Research Methodology

UNIT 1

Objectives of Research

1. **Knowledge Expansion**: To enhance existing knowledge or create new knowledge in a specific field.
2. **Problem Solving**: To identify, analyze, and find solutions to specific problems.
3. **Hypothesis Testing**: To test the validity of hypotheses through systematic investigation.
4. **Policy Development**: To provide evidence-based insights that can inform policy-making and strategic planning.
5. **Social Change**: To understand societal issues and contribute to social improvement or reform.
6. **Decision Making**: To support informed decision-making in businesses, organizations, and government.

Types of Research

1. **Basic Research**: Focuses on fundamental principles and theories without immediate practical applications. Aims to increase knowledge.
2. **Applied Research**: Targets specific practical problems and seeks to find solutions. Often results in direct applications.
3. **Quantitative Research**: Involves numerical data and statistical analysis to identify patterns and relationships. Often employs surveys and experiments.
4. **Qualitative Research**: Explores phenomena through non-numerical data like interviews, focus groups, and observations to understand deeper meanings and experiences.
5. **Mixed Methods Research**: Combines both quantitative and qualitative approaches to provide a comprehensive understanding of a research question.
6. **Descriptive Research**: Aims to describe characteristics of a population or phenomenon without manipulating variables. Often used in surveys and observational studies.
7. **Exploratory Research**: Conducted when there are few or no previous studies, aimed at gaining insights and understanding issues.
8. **Explanatory Research**: Seeks to explain the reasons behind a phenomenon or relationship, often through causal analysis.
9. **Action Research**: Involves a cycle of planning, acting, observing, and reflecting, often conducted within organizations to improve practices.
10. **Longitudinal Research**: Studies the same subjects over a period of time to observe changes and developments.

Research Approaches

- Quantitative approach and the qualitative approach.
- generation of data in quantitative form
- can be further sub-classified into inferential, experimental and simulation approaches to research. The purpose of inferential approach to research is to form a data base from which to infer characteristics or relationships of population.
- This usually means survey research where a sample of population is studied (questioned or observed) to determine its characteristics, and it is then inferred that the population has the same characteristics.
- Experimental approach is characterised by much greater control over the research environment and in this case some variables are manipulated to observe their effect on other variables.
- Simulation approach involves the construction of an artificial environment within which relevant information and data can be generated.

Qualitative approach

- It is concerned with subjective assessment of attitudes, opinions and behaviour.
- Research in such a situation is a function of researcher’s insights and impressions.
- Such an approach to research generates results either in non-quantitative form or in the form which are not subjected to rigorous quantitative analysis.

Significance of Research

- All progress is born of inquiry. Doubt is often better than overconfidence, for it leads to inquiry, and inquiry leads to invention" is a famous Hudson Maxim in context of which the significance of research can well be understood.
- Increased amounts of research make progress possible.
- Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organisation.

Research Methods versus Methodology

- research methods can be put into the following three groups:
- 1. In the first group we include those methods which are concerned with the collection of data. These methods will be used where the data already available are not sufficient to arrive at the required solution;
- 2. The second group consists of those statistical techniques which are used for establishing relationships between the data and the unknowns; 3. The third group consists of those methods which are used to evaluate the accuracy of the results obtained.

