RESEARCH METHODOLOGY & IPR
BRMK557

MODULE 1

INTRODUCTION TO RESEARCH

- The word research is composed of two syllables “Re” and “Search”.
- “Re” is the prefix meaning ‘**Again or over again** or a **new**’ and
- “Search” is the latter meaning ‘**to examine closely and carefully**’ or ‘**to test and try**’.
- Together they form, a careful, systematic, patient study and investigation in some field of knowledge undertaken to establish principles / policies.

MEANING OF RESEARCH:

Research can be defined as

1. Search for knowledge

2. Systematic and scientific search for getting relevant answers on any taken up specific topic.

3. Scientific enquiry into a subject.

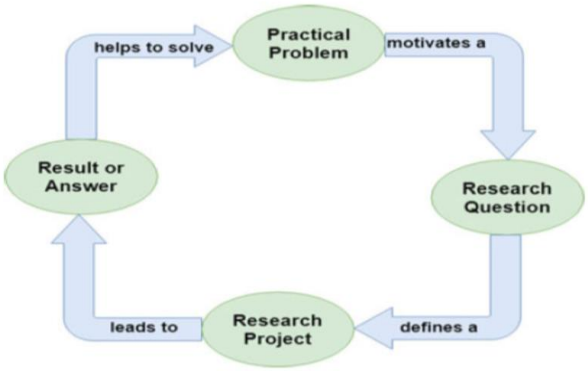
4. Research is a movement from the unknown to the known.

5. It is the voyage of discovery

DEFINITION OF RESEARCH

- Research refers to a careful, **well-defined** (or redefined), **objective**, and **systematic method** of **search for knowledge**, or formulation of a theory that is driven by interest for that which is unknown and useful on a particular aspect so as to make an original contribution to expand the existing knowledge base.
- **Engineering research** is the **backbone of innovation**, driving progress in technology and society.
- It involves **exploring new ideas**,
- **solving complex problems**, and
- improving or **creating new technologies**.
- This research is essential for **developing the tools and solutions** that shape our future.
- **For example**, research on improving battery technology focuses on making batteries last longer and charge faster. This type of research is crucial for developing better electric vehicles and smartphones, shaping the future of transportation and communication.

1 Introduction: What Is Research?



CATEGORIES OF KNOWLEDGE IN RESEARCH

The ways of developing and accessing knowledge come in three categories:

1. **Observation**: Collecting data through measurements, surveys, or tests.

For example1, recording how long a software routine takes to run.

Example2: Measuring the height of plants every day to see how fast they grow under different amounts of sunlight.

2. **Models**: Simplified representations of complex interactions, such as mathematical equations or graphs, that help understand observed data.

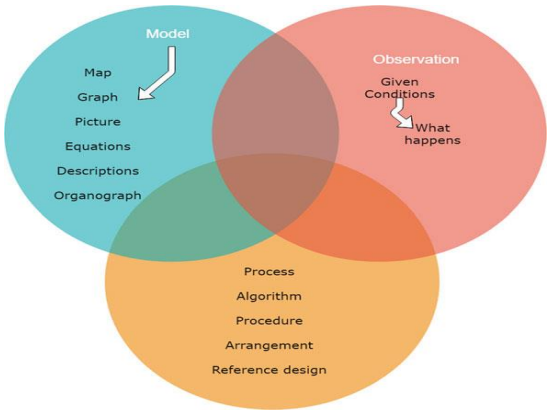
For example, using equations to describe how different factors affect a device's performance.

Example: Drawing a pie chart to show how different parts of your monthly budget (food, rent, entertainment) affect overall expenses.

3. **Processes:** Methods or procedures to achieve a specific result, like algorithms or design plans.

For example, creating a new process for developing more efficient software.

Example: Writing a step-by-step recipe to bake a cake, ensuring that all the ingredients are mixed in the right order for the best result.



OBJECTIVES OF ENGINEERING RESEARCH

1. **Advance Knowledge**

   Engineering research helps us better understand science and engineering ideas. By **exploring new ideas and conducting experiments, researchers can uncover novel insights and contribute to the advancement** of knowledge in their respective fields.

2. **Solve Real-World Problems**

   Many engineering research projects focus on **addressing real-world challenges facing society,** such as climate change, healthcare, or infrastructure development. By developing innovative solutions, engineers can improve the quality of life for people around the world.

3. **Solve Real-World Problems** For example, researchers might develop new, energy-efficient building materials to reduce energy consumption and combat climate change. These materials can help lower heating and cooling costs for homes and buildings, ultimately improving energy efficiency and reducing carbon footprints.

