ATME COLLEGE OF ENGINEERING

13th KM Stone, Bannur Road, Mysuru - 570 028

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Course Title: RESEARCH METHODOLOGY & IPR

Course CODE: BRMK557

MODULE-1: 1) INTRODUCTION TO RESEARCH

2) ETHICS IN ENGINEERING RESEARCH

SEMESTER: V

Academic Year - 2025-26

INSTITUTIONAL VISION AND MISSION

VISION:

- Development of academically excellent, culturally vibrant, socially responsible and globally competent human resources.

MISSION:

- To keep pace with advancements in knowledge and make the students competitive and capable at the global level.
- To create an environment for the students to acquire the right physical, intellectual, emotional and moral foundations and shine as torchbearers of tomorrow's society.
- To strive to attain ever-higher benchmarks of educational excellence.

Department Vision and Mission

Vision:

To create Electrical & Electronics Engineers who excel to be technically competent and fulfill the cultural and social aspirations of the society.

Mission:

- To provide knowledge to students that builds a strong foundation in the basic principles of electrical engineering, problem solving abilities, analytical skills, soft skills and communication skills for their overall development.
- To offer outcome based technical education.
- To encourage faculty in training & development and to offer consultancy through research & industry interaction.

Program Educational Objectives (PEOs)

PEO1:

To produce competent and ethical Electrical and Electronics Engineers who will exhibit the necessary technical and managerial skills to perform their duties in society

PEO2:

To make graduates continuously acquire and enhance their technical and socio-economic skills

PEO3:

To aspire graduates to embark on R&D activities leading to offering solutions and excel in various career paths.

PEO4:

To produce quality engineers who have the capability to work in teams and contribute to real time projects

Program Outcomes (POs)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design / Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

The students will develop an ability to produce the following engineering traits:

PSO1: Apply the concepts of Electrical & Electronics Engineering to evaluate the performance of power systems and also to control industrial drives using power electronics.

PSO2: Demonstrate the concepts of process control for Industrial Automation, design models for environmental and social concerns and also exhibit continuous self- learning.

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS

Course Code: BRMK557

Module-1

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem.

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

Text book referred: Dipankar Deb, Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0

Meaning of Research

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 inquisitiveness for that which is unknown and useful on a particular aspect so as to make an original contribution to expand the existing knowledge base.

What are research projects?

Research involves the formulation of hypotheses or problem-solving strategies, data analysis, and reasoning; and determine whether the results are consistent with the hypotheses. Research is the process of creating or presenting knowledge that does not yet exist.

Example:

1. **Problem:** A bridge architect is trying to build a new earthquake-proof bridge.
2. **Assumption:** The engineer thinks that the new bridge using steel and concrete will be more earthquake resistant than the existing bridge.
3. **Data Collection:** Engineers collect data on earthquake performance of different bridge designs. Experts also conducted tests to measure the strength and durability of the new

bridge.

4. **Data Analysis:** Designers analyze data to see if it supports the hypothesis. Engineers also use data to identify design flaws.
5. **Inferences:** Engineers make inferences from data and theory. Experts may conclude that the newly built bridge is more earthquake resistant than the existing bridge, but may also conclude that there are some flaws in the design standards that need to be addressed.
6. **Conclusion:** Engineers concluded that the new bridge construction is a promising solution to the bridge's seismic resistance problem. But the experts also agreed that more research is needed to measure and evaluate fitness.

Research Cycle

Research begins with practical problems: it should be clear what the problem you are trying to solve is and why it is important.

