Research in Engineering Programmes

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Outline

- Introduction
- What is Research and How to do it?
- Examples:
  - Electrical and Computer Engineering
  - Civil Engineering
  - Mechanical Engineering
  - Chemical Engineering
The role of the University

The knowledge

The intelligence includes not only the knowledge, but also in the capacity to apply the knowledge

What the country needs?

A partnership for progress
What is Research and How to do it?

Firstly, prepare yourself psychologically

1. Is being a top student/lecturer enough?
   Neither necessary nor sufficient…

2. Do you know your intellectual or mental limit?
   Ready for failures?

3. Are you extremely motivated?
   All you need is passion…

*Research is not a job *per se*, and is more like hobby !*

What is Research?

1. What is the difference between a homework problem and a research problem?
   Probably no, except for your fear.

2. Research is anything but homework:
   Finding a good problem to study is part of research too.

3. Research is about pushing the limits:
   Dismiss the problem if the solution is not interesting enough.

*Research is a game for which you get to set the rules, but it cannot be a trivial one!*
What is Engineering Research?

1. Engineering is about optimisation, but engineering research is not! Research is to find the limits and better ways for optimisation.
2. Engineering is about invention, but engineering research is not! Research is to explain why an invention works.
3. Engineering research is not science nor empirical science. It is close to applied math or applied sciences.

A good engineer needs not to be a good researcher; a good researcher needs not to be a good engineer.

Different Levels of Research

1. Level one: research assistant
   Learn the drill
2. Level two: homework like research
   Build up your confidence
3. Level three: formulating your own problem and solve it
   Exercise your creativity
4. Level four: formulating problems for others to solve
   Realize your vision

Knowing what to do is more important than knowing how!
What is Good Research?

1. Novelty (better if you were not able to publish it at first)
2. Simplicity (better if your advisor refused to grant you a degree)
3. Universality (better if others found it trivial at first sight)

You recognize a great research result if it keeps you up all night, feeling like your first date.

Warning Signs of Bogus Research

1. Prove by successful instances
2. Compound and conquer
3. Results too complicated to reproduce
4. Reinvent the wheel without proper acknowledgment
5. Tackle ill-posed problems directly
6. Solicit popularity over expert opinions
7. Occam’s razor reversed
8. Monkey collects corn cobs

Such results will NOT stand the test of time!
How to Do Research? Common Misunderstandings

1. Think research is only for genius.
2. Think yourself is a genius.
3. Think you need to know everything about the subject in advance.
4. Think you should wait for the most important problem to work on.
5. Think a solution is correct just because you cannot find anything wrong.

How to Do Research?

1. Be both confident and humble
2. Be both critical and collaborative
3. Be both ambitious and realistic
4. Be proactive and willing to take a chance!

The only way you can improve yourself is to learn things that you are the most afraid of!
How does Doing Research Feel Like?

1. An endless cycle between excitement and depression…

2. An endless cycle between sense of success and failure…

3. An endless cycle between over-confidence and self-doubt…

Research needs faith in there are always interesting new things for you to discover and by doing so you can make the world a better place!

Electrical and Computer Engineering

The technical spectrum:
Electrical and Computer Engineering

Applied Physics:

- Semiconductor Devices
- MEMS
- Sensors
- Integrated Circuit (IC) Manufacturing
- Wireless transmission

Electrical and Computer Engineering

Electrical Circuits:

- Digital Circuits
- Electronic Design Automation
- Analog Circuits
Electrical and Computer Engineering

Signals & Systems:

- Digital Communication
- Image Processing
- Control Systems
- Robotics

Electrical and Computer Engineering

Computer Systems:

- Computer Networks
- Data Storage Systems
- Computer Security
Electrical and Computer Engineering

Computer Software:

Embedded Systems

Middleware

Electrical and Computer Engineering

Computer Hardware:

Processor Architectures

Embedded Systems
Civil Engineering

Civil engineering is a composite of many specific disciplines:

- Structural & solid mechanics.
- Waste treatment & environmental.
- Transportation.
- Geotechnical & soil mechanics.
- Hydraulics & water management.
- Construction management.

Civil Engineering

Structural & Solid Mechanics

• Structural engineers design steel, concrete, or timber framed structures such as:
  – Tall buildings & towers,
  – Bridges,
  – Dams,
  – Retaining walls, & foundations, &.
  – Stadiums.
Wastewater treatment engineers are civil or chemical engineers trained to design or analyze water treatment plants.

Water treatment plants are categorized as follows:
- Sanitary waste treatment facilities,
- Industrial waste treatment facilities,
- Potable (drinking) water treatment facility.

Transportation Engineers design and analyze
- Highways,
- Railways,
- Airports,
- Urban and Suburban Road Networks,
- Parking Lots, and
- Traffic Control Signal Systems.
Geotechnical & Soil Mechanics

- Geotechnical Engineers analyze the subterranean rock and soil to determine its suitability to support extreme loads.
- Proper geotechnical engineering is essential for a safe and secure structure.

Hydraulics & Water Management

- Water management involves the use of hydrologic and hydraulic principles to design:
  - Drainage systems,
  - Detention/retention ponds,
  - Navigational waterways, and
  - Flood control levees, dams, and lakes.
Civil Engineering

Construction Management

- Construction managers:
  - Review contracts,
  - Order materials,
  - Hire and schedule sub-contractors.
- The job of a construction manager is to:
  - Provide quality control and insure project is completed on time and within budget.
Mechanical Engineering
Major Areas of Research

- Acoustics and Dynamics
- Automation and Mechatronics
- Bioengineering
- Computer Aided Design
- Fluid Mechanics
- Microelectromechanical Systems (MEMS), Heat Transfer, Combustion and Energy Systems
- Manufacturing
- Mechanics of Materials
- Tribology
- Nuclear Engineering

Chemical Engineering at the Centre

Chemical Engineering is connected to many disciplines
**Industrial Engineering**

- To design or to improve systems for the physical distribution of goods and services and to determine the most efficient plant locations.
- To increase/maximize productivity through the management of people, methods of business organization, and technology.
- To develop methods for handling and transporting materials.
- To increase/maximize efficiency.
- To eliminate worker fatigue.
- To design production planning and control systems to coordinate activities and ensure product quality.
- To develop wage and salary administration systems and job evaluation programs.
- To develop management control systems to aid in financial planning and cost analysis.