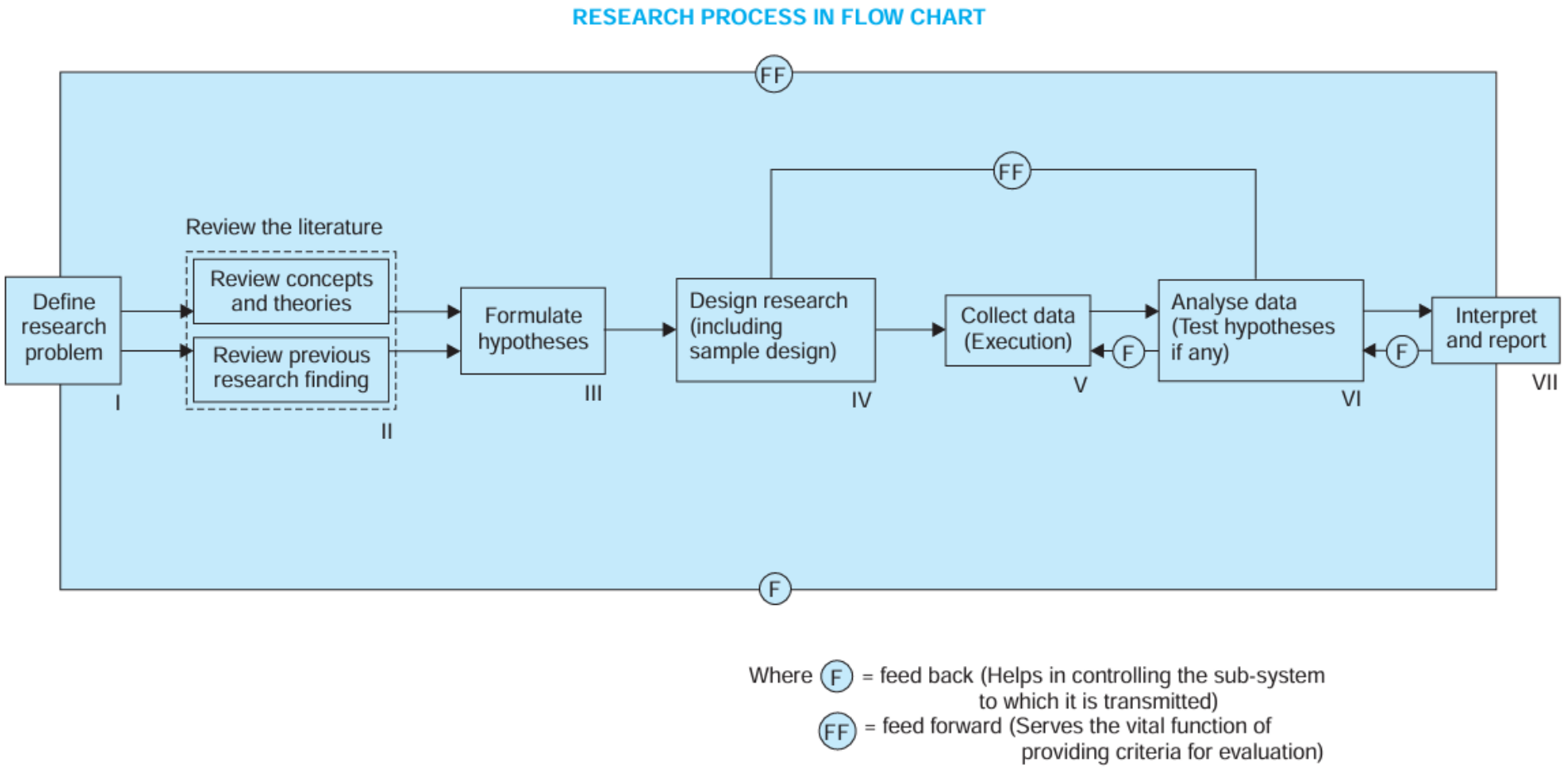
Research Methods versus Methodology

- research methodology has many dimensions and research methods do constitute a part of the research methodology.
- The scope of research methodology is wider than that of research methods.
- Thus, when we talk of research methodology we not only talk of the research methods but also consider the logic behind the methods we use in the context of our research study and explain why we are using a particular method or technique and why we are not using others so that research results are capable of being evaluated either by the researcher himself or by others.

Research and Scientific Method

- The scientific method is, thus, based on certain basic postulates which can be stated as under:
- 1. It relies on empirical evidence;
- 2. It utilizes relevant concepts;
- 3. It is committed to only objective considerations;
- 4. It presupposes ethical neutrality, i.e., it aims at nothing but making only adequate and correct statements about population objects;
- 5. It results into probabilistic predictions;
- 6. Its methodology is made known to all concerned for critical scrutiny are for use in testing the conclusions through replication;
- 7. It aims at formulating most general axioms or what can be termed as scientific theories.

