RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS (IPR)

Course Code: BRMK557

MODULE -1

Introduction to Research & Ethics in Engineering Research

A Simplified Notes for the 5th Semester As per VTU Syllabus - 2022 Scheme

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Module 1

Introduction to Research & Ethics in Engineering Research

- **Learning Module Outcomes**

  After reading this Module, the student will be able to:

  - To Understand the knowledge on basics of research and its types.
  - To learn Ethics in Engineering Research.

Chapter 1: Introduction to Research (Textbook 1: Page 1-7)

- Meaning of Research
- Objectives of Engineering Research
- Motivation in Engineering Research
- Types of Engineering Research
- Finding and Solving a Worthwhile Problem

Chapter 5: Ethics in Engineering Research (Textbook 1: Page 43 - 48)

- Ethics in Engineering Research Practice
- Types of Research Misconduct
- Ethical Issues Related to Authorship

Text Book: *"Engineering Research Methodology"* by Dipankar Deb etal, Intelligent Systems Reference Library, edition 1, Springer.

Chapter 1: Introduction to Research

1.1 Meaning of Research: It can be defined in several ways

- Research can be defined as the scientific and systematic search for information for a specific task.
- Research is a process of creating or formulating knowledge that does not yet exist.
- Research is a systematic and organised process of inquiry that involves the investigation of a specific topic, problem, or question through the collection, analysis, and interpretation of data and information.
- Research refers to a careful, well-defined objective, and systematic method of search for knowledge, or formulation of a theory.
- Research involves formulation of a hypothesis or proposition of solutions and data analysis.

- *The primary goal of research* is to generate new knowledge, enhance understanding, or contribute to developing theories and applications in a particular field.

- **Research flow cycle:** The research cycle flow diagram is shown in Fig 1.1. The flow starts with a *practical problem*. One must be clear about what the problem being attempted to solve is and why it is important.

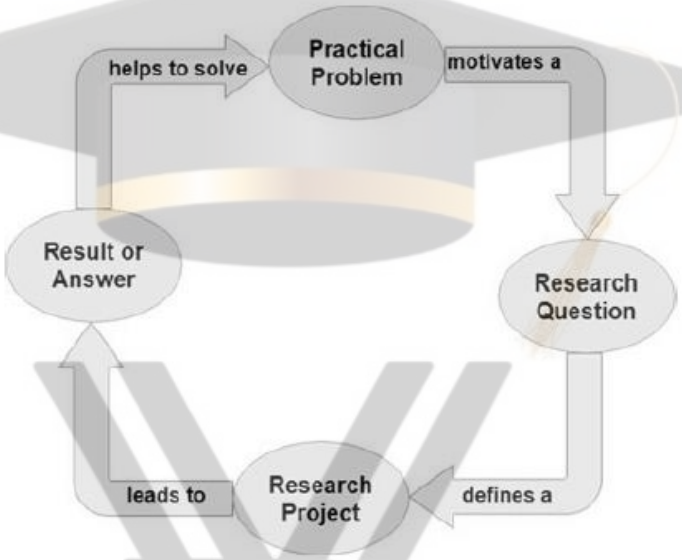

Fig. 1.1 The research flow diagram

This problem motivates a *research question* and this question helps to collect a manageable volume of information, and in turn, defines a *research project* which is an activity or set of activities that ultimately leads to *results*.

- **The categories of knowledge in research:** The ways of developing and accessing knowledge in research come in THREE broad categories:
  1. ***Observation:*** It is the most fundamental way of obtaining information from a source. Observation takes different forms from something like measurements in a laboratory, to a survey among a group of subjects. The observational data often needs to be processed in some form and this leads to the second category of knowledge, the model.
  2. ***Model:*** Models are approximated, often simplified ways of describing sometimes very complex interactions in the form of a statistical relationship. For example a block diagram, flow chart, figure, or a set of mathematical equations etc.
  3. ***Proces***: It is a way of arranging or doing things. Examples are algorithms, procedures, arrangements, or reference designs, to get a certain desired result.

The categories of above three knowledge as described briefly in Fig. 1.2.