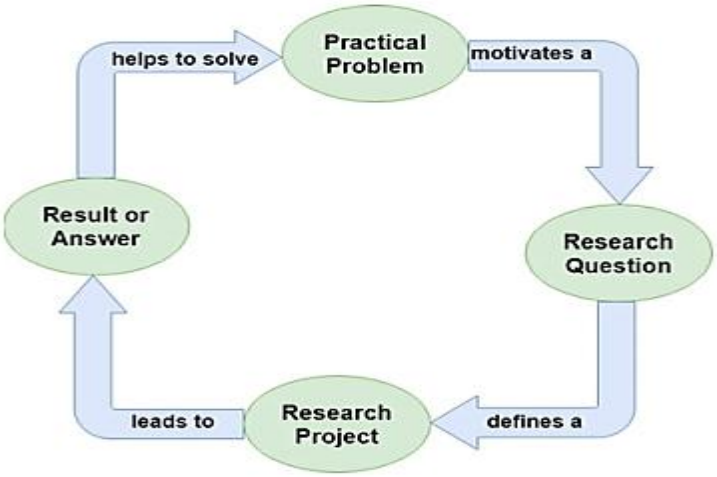

Fig. 1.1 The research flow diagram

This question raises a research question that most people would get lost in large volumes of data. The question will help to focus on the data and then explain research, which is a study or study in the result or answer, which will help solving a real problem begin with research. The initial position is shown in Figure 1.1.

Note: Research questions? - A research question is one that the researcher tries to answer through research. It is important to formulate questions clearly and precisely before conducting any research as this will help guide the research process and ensure the accuracy and importance of the research.

Example: How does the addition of graphene nanolayers to a polymer matrix affect the properties of the composite?

This research question is unique because it focuses on the effect of graphene nanolayers on the electrical properties of the polymer matrix.

Here was also intrigued for asking the difference regarding the addition of graphene nanosheets. These questions can also be answered as experiments can be conducted to evaluate the properties of composites with and without graphene nanolayers.

What is the importance of research and how is it done well?

Research aimed at contributing to knowledge. Research questions should be relevant to the world we live in and should be answered with appropriate time and resources.

The investigation must be systematic and precise. The purpose of research is to understand something or solve a problem. Qualitative research questions change throughout the project and can be modified as needed. Research should be used to create new knowledge that can be written or recorded in some way. Research is not just about following steps.

It's about being able to ask new questions, look at things in a new light, and come up with new solutions. Critical thinking and creativity are important aspects of research work. Through research, one seeks to create or create new information about the
world around us that can be written or recorded in some way and accessed by writing or recording.

What are the ways in which intelligence is created and acquired?

1. Observation is the easiest way to get information from places, and observation itself is important if what we are trying to observe is unusual or happy or difficult to observe. Observations lead to everything from measurement to analysis of a group of subjects to how long the firmware will take.

   Survey data usually needs to be completed in some form; this leads to a second piece of information, namely the model. For example:

   - A mechanical engineer can observe how a new product behaves under different loads. This analysis could lead to the creation of new models of energy products.
   - Observe the wear of the bearings to determine the cause of the failure.
   - Monitor the performance of the new engine to determine fuel efficiency.

2. Formulas are approximate and often simple ways of describing sometimes very complex relationships between numbers, shapes, or equations. For example, the equation of the relationship between different objects or tools in abstract form allows us to understand the phenomenon.

For example:

- An engineer might develop a mathematical model of airflow around the wing of an airplane. The model can be used to predict the lift and drag characteristics of wind turbines.
- Construct a stress distribution model in the beam under load. The model can be used to estimate beam deflections and damage loads.
- Construct a model of the water flow in the pump. The model can be used to predict the performance of the pump and head.

3. The last category is the way things are prepared or processed by processes, procedures, methods, plans or designs to meet certain needs.

   For example:

   - An engineer may develop a method for making a new type of turbine blade. This technique can be used to create better and more durable teeth.
   - Develop a process for casting metal parts. The process can be used to produce products with high precision and repeatability.
   - Improved steel plate welding process. This technique can be used to create strong and durable connections. Section