Research Process



Criteria of Good Research

- 1. The purpose of the research should be clearly defined and common concepts be used.
- 2. The research procedure used should be described in sufficient detail to permit another researcher to repeat the research for further advancement, keeping the continuity of what has already been attained.
- 3. The procedural design of the research should be carefully planned to yield results that are as objective as possible.
- 4. The researcher should report with complete frankness, flaws in procedural design and estimate their effects upon the findings.
- 5. The analysis of data should be sufficiently adequate to reveal its significance and the methods of analysis used should be appropriate. The validity and reliability of the data should be checked carefully.
- 6. Conclusions should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.
- 7. Greater confidence in research is warranted if the researcher is experienced, has a good reputation in research and is a person of integrity

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem

- Research Problem: the components of a research problem as under:
- (i) There must be an individual or a group which has some difficulty or the problem.
- (ii) There must be some objective(s) to be attained at. If one wants nothing, one cannot have a problem.
- (iii) There must be alternative means (or the courses of action) for obtaining the objective(s) one wishes to attain. This means that there must be at least two means available to a researcher for if he has no choice of means, he cannot have a problem.
- (iv) There must remain some doubt in the mind of a researcher with regard to the selection of alternatives. This means that research must answer the question concerning the relative efficiency of the possible alternatives.
- (v) There must be some environment(s) to which the difficulty pertains

Selecting the Problem

- (i) Subject which is overdone should not be normally chosen, for it will be a difficult task to throw any new light in such a case.
- (ii) Controversial subject should not become the choice of an average researcher
- (iii) Too narrow or too vague problems should be avoided.
- (iv) The subject selected for research should be familiar and feasible so that the related research material or sources of research are within one's reach. Even then it is quite difficult to supply definitive ideas concerning how a researcher should obtain ideas for his research.
- (v) The importance of the subject, the qualifications and the training of a researcher, the costs involved, the time factor are few other criteria that must also be considered in selecting a problem.

Necessity of Defining the Problem

- What data are to be collected?
- What characteristics of data are relevant and need to be studied? What relations are to be explored.
- What techniques are to be used for the purpose? and similar other questions crop up in the mind of the researcher who can well plan his strategy and find answers to all such questions only when the research problem has been well defined.
- Thus, defining a research problem properly is a prerequisite for any study and is a step of the highest importance.

Technique Involved in defining a problem and Illustrations

- The research problem should be defined in a systematic manner, giving due weightage to all relating points. The technique for the purpose involves the undertaking of the following steps generally one after the other:
- (i) statement of the problem in a general way;
- (ii) understanding the nature of the problem;
- (iii) surveying the available literature
- (iv) developing the ideas through discussions; and
- (v) rephrasing the research problem into a working proposition.

Importance of Ethics in Engineering

- **Public Safety**: Engineers have a responsibility to ensure that their designs and research do not harm individuals or the environment. Ethical practices help prevent accidents and failures.
- **Trust and Credibility**: Upholding ethical standards enhances the credibility of engineering research. It builds public trust in engineers and their contributions to society.
- **Professional Responsibility**: Engineers are bound by codes of conduct from professional organizations (e.g., ASCE, IEEE), which promote ethical behavior in research and practice.
- **Honesty and Integrity**: Researchers must present their findings truthfully, avoiding fabrication, falsification, or plagiarism.
- **Accountability**: Engineers are responsible for the consequences of their research and must be willing to stand by their work.
- **Transparency**: Open communication about methods, funding sources, and potential conflicts of interest is essential to maintain trust.
- **Informed Consent**: When human subjects are involved, obtaining informed consent is necessary. Participants should be fully aware of the research purpose, procedures, risks, and benefits.
- **Respect for Confidentiality**: Researchers must safeguard the privacy of participants and ensure that sensitive data is protected.
- **Environmental Responsibility**: Engineering research should consider environmental impacts, striving for sustainable practices and minimizing harm.

