2. Problem Solving

Dr. Tarek A. Tutunji
Philadelphia University, Jordan

Problem Solving

- In the previous session, an *introduction to engineering* was provided.
- This session is concerned with *Problem Solving*

1. Types of Problems
2. Skills and Approach
3. Procedure
4. Estimation
5. Creativity I
6. Creativity II

2.1 Types of Problems

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Preview

- In this sequence,
- The definition of a *problem* and *problem solving* will be provided.
- Problems will be classified under different types.

What is a Problem?

- A *problem* is a situation, faced by an individual or a team, for which there is no obvious solution.

Problem Solving Defined

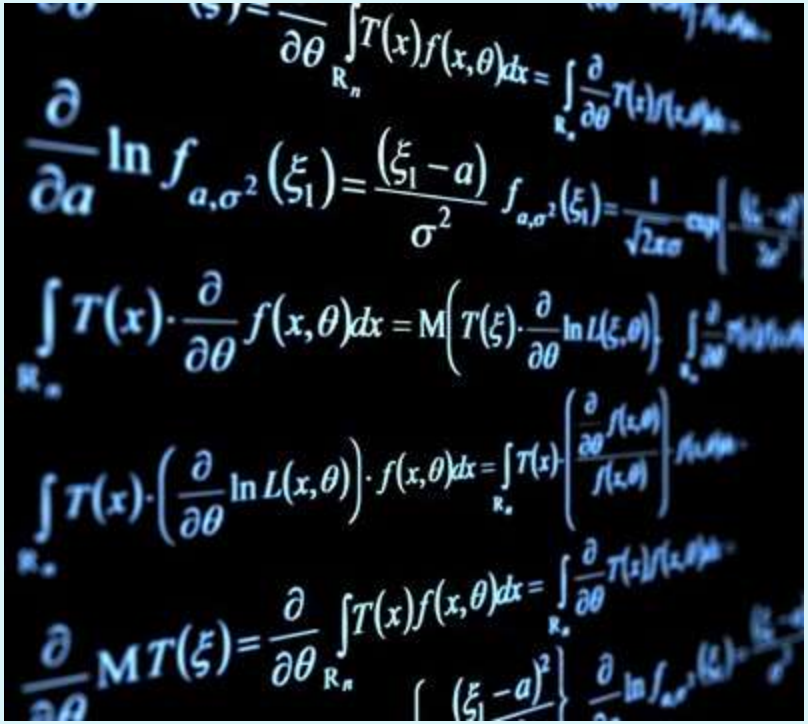
- *Problem solving* is a process in which an individual (or a team) applies knowledge, skills, and understanding in order to overcome obstacles and achieve a desired outcome in an unfamiliar situation.

Types of Problems

- Mathematics problems.
- Knowledge problems.
- Troubleshooting problems.
- Resource problems.
- Research problems.
- Design problems.

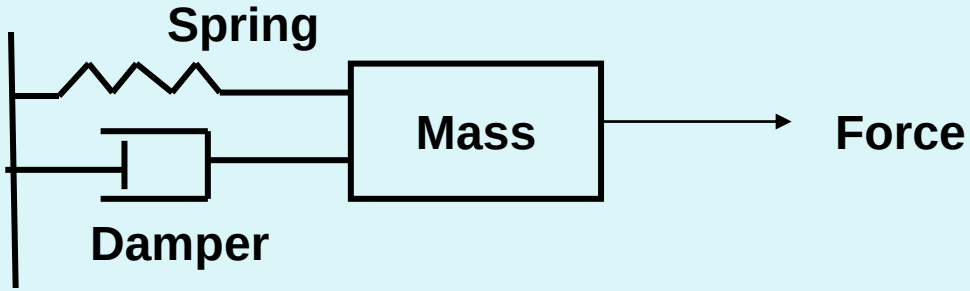
Mathematics Problems

- Describe physical phenomena with a mathematical equation.
- Might involve the application of theory and the development of algorithms.



