KPST(1). EL- TT

- Assignments in groups a maximum of 3 students/groups.

### ASSIGNMENT :

- Find a problem in your daily life...
- How do you provide the target solution for the program...
- What/How is the scientific method to solve the problem...
- What are the basic of science (Physics & Mathematic, Chemistry, etc) used to solve the problem.

# Example of Application Science & Technology Development in Daily Life





# Development of Science & Technology Methods - Scientific



## Swing (Pendulum)

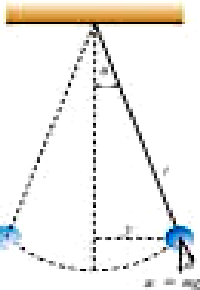
The scientific approach, (physics-mechanics)?  
What are the main physical quantities?

Advantages :

- science development,
- technology development,

} application in  
real life

### e. Ayunan atau Bandul Matematis



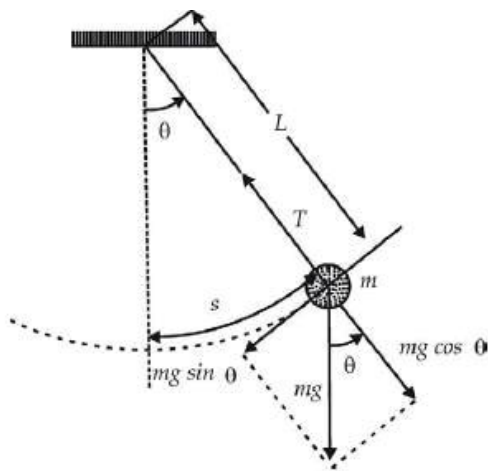
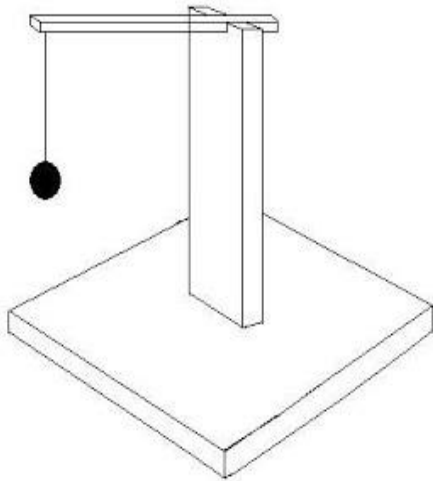
Frekuensi ayunan bandul ditentukan dengan rumus,

$$f = \frac{1}{2\pi} \sqrt{\frac{g}{l}}$$

Keterangan:

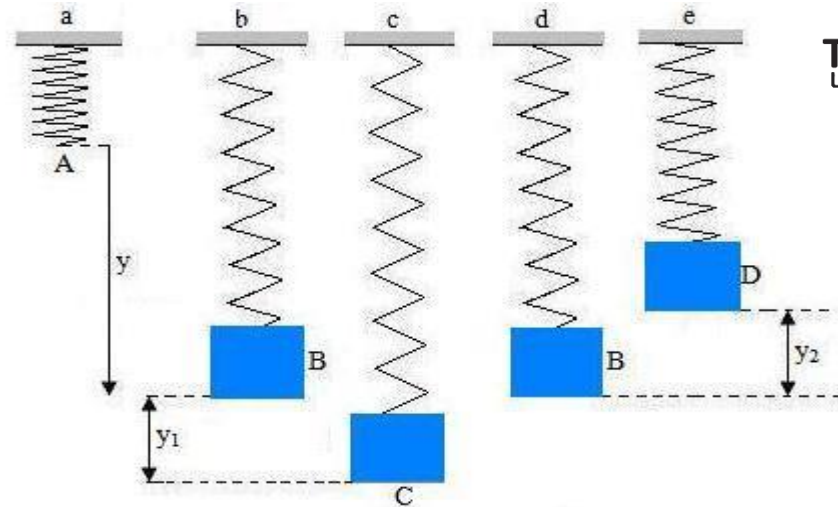
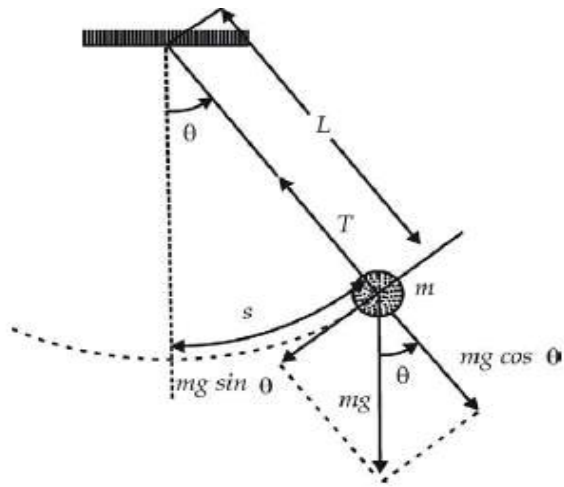
- f = frekuensi ayunan (Hz)
- g = percepatan gravitasi ( $m/s^2$ )
- l = panjang tali (m)