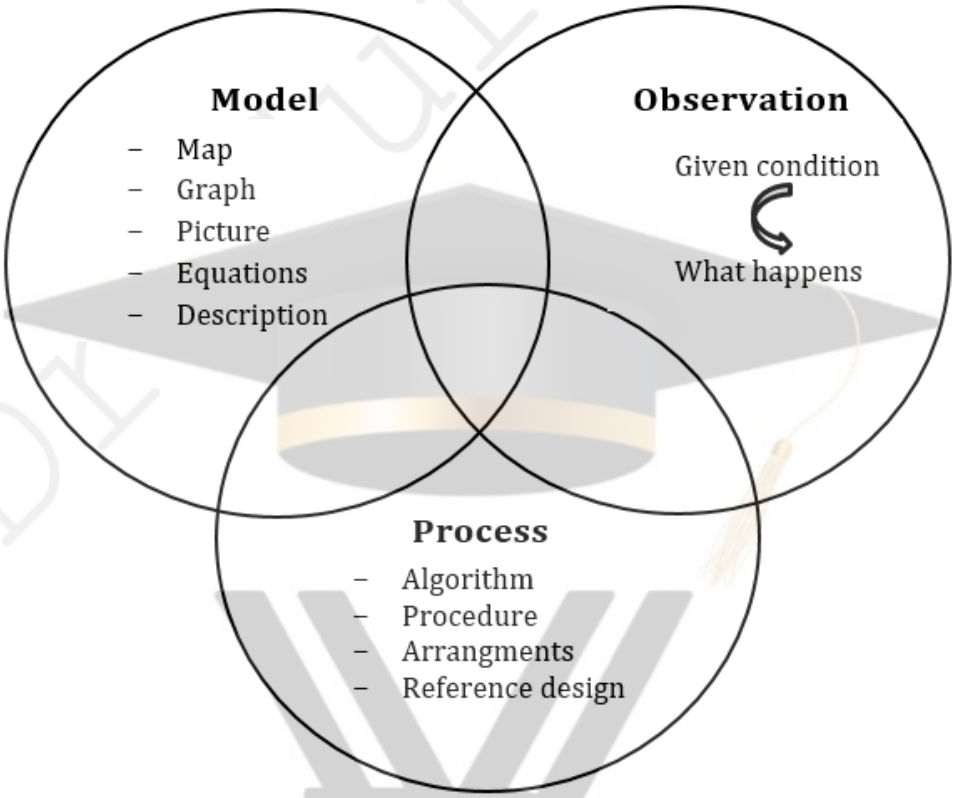

Fig: 1.2 Categories of three knowledge

Good research involves systematic collection and analysis of information and is followed by an attempt to infer a little bit beyond the already known information in a the way that is a significant value addition.

Usually, engineering research is a journey that traverses from a research area (example: Control Systems) to the topic (example: Control of Microbial Fuel Cells) and finally onto the problem (example: Adaptive Control of Single Chamber Microbial Fuel Cells) (Area → Topic → Problem). Getting a good problem to solve is more than half the work done.

- **Engineering research:**
  - It is the systematic process of learning about and building new technologies to design a product.
  - Engineering research refers to the systematic and organized process of investigating, studying, and discovering new knowledge, innovations, and solutions within the field of engineering.

1.2 Objectives of Engineering Research *:** The purpose of research is to discover the answer to the question through the application of scientific procedures. The objective of the research is maybe of broad categories.

- *The research aims to find out the truth which is hidden and which is not discovered yet.*
- *The main aim of the research is to apply scientific approaches to seek answers to open questions through different types of research studies.*
- *Gain familiarity with a phenomenon or achieve new insight into it.*
- *Portray accurately the characteristics of a particular individual situation or group.*
- *It aims to solve new and important problems, and since the conclusion at the end of one's research outcome has to be new when one starts, the conclusion is unknown.*
- *Test a hypothesis of a casual relation between them.*

1.3 Motivation in Engineering Research:

- Intrinsic motivations like interest, challenge, learning, meaning, and purpose, are linked to strong creative performance.
- Extrinsic motivating factors like rewards for good work including money, fame, awards, praise, and status are very strong motivators.
- Influences from others like competition, collaboration, commitment, and encouragement are also motivating factors in research.
- Personal motivation in solving unsolved problems, intellectual joy, service to the community and respectability are all driving factors.
- The following factors would be a mix of extrinsic and intrinsic aspects:
    1. *Wanting to do better than what has been achieved in the world.*
    2. *improve the state of the art in technology.*
    3. *Contribute to the improvement of society.*
    4. *Fulfillment of the historical legacy in the immediate sociocultural context.*
    5. *Several other factors like government directives, funding opportunities in certain areas, and terms.*

1.4 Types of Engineering Research:*** The different types of research are

(i) Descriptive versus Analytical

(ii) Applied versus Fundamental

(iii) Quantitative versus Qualitative

(i) Descriptive versus Analytical:

- *Descriptive research:*
  - It is a fact-finding research.
  - It uses surveys and fact-finding enquiries.
  - It adopts comparative and correlational methods.
  - It effectively describes the present state of the art.
  - The researcher holds no control over the variables; rather can only report what has happened and what is happening.
- *Analytical research:*
  - Has to use facts/information that is already available.
  - Analysis of these to make a critical evaluation of the materials.