These 3 ways are shown in the figure 1.2

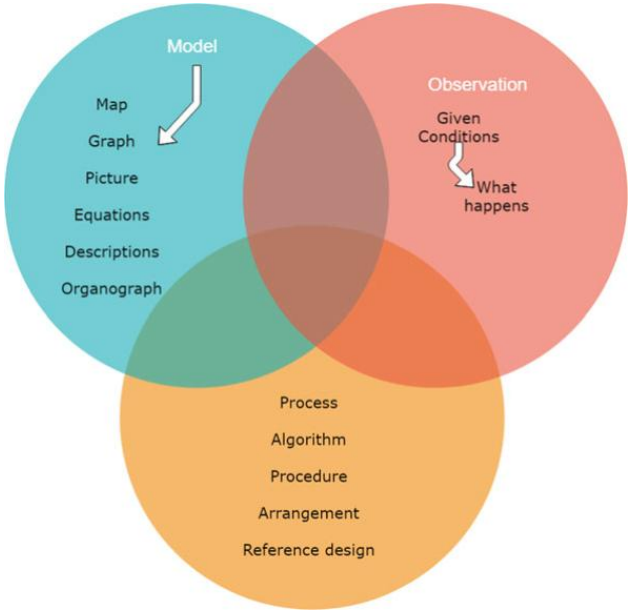

Figure 1.2 Scientific knowledge

What are the different stages of Engineering Research?

Engineering studies usually begin with a broad field of study, such as management. The work is then narrowed down to one specific topic, such as microbial oil control.

Finally, the topic narrows down to a specific question the study is trying to answer, such as the management of single- compartment microbial fuel cells. Sometimes this can be reversed. Also, solving the problem effectively is doing more than half the work done. Because a good problem is difficult but successful and has the potential to benefit the region.

Definition of engineering research: Engineering research is the process of developing ideas and seeking improvements in knowledge and skills in order to be able to analyze, plan, design and conduct various types of research related to engineering and technology research and development.

Meaning of Selected Words:

- **Curious** – I am interested in learning different things.
- **Critical thinking** - Self-directed, self-disciplined, trying to think the best of the wrong.

1.1 Objectives of Engineering Research

Objectives of Engineering Research/ challenges of engineering research?

The objective of engineering research is to solve new and important problems, the results of the research should be new, but the results are not known when the research starts. Therefore, it can be argued that getting started is difficult on its own. The answer is that people make predictable decisions based on "quasi-evidence", intuition, and imagination. The prediction gives a target to strive for and after the first attempt the result will prove the prediction wrong. However, this work may suggest new avenues or goals that may rely on some changes in the original goals or require new ideas or have negative consequences that make the original goal or some goals impossible to achieve.

Aim of Research

The main purpose of research is to use the research method to find answers to open questions, although each research is appropriate in some way.

What are different types of research studies? Give an example.

Research or theory of structure, explanation, diagnosis, and evaluation.

- **Research or Scientific Research:** This type of research is often used to understand a problem or problem. **For example**, an engineer might do scientific research to better understand why machines fail.
- **Scientific Research:** This type of research is used to describe current events.

  For example, an engineer might make a statement to determine the average lifespan of a species.
- **Diagnostic Study:** This type of study is used to determine the cause of the problem.

  For example, an engineer may investigate to determine why some engines are not performing as expected.
- **Hypothesis Testing Research:** This type of research is used to test a hypothesis.

  For example, an engineer may conduct a hypothesis test to determine whether a new wind turbine design will make it work.

1.2 Motivation in Engineering Research

- **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.
- **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.
- **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.
- Engineers are motivated by thinking in addition to these three main motivations:

  1. **Solving unsolvable problems:** Engineers are often motivated by thinking to find solutions to problems in the world's most difficult problems.
  2. **Improving the Latest Technology:** Engineers are constantly looking for ways to improve existing technologies and create new ones.

3. **Contributing to the Improvement of Society**: Engineers want to use their knowledge and skills to make the world a better place.

Finally, the motivation for engineering research is as diverse as the engineers themselves. But all engineers want to change the world.

Types of Engineering Research

There are three main types of research: descriptive research, applied research, and basic research.

Scientific explanation of current events. It doesn't try to explain why things are the way they are, but can be used to identify patterns and trends. Example: A description might look at the average lifespan of a lighting type.

(i) Descriptive versus Analytical

(ii) Applied versus Fundamental

(iii) Quantitative versus Qualitative

1. **Descriptive Research:**

Descriptive research focuses on describing a situation or phenomenon without manipulating variables. It aims to provide a snapshot of the current state.

Example:

1. Suppose you want to understand the shopping habits of people in a particular neighbourhood. You conduct a survey asking questions about where they shop, how often, and what products they prefer. The results provide a description of the current state of shopping habits in that neighbourhood.
2. Conducting a survey to understand the preferences of students in your school without manipulating any factors.