Ethical Issues Related to Authorship

- Authorship in research is a critical aspect that carries significant ethical responsibilities. Misunderstandings and mismanagement of authorship can lead to various ethical issues. Here are the key ethical concerns related to authorship:
- **1. Criteria for Authorship**
- **Definition of Contribution**: Different fields have varying standards for what constitutes substantial contribution. Ethical issues arise when contributors are either unjustly excluded or included.
- **Guidelines**: Many academic journals and organizations have established criteria for authorship, typically requiring substantial contributions to conception, design, execution, or interpretation of the research.
- **2. Ghostwriting**
- **Definition**: When a paper is written by someone who is not credited as an author.
- **Ethical Concern**: This practice can mislead readers about the actual contributors and their expertise, potentially compromising the integrity of the research.
- **3. Guest Authorship**
- **Definition**: Including individuals as authors who did not contribute significantly to the research.
- **Ethical Concern**: This can dilute the responsibility for the work and misrepresent the actual contributors, leading to issues of accountability.
- **4. Order of Authors**
- **Significance of Position**: The order in which authors are listed can imply the level of contribution, with first and last authors often receiving the most recognition.
- **Ethical Issues**: Disagreements over authorship order can lead to conflict among collaborators, impacting relationships and future collaborations.

Ethical Issues Related to Authorship

- **5. Attribution and Acknowledgment**
- **Proper Citation**: Failing to acknowledge the contributions of others appropriately can lead to accusations of plagiarism.
- **Ethical Concern**: Authors must ensure that all contributors are acknowledged and that prior work is properly cited.
- **6. Conflict of Interest**
- **Undisclosed Interests**: Authors must disclose any potential conflicts of interest that could influence the research.
- **Ethical Implications**: Failure to do so can compromise the perceived integrity of the research and mislead readers.
- **7. Retaliation and Pressure**
- **Coercion for Authorship**: Sometimes, senior researchers may pressure junior colleagues to include them as authors, regardless of their actual contributions.
- **Ethical Concerns**: This practice undermines genuine collaboration and can discourage honest communication.
- **8. Changes in Authorship**
- **Post-Publication Changes**: Changing authorship status after a paper has been accepted or published raises ethical questions.
- **Transparency**: Any changes should be documented and communicated transparently to maintain trust within the academic community.

Types of Research Misconduct

- **1. Fabrication**
- **Definition**: The invention of data or results that are not based on actual research.
- **Example**: A researcher creates fictitious data for experiments that were never conducted, leading to misleading conclusions.
- **2. Falsification**
- **Definition**: Manipulating research processes, equipment, or data to produce false results.
- **Example**: A scientist alters data points to fit a desired outcome or omits negative results to make the findings appear more favorable.
- **3. Plagiarism**
- **Definition**: Using someone else's work, ideas, or intellectual property without proper attribution.
- **Example**: Copying text from another researcher's paper without citation or presenting someone else's research findings as one's own.
- **4. Improper Authorship**
- **Definition**: Failing to give credit to those who contributed to the research or including individuals as authors who did not contribute significantly.
- **Example**: Adding a colleague who provided minimal input to a research paper as a co-author, while excluding those who made substantial contributions.
- **5. Misleading or Incomplete Reporting**
- **Definition**: Presenting research findings in a way that misleads or omits essential information.
- **Example**: Selectively reporting only favorable outcomes while ignoring data that does not support the hypothesis.
- **6. Conflict of Interest**
- **Definition**: Failing to disclose financial, personal, or professional interests that may influence research outcomes.
- **Example**: A researcher conducts a study funded by a pharmaceutical company without disclosing this relationship, potentially biasing the results.
- **7. Violation of Research Protocols**
- **Definition**: Ignoring established protocols or ethical guidelines, particularly in studies involving human or animal subjects.
- **Example**: Conducting experiments without the necessary ethical approvals or not adhering to approved methods.
- **8. Retaliation Against Whistleblowers**
- **Definition**: Taking adverse actions against individuals who report misconduct.
- **Example**: Punishing a colleague who reports unethical practices by sabotaging their work or denying them opportunities.
- **9. Ghostwriting**
- **Definition**: When someone other than the listed authors writes a manuscript, often without acknowledgment.
- **Example**: A pharmaceutical company hires a professional writer to produce a study that is then attributed to researchers who had minimal involvement.

Ethics in engineering research practice

- **1. Integrity and Honesty**
- Researchers must conduct their work honestly, reporting results accurately without fabrication or falsification.
- Proper acknowledgment of contributions from collaborators and prior work is essential to maintain transparency.
- **2. Safety and Risk Management**
- Ethical engineering research involves assessing and minimizing risks to both researchers and the public.
- Safety protocols should be strictly followed, especially when dealing with potentially hazardous materials or processes.
- **3. Environmental Responsibility**
- Engineers must consider the environmental impact of their research and strive to promote sustainability.
- Research should aim to innovate solutions that reduce waste and energy consumption.
- **4. Social Responsibility**
- Engineering research should serve the public good, addressing societal challenges and improving quality of life.
- Researchers should engage with communities and stakeholders to understand their needs and concerns.