(iii) Quantitative versus Qualitative:

- *Quantitative research:*
  - It uses statistical observations of a sufficiently large number of representative cases to draw any conclusions.
  - Based on measurement of quantity or amount.
  - Expressed in terms of quantity.
- *Qualitative research:*
  - It relies on a few nonrepresentative cases or verbal narratives in behavioural studies.

1.5 Finding and Solving Worthwhile Problem

- The flow of research starts with basically finding practical problems.
- The problems stated by the Supervisor or posed by others that are yet to be solved.
- It may involve rethinking a basic theory or need to be formulated or put together from the information provided in a group of papers suggested by the Supervisor.
- A worthwhile research problem would have one or more attributes.
- It could be nonintuitive/counterintuitive even to someone who knows the area, something that the research community had been expecting for some time, a major simplification of a central part of the theory and a new result.

- The recommended steps to solve a research problem are

  (i) Understand the problem, restate it as if it's your own, and visualize the problem by drawing figures, and determining if something more is needed.

  (ii) One must start somewhere and systematically explore possible strategies to solve the problem or a simpler version of it while looking for patterns.

  (iii) Execute the plan to see if it works, and if it does not then start over with another approach.

  (iv) Looking back and reflecting helps in understanding and assimilating the strategy, and is a sort of investment into the future.

Chapter 5: Ethics in Engineering Research

5.1 Introduction: Ethics refers to a set of rules distinguishing acceptable and unacceptable conduct. It also deals with the principles of morality and the concept of right and wrong conduct. Ethics provides a framework for individuals and groups to make decisions, evaluate actions, and navigate moral dilemmas. Although ethics are not laws, laws often follow ethics because ethics are our shared values.

Government bodies, and universities worldwide have adopted certain codes for research ethics. Research ethics and the responsible conduct of research are often erroneously used interchangeably. Research ethics examines the appropriate application of research outcomes, while responsible conduct of research deals with the the way the work is undertaken.

5.2 Ethics in Engineering Research Practice

- Ethics in engineering is the ability as well as the responsibility of an engineer to judge his decisions from the context of the general well-being of society.
- It is the study of moral issues that confront engineers and engineering organizations when some crucial decisions are taken.
- Engineering research and practice requires that the task being performed considers all the pros and cons of a certain action and its implementation
- Engineering researchers need to make ethical decisions and are answerable for the repercussions borne out of their research as outcomes. The reason that ethics matter in data used in engineering research is usually that there is impact on humans.

- Engineering research does not work in isolation from the technological development taking place.
- Researchers' choices that matter from an ethical perspective and influence the effects of technology in many different ways:

  (i) *By setting the ethically right requirements at the very outset, engineering researchers can ultimately influence the effects of the developed technology.*

  (ii) Inresearchers may also apply influence through design. During the design process, the decision is to be made about the priority in importance of the requirements considering ethical aspects.

  (iii) Thirdly, engineering researchers must choose between alternatives fulfilling similar functions.
- *Conclusion:*
  - Research outcomes can lead to unintended side effects. Researchers are ethically responsible for minimising risks associated with their technologies and exploring safer alternatives. Designs should aim to be inherently safe or include multiple safety barriers.

5.3 Types of Research Misconduct*:** There may be different types of research misconduct, which can be summarised as follows:

(i) Fabrication

(ii) Falsification

(iii) Plagiarism

(iv) Other Aspects of Research Misconduct

(i) Fabrication (Illegitimate creation of data)

- *Fabrication* refers to the act of making up or falsifying data or results.
- Creating a data set for an experiment that was never actually conducted.
- Adding fictitious data to a real data set collected during an actual experiment to provide additional statistical validity.
- Fabrication is the intentional misrepresentation of research results. This is due to the researcher cannot wait for the results possibly due to timeline pressures from supervisors or customers.
- It is a serious ethical violation and is considered research misconduct.

(ii) Falsification (Inappropriate alteration of data)

- *Falsification* is "manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record."
- It is a misrepresentation, or misinterpretation, or illegitimate alteration of data or experiments.
- Misleading data can also crop up due to poor design of experiments or incorrect measurement practices.