## System Engineering Steps

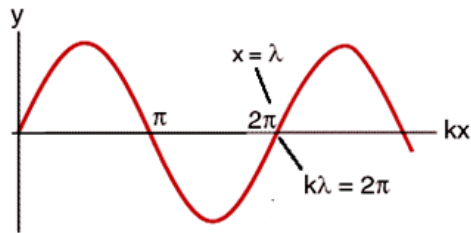
1. Problem Definition / Hypothesis
2. Experimentation and Measurement (Observation)
3. System Characteristics based on Measurement Data
4. Mathematical Models of Physical Systems (Laws)
5. System Analysis
6. System Improvement Method



Semi - Horizontal Swing

Swing-Vertical

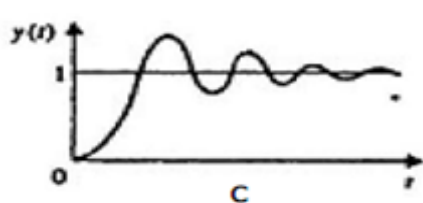
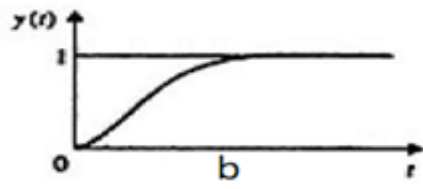
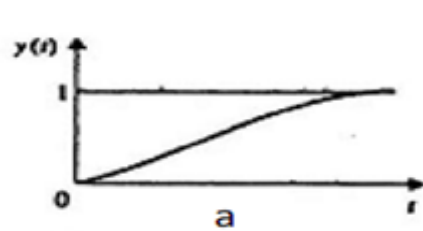
$$\theta = \omega t.$$



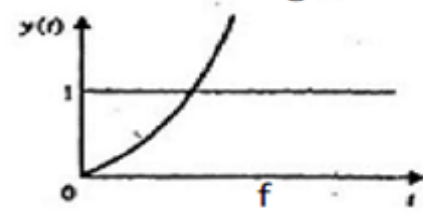
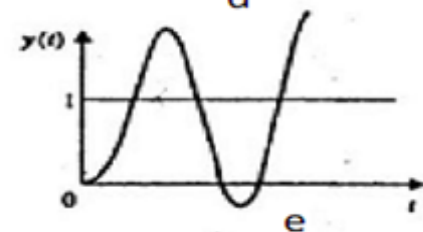
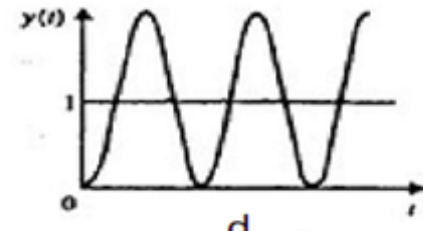
Gambar 2.5 Pola gerakan berulang dari bandul fisis

Swing Mathematical Model →  
(Equation of vibration) :