Math Problem Example

- Consider the problem below



- The free body diagram can then be presented by the following equation

$$ma = F - kx - c\frac{dx}{dt}$$

Knowledge Problems

- A situation that one does not understand.
- Usually is resolved by reviewing the theory of the problem at hand.

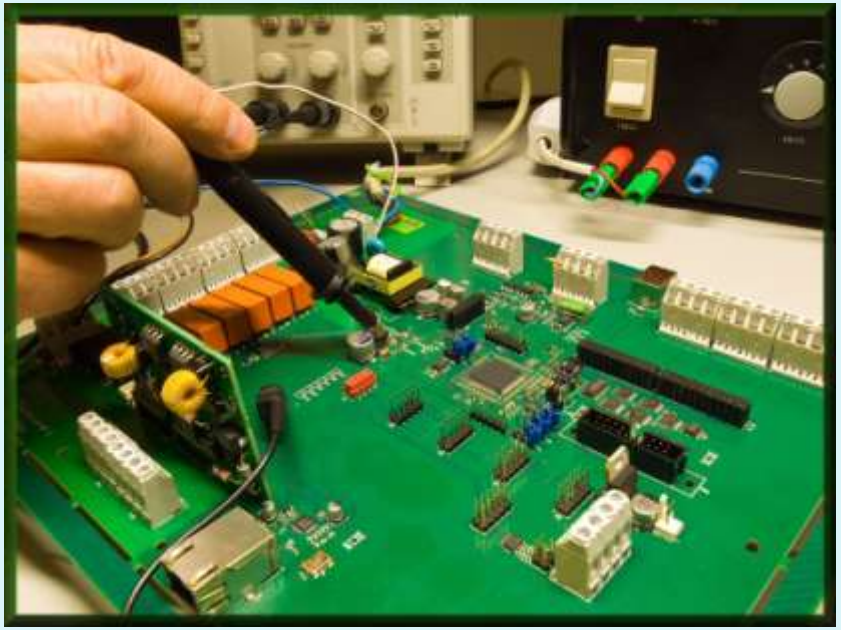
Knowledge Problem Example

- Example 1: A mechatronics engineer is testing a digital controller and finds that the simulated controller behaves similar to the implemented controller, but with unexpected delay. He later learns that digital controllers produce delays because of D/A conversion.

- Example 2: A chemical engineer notices that a chemical plant produces more product when it rains. He later realizes that the heat exchangers cool faster with cold weather.

Troubleshooting Problems

- Troubleshooting is applied to repair products or processes that behave in an unexpected or unfamiliar way.



- Troubleshooting is a logical and systematic search for the source of a problem.
  - Reproducing symptoms
  - Intermittent symptoms
  - Multiple symptoms

Troubleshooting Problem Example

- Example 1: An electronic engineer is testing a digital circuit that uses switches as inputs. He notices that when the switches are closed the signal does not produce ‘0’ volts as expected. After reviewing the circuit connections, he notices that the switch is not directly connected to ground.

- Example 2: Transmission lines have a 50 Hz noise. Shielding is applied to the wires in order to filter the noise.

