All that begins . . .

السلام عليكم

peace be upon you

UTM UNIVERSITI TEKNOLOGI MALAYSIA

Faculty of Mechanical Engineering
Department of Thermo Fluids

Mechanical Engineering

« an etymology »

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Outline

Science

- Science is a systematic and logical approach to discovering how things in the universe work.
- The word "science" is derived from the Latin word **scientia**, which is knowledge based on *demonstrable* and *reproducible* data.
- Understanding **laws of nature* such as those involving physics, biology, chemistry and mathematics is what science is all about. Science makes us knowledgeable about our world and how it works.
- Science can only address natural phenomena (not *supernatural* phenomena—see ***qudratullah*).

*LAWS OF NATURE:
"SUNNATULLAH to Muslims—it refers to the way ALLAH rules and governs His creation's raison d'être"
**QUDRATULLAH:
"power of Allah"; Be! And it is! [Baqarah (2):117]

See http://www.livescience.com/20896-science-scientific-method.html
http://www.differencebetween.com/difference-between-science-and-vs-engineering/
http://www.indiana.edu/~ensiweb/nos.html

Engineering

- Engineering is the study of the existing body of scientific knowledge to make its use to create new designs and structures.
- Engineering makes use of science and mathematical principles to come up with better and more efficient structures and designs.
- According to Accreditation Board for Engineering and Technology (ABET): *"... engineering is the profession in which a knowledge of the mathematical and *natural sciences gained by study, experience, and practice is applied with judgement to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind."*

*NATURAL SCIENCE:
"a branch of science that deals with the physical world, e.g. physics, chemistry, geology, and biology"

See http://www.livescience.com/20896-science-scientific-method.html
http://www.differencebetween.com/difference-between-science-and-vs-engineering/

Engineer

- **Etymology:** *engineour* (middle English), borrowed from *engigneor* (old French), from *ingeniator* (medieval Latin) for “one who creates” or “one who uses an engine”, from *ingenium* (“nature, native talent, skill”), from in (“in”) + *gignere* (“to beget, produce”), *genere* (old Latin); see ingenious hence “one who produces or generates [new] things”.
- Engineers *design* materials, structures, and systems while considering the limitations imposed by practicality, regulation, safety, and cost.
- Work of engineers forms the *link* between *scientific discoveries* and their subsequent *applications* to human needs and quality of life.

- **Mechanics** is
  - the branch of *Applied Mathematics* dealing with *motion* and *forces*,
  - the branch of *Physics* dealing with the study of *motion*,
  - the technical aspect or working part; mechanism; structure.
- **States of Matter**
  - There are five known phases, or states, of matter: solids, liquids, gases, plasma, Bose-Einstein condensates.
    The main difference in the structures of each state is in the densities of the particles
  - A *solid* can resist a *shear stress* by a static deformation.
  - In physics a *fluid* is a substance that **CANNOT** resist and thus continually deforms (flows) under an applied shear stress.
- In your pursuit to become a mechanical engineer, you will become familiar with the *mechanics* of these various *states of matter*, particularly the *Solid Mechanics* and the *Fluid Mechanics*.

What is Mechanical Engineering?

- *Mechanical engineering* is a diverse subject that derives its breadth from the need to *design & manufacture* everything from small individual parts and devices (e.g. microscale sensors and inkjet printer nozzles) to large systems (e.g. spacecraft and machine tools).

See http://me.columbia.edu/what-mechanical-engineering

- The role of a *mechanical engineer* is to take a product from an idea to the marketplace. In order to accomplish this, a broad range of skills are needed. The mechanical engineer needs to acquire particular skills and knowledge. He or she needs
  - to understand the forces and the thermal environment that a product, its parts, or its subsystems will encounter;
  - to design them for functionality, aesthetics, and the ability to withstand the forces and the thermal environment they will be subjected to; and
  - to determine the best way to manufacture them and ensure they will operate without failure.
- Perhaps the one skill that is the mechanical engineer's exclusive domain is the ability to analyze and design objects and systems with *motion* . . .
- . . . and (classical) *mechanics* describes the motion of macroscopic objects, from projectiles to parts of machinery, as well as astronomical objects, such as spacecraft, planets, stars, and galaxies.

See http://me.columbia.edu/what-mechanical-engineering

Top 10 Qualities of a Great Engineer

http://engineeringschools.com/resources/top-10-qualities-of-a-great-engineer

Engineers are responsible for some of the greatest inventions and technology the world depends on. Everything from space shuttles to air conditioning systems to bridges requires the work of an engineer. To be successful in the field of engineering, one must have certain qualities. Some of those top qualities include:

- **Possesses a Strong Analytical Aptitude**: A great engineer has excellent analytical skills and is continually examining things and thinking of ways to help things work better. They are naturally inquisitive.
- **Shows an Attention to Detail**: A great engineer pays meticulous attention to detail. The slightest error can cause an entire structure to fail, so every detail must be reviewed thoroughly during the course of completing a project.
- **Has Excellent Communication Skills**: A great engineer has great communication skills. They can translate complex technical lingo into plain English and also communicate verbally with clients and other engineers working together on a project.
- **Takes Part in Continuing Education**: A great engineer stays on top of developments in the industry. Changes in technology happen rapidly, and the most successful engineers keep abreast of new research and ideas.