   Healthcare: Engineers are creating smart bandages that can monitor wounds and help them heal faster, improving care for patients without frequent doctor visits.
   Infrastructure Development: Engineers are designing stronger, flexible roads that repair themselves when small cracks form, making roads last longer and reducing maintenance costs.

4. **Develop New Technologies**

   Engineering research plays a crucial role in the **development of new technologies**, from cutting-edge medical devices to advanced communication systems. Research enables engineers to **push the limits of what is possible and create transformative innovations.**

5. **Improve Existing Technologies**

   Engineering research is not limited to developing new technologies. It also focuses on **improving existing technologies** to make them more efficient, reliable, sustainable, and user-friendly.

MOTIVATION IN ENGINEERING RESEARCH

1. **Curiosity**

   A natural curiosity about the world and a desire to explore new ideas drive many engineers to engage in research. They seek to understand **how things work**, to **discover new knowledge**, and to **solve interesting puzzles.**

2. **Passion for Innovation**

   Many engineers are **passionate about creating new technologies** and solutions. They are driven by a desire to **make a positive impact** on the world and to improve the lives of others through their innovations.

3. **Desire to Make a Difference**

   Some engineers want to solve big problems that affect society, like poverty, sickness, or pollution. They believe research can help find solutions and make the world a better place.
   Example: An engineer might work on creating affordable water filters for communities without clean water, helping to prevent diseases and improve health in poor areas..

4. ***Intrinsic Motivation***: This is the desire to do something for one's own good without any external reward. Intrinsically motivated engineers are driven by a passion for learning, solving problems, and changing the world.

5. ***Extrinsic Motivation***: The desire to do something for reward or recognition. Extrinsically motivated engineers may be motivated by money, fame, awards, or career advancement opportunities.

6. ***Social Motivation***: The desire to do something to meet the needs of others or to fit into the group. A social worker may be motivated by a desire to please a colleague, please a mentor, or meet the expectations of a parent or teacher.

7. ***Engineers are motivated by thinking in addition to these three main motivations****:* Solving unsolvable problems: Engineers are often motivated by thinking to find solutions to problems in the world's most difficult problems.

8. ***Improving the Latest Technology:*** Engineers are constantly looking for ways to improve existing technologies and create new ones. **Contributing to the Improvement of Society: Engineers want to use their knowledge and skills to make the world a better place.**

TYPES OF RESEARCH

1.Descriptive versus Analytical

- Descriptive research includes comparative and co-relational methods, and fact-finding inquiries, to effectively describe the present state of art. The researcher holds no control over the variables; rather only reports as it is.

- The primary methods used in descriptive research include observations, surveys, and case studies. One can use many variables in descriptive research to explain the facts.

- Its advantages include

a) being effective at analyzing topics and issues that cannot rely on numbers,

b) being observable in an unaltered natural environment,

c) taking less time than quantitative experiments.

Analytical research, already available facts for analysis and critical evaluation are utilized.

- Analytical research uses existing information to study and evaluate it in detail.

- Researchers look at this data to support their previous findings or come up with new ideas related to their research topic.

- Some common ways to do this are by analyzing other studies, scientific experiments, or public opinion.

- Example: Suppose a researcher wants to know if a new teaching method really helps students learn better. They would collect and study data from past experiments, surveys, and studies on different teaching methods. By carefully analyzing this data, they can confirm if their idea about the new method is correct or if they need to rethink it.

2. Applied versus Fundamental(basic or pure)

- Applied research focuses on solving real problems that businesses, organizations, or society face right now.
- It's done to find immediate solutions, often without following a strict research plan.
- Companies, governments, or individuals carry out this type of research to fix specific issues.
- Example: Imagine a company is losing customers because their website is too slow. They might conduct applied research to find better software or redesign their website to load faster. This directly addresses their problem of losing customers by applying existing knowledge to improve the website's performance.
- **Basic research (fundamental research)**
- Basic research, also known as fundamental research, focuses on gaining knowledge that might be useful in the future.
- The goal is to explore new ideas and theories without looking for immediate practical solutions.
- This type of research helps us understand how things work and can have many uses later on.
- Example: Scientists studying how gravity works on different planets are doing basic research. They aren't trying to solve an immediate problem, but the knowledge they gain might help in the future, like designing spacecraft for better space exploration.