Resource Problems

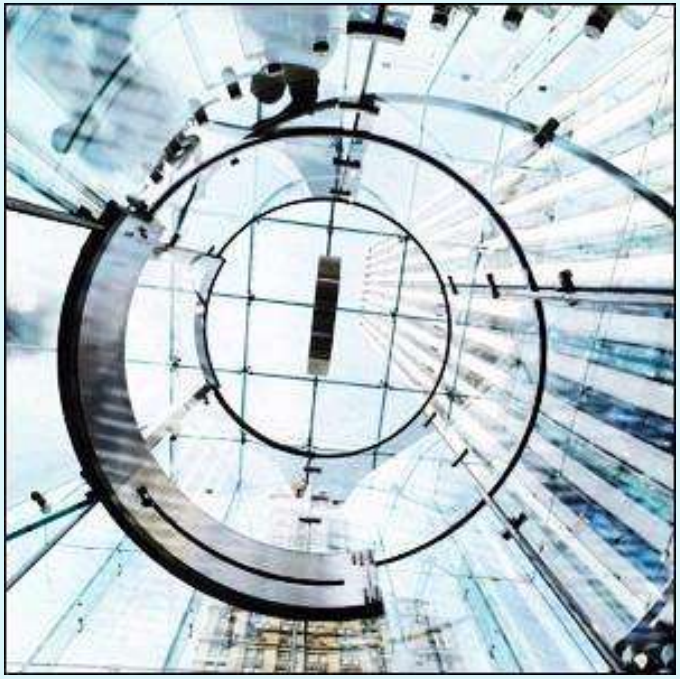
- Engineers usually work in constraints (i.e. limited resources) such as:
  - Time
  - Money
  - Man power

Resource Problem Example

- Example: A project engineer is given the task to develop an automated production line. However,
  - He has limited budget. So, he cannot buy all the components that he needs.
  - He does not have an experienced programmer. So, he has to choose the most appropriate team member for the job.
  - He needs to finish the project in 6 months and is also required to do other work for the company as well.

Research Problems

- Research problems involve advanced topics that have not been fully tackled yet.
- They might require a hypothesis to be proved or disproved.
- The research process involves investigation and further education.



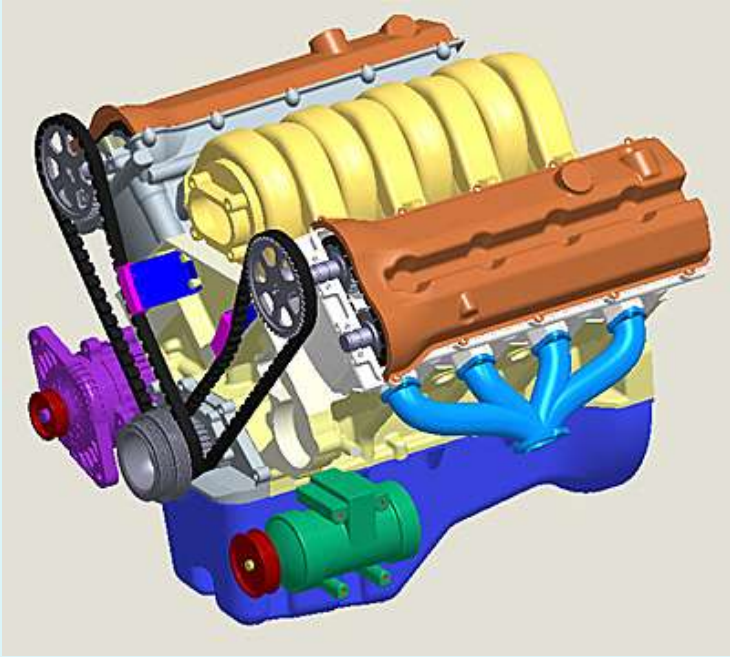
Research Problem Example

- Example 1: A software engineer is asked to develop a fast search algorithm for nonlinear problems.

- Example 2: A scientist may hypothesize that CFC are destroying the atmosphere. He needs to develop an experiment to prove (or disprove) his hypothesis.

Design Problems

- Design is the process of originating , developing, and implementing a plan for a new product using systematic steps.
- Design problems are at the heart of engineering
- Design involves creativity, teamwork, and broad knowledge.



Design Problem Example

- Example: A team of engineers are asked to design a car that
  - Accelerates from 0 - 100 Km/hr in 10 seconds.
  - Consumes less than 20 Liter per 180 Km.
  - Costs less than $15,000 to the consumer.

Conclusions

- *Problem solving* is a process where knowledge and skills are applied to overcome obstacles and achieve a desired outcome.

- Problems can be divided into several types: math, knowledge, troubleshooting, resource, research, and design.