$$Y = A_m \text{Sin} (\omega t + \varphi)$$



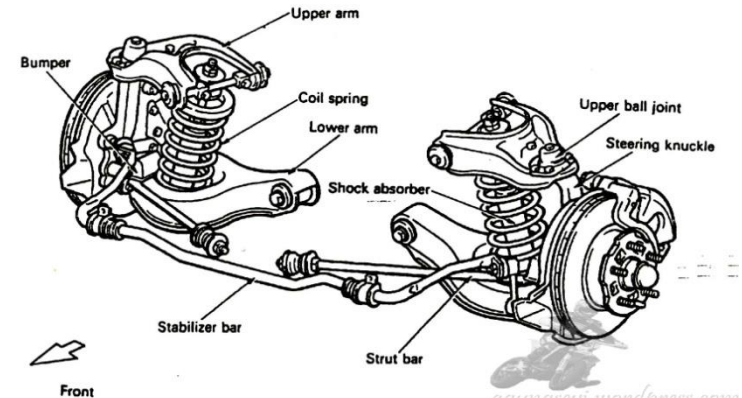
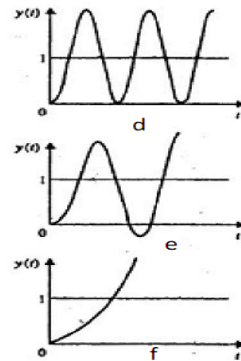
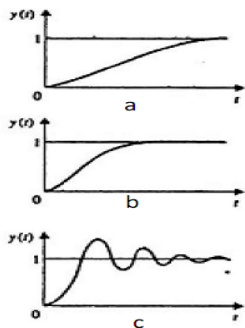
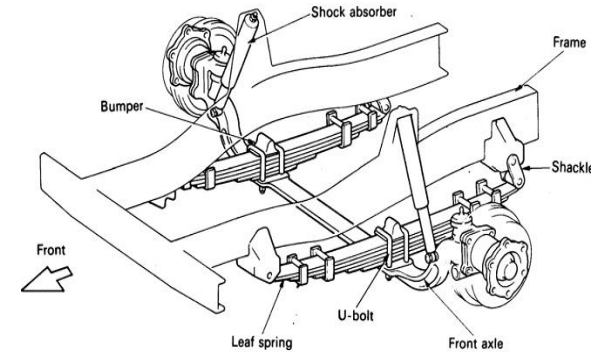
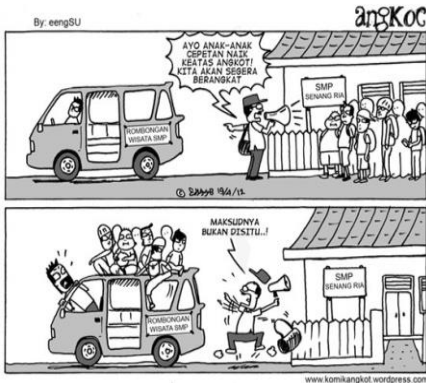
(Damped oscillations (suspension system: per and shock breaker)



Swing Mathematical Model →  
(Damped wave equation) :

$$Y = A_m \sin(\omega t + \varphi) * \exp(-at)$$

# Application of Swing Models in Vehicle Suspension Systems



Problem: ...  
 Solution innovation and solution targets: .....  
 Method: .....  
 Measuring achievement of the solution: ...

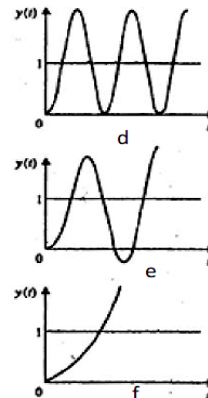
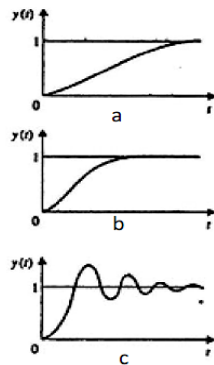
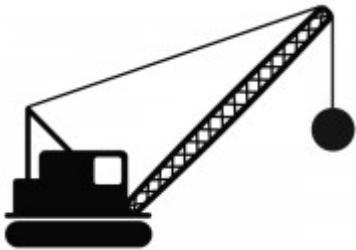
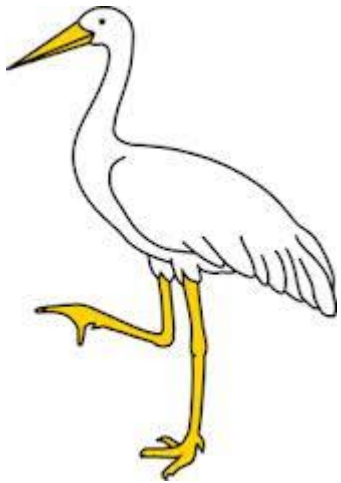
# Example OutoCar \_ TESLA

<https://www.tesla.com/videos/autopilot-self-driving-hardware-neighborhood-long>

## Critical Aircraft Landing (Creative Thinking for Critical Problem Solving)

[https://www.youtube.com/watch?v=T\\_L2iMvowCg&t=525s](https://www.youtube.com/watch?v=T_L2iMvowCg&t=525s)