(iii) Plagiarism (Taking other's work sans attribution)

- *Plagiarism* takes place when someone uses or reuses the work (including portions) of others (text, data, tables, figures, illustrations or concepts) as if it were his/her own without explicit acknowledgement.
- Copying or reusing one's own published work is termed self-plagiarism and is also an unacceptable practice in scientific literature.
- The increasing availability of scientific content on the internet seems to encourage plagiarism in certain cases but also enables detection of such practices through automated software packages.

How are supervisors, reviewers or editors alerted to plagiarism?

(i) The original author comes to know and informs everyone concerned.

(ii) Sometimes a reviewer finds out about it during the review process.

(iii) Or, readers who come across the article or book, while doing research.

- Many free and paid tools can help identify similarities between published and unpublished content, but none can definitively detect plagiarism. Researchers should aim to clearly distinguish their ideas from those of others, which helps prevent over-reliance on existing literature..

(iv) Other Aspects of Research Misconduct

- Submission of the same article to two different journals also violates publication policies. When mistakes are found in any published content, they are generally not reported for public access.
- Research misconduct includes serious deviations from accepted conduct and fraud is the result of deception and damage.
- Fraudulent activities in research can have severe consequences, not only for the individuals involved but also for the broader scientific community.

5.4 Ethical Issues Related to Authorship***

- Credit for research contributions is attributed in **THREE** major ways in research publications:
  1. *Authorship (of the intended publication)*
  2. *Citation (of previously published or formally presented work)*
  3. *Acknowledgment (of some inputs to the present research)*
- Authorship is crucial for accountability and credit. Individuals should be listed as authors only if they significantly contributed to the research design, data interpretation, or writing of the paper. It also involves important ethical considerations in academic and research publications.
- *Some of the key ethical issues related to authorship include:*
  1. ***Gift Authorship*:** This occurs when someone is listed as an author without having made a significant contribution to the research. Gift authorship can be an ethical issue, as it misrepresents the individual's involvement and dilutes the accountability of true contributors.
  2. ***Ghost Authorship:*** In contrast to gift authorship, ghost authorship involves individuals who make significant contributions but are not named as authors. This is due to a nondisclosed conflict of interest within the organization. This can be an ethical concern as it fails to give credit to those who deserve it and may involve conflicts of interest.
  3. ***Career-boost authorship:*** On occasion, senior authors may grant coauthorship to junior faculty or students for questionable reasons. Coauthorship of a junior faculty or a student to boost their chances of employment or promotion.
  4. ***Career-preservation authorship:*** Refers to a situation in academic and scientific publishing where HOD, Dean, provost or other administrators are added as Coauthors on a research paper primarily to protect their careers, reputation, or relationships rather than based on substantial contributions to the research itself.
  5. ***Redundant and Duplicate Publication*:** Submitting the same research to multiple journals or publishing the same findings more than once without proper disclosure is considered unethical. It can mislead readers and waste valuable resources.

VTU QUESTIONS: MODULE 1

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Research Methodology & Intellectual Property Rights

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. What is Engineering Research? What are the primary objectives of conducting research in engineering? **(10 Marks)**

b. What are the various types of engineering research? Explain. **(10 Marks)**

OR

2 a. Explain Fabrication, Falsification and Plagiarism related to Engineering research. **(10 Marks)**

b. What ethical considerations and responsibilities should be taken into account when determining authorship in Engineering research? **(10 Marks)**

Fifth Semester B.E. Degree Examination
Research Methodology & Intellectual Property Rights (IPR)

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	Define the term research and explain the research flow cycle with a relevant diagram.	L1	7
	b	What are the three broad categories of developing and accessing knowledge in research? Explain with a diagram.	L1	7
	c	What are the key ethical issues related to authorship? Explain each one.	L1	6
		OR		
Q.02	a	Discuss the different types of engineering research. Clearly point out the differences between all of them with examples.	L2	10
	b	List the different types of research misconduct and provide a brief explanation for each one.	L3	10

Fifth Semester B.E. Degree Examination
Research Methodology & Intellectual Property Rights (IPR)

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	Define engineering research and list its aims and objectives.	L1	7
	b	What are the factors that motivate you to do engineering research? Briefly explain	L2	7
	c	Compare descriptive research versus analytical research with examples.	L2	6
		OR		
Q.02	a	What is the meaning of ethics and why is it important in the practice of engineering research?	L1	7
	b	Write a note on the following research misconduct (i) Falsification (ii) plagiarism.	L2	8
	c	What are three ways to credit the research contributions? Explain	L2	5

- **Acknowledgment:**

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