Ethics in engineering research practice

5. Respect for Intellectual Property

•Properly crediting ideas and inventions while respecting copyrights and patents is vital.

•Engaging in plagiarism or unauthorized use of others' work undermines the trust and collaboration necessary in research.

6. Human and Animal Rights

•When research involves human participants or animals, ethical standards require obtaining informed consent and ensuring humane treatment.

7. Bias and Fairness

•Researchers should be unbiased in study design, data collection, and analysis.

•Fair representation in research practices ensures diverse perspectives and equitable treatment of all participants.

8. Publication Ethics

•The publication process should be transparent, and researchers should avoid publishing the same findings in multiple journals (duplicate publication).

•Conflicts of interest must be disclosed to maintain the credibility of research findings.

Types of Research Misconduct

1. Fabrication

•**Definition:** Making up data or results and recording or reporting them as if they were obtained through research.

•**Example:** Inventing experimental results that were never actually observed.

2. Falsification

•**Definition:** Manipulating research materials, equipment, or processes, or changing or omitting data or results to misrepresent the research.

•**Example:** Altering images in a scientific publication to exaggerate findings.

3. Plagiarism

•**Definition:** Using someone else's work, ideas, or intellectual property without proper attribution, presenting it as one's own.

•**Example:** Copying text from a published paper without citation.

4. Duplicate Publication

•**Definition:** Publishing the same research findings in multiple journals or venues without proper acknowledgment.

•**Example:** Submitting the same manuscript to different journals simultaneously.

Types of Research Misconduct

6. Noncompliance with Research Regulations

•**Definition:** Failing to adhere to established guidelines, protocols, or regulations governing research practices, particularly involving human or animal subjects.

•**Example:** Not obtaining necessary ethical approvals for a study involving human participants.

7. Misrepresentation of Research Findings

•**Definition:** Providing false or misleading interpretations of research results.

•**Example:** Exaggerating the significance of findings in a way that misleads stakeholders or the public.

8. Data Mismanagement

•**Definition:** Inadequate handling of data, including poor record-keeping, failure to store data securely, or improper data sharing.

•**Example:** Losing or destroying data that is critical for verification of research.

9. Conflict of Interest

•**Definition:** Failing to disclose financial or personal interests that could bias research outcomes.

•**Example:** Not revealing a financial stake in a company related to the research being conducted.

Ethical Issues Related to Authorship

1. Ghost Authorship

•**Definition:** Individuals who contribute to the research but are not listed as authors.

•**Ethical Concern:** This can misrepresent the true contributions of those involved, undermining accountability and recognition.

2. Guest Authorship

•**Definition:** Individuals who are credited as authors despite not having made substantial contributions.

•**Ethical Concern:** This practice can inflate author lists and mislead readers about the research's credibility and integrity.

3. Misrepresentation of Contributions

•**Definition:** Misleading descriptions of each author's contributions to the research.

•**Ethical Concern:** This can distort the perception of the research team's collective effort and the work's overall integrity.

4. Order of Authors

•**Definition:** The sequence in which authors are listed can imply varying levels of contribution.

•**Ethical Concern:** Disagreements about author order can lead to conflicts, particularly if the ordering does not accurately reflect contributions.

Ethical Issues Related to Authorship

5. Conflicts of Interest

•**Definition:** Failing to disclose personal, financial, or professional interests that could influence research outcomes.

•**Ethical Concern:** Undisclosed conflicts can compromise the perceived objectivity of the research and its authors.

6. Revisions and Updates

•**Definition:** When authorship changes occur during revisions of a manuscript, sometimes without proper justification.

•**Ethical Concern:** This can lead to disputes and a lack of clarity about who is accountable for the final work.

7. Retraction and Accountability

•**Definition:** Issues related to retractions of published works often involve questions about author accountability.

•**Ethical Concern:** Determining who is responsible for errors or misconduct can be complex, especially if multiple authors are involved.