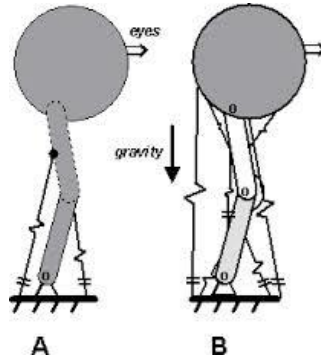
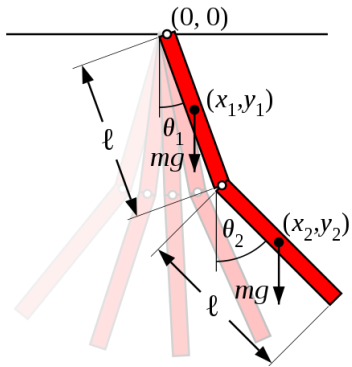
# Craine System



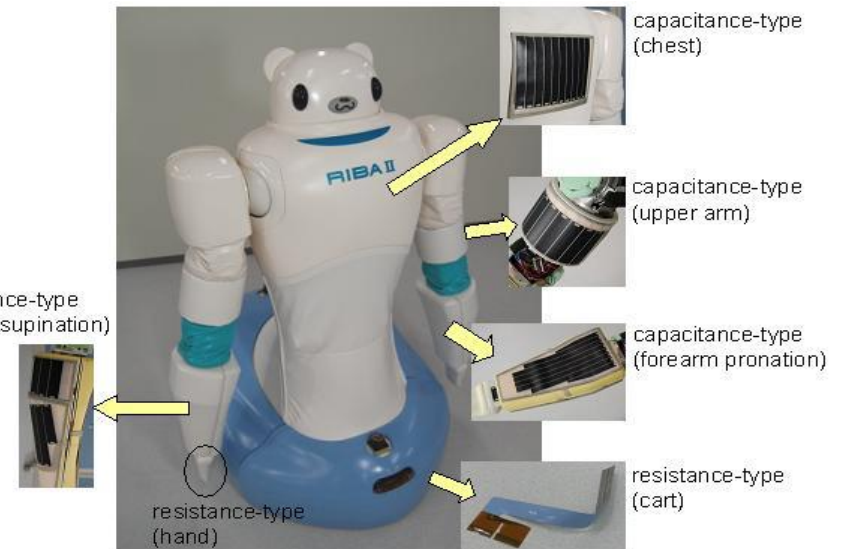
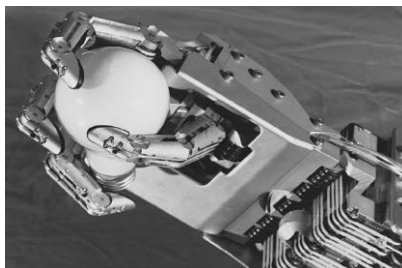
## Problem:

- System stability problems, so that oscillations do not occur for a long time and finally Craine collapses.
- The solution step .. ?

# Double Pendulum (Case: Hand-robot)



- What's the Problem?
- What hypotheses can be defined to get the solution to the problem?
- What is the solution step?





# Hydro Turbine Frequency Control System/Steam Turbine PLT

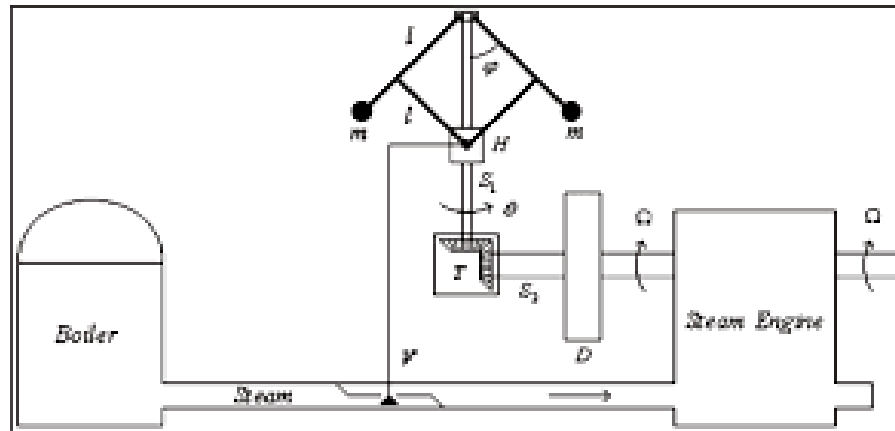


Figure 1 – Watt-centrifugal-governor-steam-engine system.