Top 10 Qualities of a Great Engineer

http://engineeringschools.com/resources/top-10-qualities-of-a-great-engineer

- **Is Creative**: A great engineer is creative and can think of new and innovative ways to develop new systems and make existing things work more efficiently.
- **Shows an Ability to Think Logically**: A great engineer has top-notch logical skills. They are able to make sense of complex systems and understand how things work and how problems arise.
- **Is Mathematically Inclined**: A great engineer has excellent math skills. Engineering is an intricate science that involves complex calculations of varying difficulty.
- **Has Good Problem Solving Skills**: A great engineer has sharp problem solving skills. An engineer is frequently called upon solely to address problems, and they must be able to figure out where the problem stems from and quickly develop a solution.
- **Is a Team Player**: A great engineer understands that they are part of a larger team working together to make one project come together successfully, and therefore, must work well as part of that team.
- **Has Excellent Technical Knowledge**: A great engineer has a vast amount of technical knowledge. They understand a variety of computer programs and other systems that are commonly used during an engineering project.

- **Scientific method** has a 1,000-year old history:
  - About 1,000 years ago, Ibn al-Haytham (965–1039, Iraq), argued the importance of forming questions and subsequently testing them, an approach which was later advocated by ...
  - ...Galileo with the publication of *Discourses and Mathematical Demonstrations Relating to Two New Sciences* (1638).
  - The current method is based on a *hypothetico-deductive* model formulated in the 20th century, although it has undergone significant revision since first proposed.
- Nowadays, when conducting research, scientists/engineers use the *scientific method* to collect measurable, **empirical evidence* in an experiment related to a *hypothesis* (often in the form of an if/then statement), the results aiming to support or contradict a *scientific theory*.

*EMPIRICAL EVIDENCE:
"evidence that one can see, hear, touch, taste, or smell; it is evidence that is susceptible to human senses"

See http://www.livescience.com/21491-what-is-a-scientific-theory-definition-of-theory.html
http://www.geo.sunysb.edu/esp/files/scientific-method.html

- **Scientific method** is a way to solve problems through:
  - **Observation**: what is seen or measured.
  - **Hypothesis**: possible explanation why things behave the way they do.

    Hypothesis is an EDUCATED, not random, guess.

  - **Experiment**: designed to test hypothesis, may/will lead to new observations and the cycle goes on ...
  - **Theory**: a hypothesis that has been investigated through experimental tests and observation and seems to be correct at explaining WHY things behave the way they do most of the time. Theory has predictive value(s) and if the prediction is wrong, the theory must be changed.

    Theory explains WHY a natural phenomenon occurs.

  - **Law**: After a theory has been tested for an extended period of time using all possible methods of experimentation and observation and no exceptions have been found, then it is changed to a law, which summarizes a body of observations (often in the form of mathematical relationships).

    Law tells us HOW it happens i.e. equation of how things change.

- During your engineering training course, you will be exposed to all of these stages of **scientific method**!

- **Scientific method** is iterative in nature.

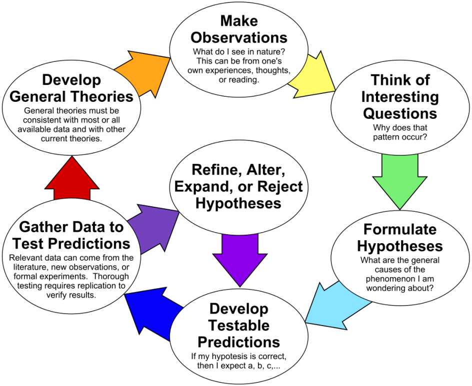

Figure 1: Scientific method.

See http://www.tvgreen.com/apchem/apnotes.htm
https://en.wikipedia.org/wiki/Scientific_method

- Thanks to the advent of digital computers in the mid-20th century, the traditional scientific method has now spawned the *computational method*.
- Traditional science, using the *scientific method*, advances when someone
  1. carefully observes something,
  2. develops a hypothesis,
  3. designs experiments to test the hypothesis, and
  4. formulate a theory.

  When the experimental data supports the theory, mathematical models are developed that can be used to predict future outcomes.
- There are often drawbacks to traditional science. As mathematical models become more complex, the procedures required are increasingly time consuming, tedious, and error-prone. Modern computer systems usher in *computational method* which can perform algorithms quickly, tirelessly, and with minimal computational error.
- *Computational method* is thus an extension of the traditional *scientific method*; it is an intersection between science, math, and computing.

Kevin Brewer & Cathy Bareiss (2016):
Concise Guide to Computing Foundations
Springer (ISBN 978-3-319-29952-5)

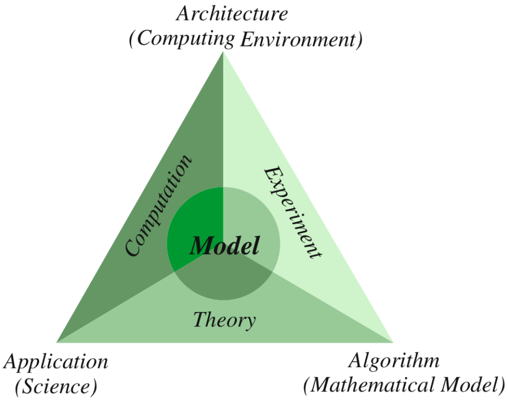

Figure 2: Overview of computational method.

Image from www.shodor.org

. . . must end

- . . . and I end my presentation with two supplications

رَّبِّ زِدْنِى عِلْمًا

my Lord! increase me in knowledge

(Taa-Haa (20):114)

اَللّٰهُمَّ اِنَّا نَسْئَلُكَ عِلْمًا نَافِعًا

O Allah! We ask You for knowledge that is of benefit

(ibn Majah)