3. Quantitative versus Qualitative

- **Quantitative research** focuses on measuring things with numbers. It collects and analyzes numerical data to find patterns, averages, or predictions. This type of research uses large groups of data to make accurate conclusions, often using charts, tables, or graphs to show results. It's common in scientific studies or fieldwork.
- For Example Suppose a team is developing an AI system to predict customer preferences for a new product. They might collect numerical data from thousands of customer surveys, like ratings on different features.
- **Qualitative research** Qualitative research focuses on understanding non-numerical aspects, like people's thoughts, feelings, and behaviors. It helps researchers understand why people behave in certain ways or have specific preferences when numerical data alone doesn't provide the full picture.

Example - If an AI team wants to improve the user experience of their app, they might conduct interviews or focus groups with users to understand their feelings and preferences. This research helps the team learn why users like certain features or find certain aspects confusing. By gathering and analyzing these insights, the team can make changes to the app that better meet user needs and improve overall satisfaction

FINDING AND SOLVING A WORTHWHILE PROBLEM

1. **Identify a Problem**

   The first step is to **identify a problem that is significant, relevant, and addresses a real-world need**. Look for areas where existing solutions are inadequate or where there is a gap in our understanding. Consider the impact your research could have on society and the potential benefits it could provide.

2. **Define the Scope**

Once you've identified a problem, carefully define its scope. This involves outlining the specific aspects of the problem you will focus on, the parameters of your research, and the **boundaries of your investigation**. A well-defined scope ensures that your research is manageable and focused.

3. **Develop a Solution**

   Based on your research, **develop a solution that addresses the identified problem.** This may involve proposing a new technology, improving an existing process, or designing a new system. Your solution should be feasible, practical, and address the root causes of the problem.

4. **Test and Evaluate**

   After developing a solution, **it's crucial to test and evaluate its effectiveness**. Conduct experiments, simulations, or pilot studies to determine whether your solution works as intended and meets the desired criteria. This step helps refine your solution and ensures its reliability.

ETHICS IN ENGINEERING RESEARCH

1. **Honesty and Integrity**

   Researchers must be **honest and transparent in their work**. They must accurately report their findings, **acknowledge all sources of information**, and avoid **plagiarism or falsification** of data.

2. **Respect for Intellectual Property**

   Researchers must respect the intellectual property rights of others, including patents, copyrights, and trademarks. They must properly **cite all sources of information** and avoid using the work of others without permission.

3. **Confidentiality**

   Researchers must **protect the confidentiality** of **sensitive information**, such as proprietary data, personal information, and trade secrets. They must only share information with authorized individuals and organizations.

4. **Responsible Conduct**

   Researchers must adhere to **ethical guidelines and principles i**n all aspects of their work. They must act in a **professional and responsible manner**, avoiding conflicts of interest and upholding the highest standards of conduct.

ETHICAL ISSUES RELATED TO AUTHORSHIP

1. **Authorship Credit**
   All authors must have made **significant contributions to the research and publication**. Credit should be given to those who have made substantial intellectual contributions, such as designing the study, collecting data, analyzing data, writing the manuscript, or reviewing and revising the manuscript.
2. **Order of Authors**

The order of authors should **reflect the relative contributions of each individual.** The first author typically has made the most significant contributions to the research, followed by subsequent authors in decreasing order of contribution.

3. **Ghostwriting**
   Ghostwriting is when **someone writes a book, article, or paper for someone else but doesn't get credit for it**. This can be unethical because it misrepresents who actually did the work. For example, if a researcher hires someone to write their academic paper and submits it under their own name, it's misleading because the credit goes to the wrong person.
4. **Gift Authorship**
   Gift authorship involves **adding an individual's name to the author list as a favor, even if they did not contribute significantly to the research**. This practice is unethical and can undermine the credibility of the research.
5. **Double Submission**: Avoid submitting the same work to multiple journals.

TYPES OF RESEARCH MISCONDUCT

1. **Fabrication**
   This is when **someone makes up data or results and pretends they are real**. **For example,** if a scientist claims they discovered a new drug that cures a disease **but their experiments never actually happened**, that's fabrication. It's a serious issue because it can mislead others and damage the integrity of research.
2. **Plagiarism**
   Plagiarism involves **presenting the work of others as your own without proper attribution**. This includes copying text, ideas, or data without acknowledging the original source.
3. **Falsification**
   This involves **changing or manipulating data to make it seem like it supports a certain result**. **For example**, if a researcher alters their experiment's results to show that a new product works better than it actually does, that's falsification. It can lead to incorrect conclusions and harm trust in research.