2. **Analytical Research:**

Analytical research goes a step further, analysing existing data to uncover patterns, relationships, or reasons behind observed phenomena.

Example: Building on the descriptive research, you now want to analyze the data more deeply. You take the information gathered and try to identify patterns and reasons behind the shopping habits. For example, you might analyze whether income levels or age influence where people

shop. This deeper analysis helps you understand the factors influencing the observed shopping behaviours.

3. **Applied Research:**

Applied research seeks to solve practical problems or address real-world issues. Its goal is to provide solutions and is often more focused on immediate, practical applications.

Example: Developing a new type of fertilizer to increase crop yield in agriculture.

4. **Fundamental Research:**

Fundamental research, on the other hand, is driven by a curiosity to expand knowledge. It doesn't necessarily have an immediate practical application and often explores theoretical concepts.

Example: Studying the behaviour of subatomic particles in physics to enhance our understanding of the fundamental principles of the universe.

5. **Quantitative Research:**

Quantitative research involves the collection and analysis of numerical data. It is focused on measurable variables to establish patterns or relationships.

Example: Conducting a survey to gather numerical data on the number of hours students spend on homework each week.

6. **Qualitative Research:**

Qualitative research deals with non-numerical data, often using methods like interviews or observations to explore underlying meanings, attitudes, or perspectives.

Example: Conducting in-depth interviews with individuals to understand their experiences and perceptions of a particular social issue.

Finding and Solving a Worthwhile Problem

- Qualifying research questions may contain one or more features. Something the social sciences hope for from time to time may lead to a lack of understanding/idea even for a person familiar with the work, the simplicity of the method's importance, a new topic or a new phenomenon to initiate an answer.
- Giving a new method or developing a method of knowledge that is in good use or is the result of being unable to continue in a region.
- The researcher must ensure that the problem is appropriate before starting work on it, as the best

effort is made when the work is appropriate and the problem and/or solution will be accepted by the scientific community.

- Unresolved issues raised by the research director or raised by others. It may involve a rethinking of key assumptions or may need to be developed or compiled from information provided by the supervisor in the report.
- The task facing scientific researchers is to find the right problem to begin their research. The skills needed to complete these tasks from the start. Once the problem is clearly identified, the research and reading process is done to clarify the value of the problem.

George Pólya (1887-1985) proposed four steps for solving mathematical problems.

Suggested steps in solving a research question are:

(i) understand the question, modify it to suit you, visualize the problem, and decide if there is more detail.

(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) Follow the plan to see if it works, if not, start over with another method. After researching a problem and coming back many times, people may experience a sudden revelation or come up with a new idea to solve the problem.

(iv) Looking back and thinking helps to understand and assimilate ideas and is an investment in the future.

Ethics in Engineering Research

Ethics is generally concerned with the processes or skills that distinguish bad behavior from wrong. Everyone knows some moral principles, but there are differences in their interpretation and application. Moral development proceeds through various stages of development. Ethics can be used to evaluate, recommend, or interpret policy.

- Morality is not law, but laws usually follow morality because morality is our common virtue.
- International codes of ethics have emerged since the Nuremberg Law was passed in 1947. Issues related to research scores date back to the 17th century, from the founding of the Royal Society (BRS) to refine scientific credit methods and methods. modern scientific practice. Rather than trying to identify who made the first discovery, BRS focuses on who first submitted

research results to publication.

- Whitbeck [4] tackles the thorny issue of authorship in science by asking two simple but important questions:
  - who should be listed as the author; and
  - the appropriate registration orders.
- Government agencies and universities around the world have adopted specific policies regarding research practices.
- Research ethics and responsible research are often used interchangeably. Research ethics examines the appropriate use of research results, while research responsibility is about performance.

Ethics in Engineering Research Practice

Engineering researchers must make ethical decisions and be responsible for the impact of their research. Information used in engineering research is important because it affects people.

Some practices may be acceptable to some people in some circumstances, and the reasons for their acceptance may not be entirely valid. Today we have unprecedented access to data, unprecedented options for data analysis, and the emergence of engineering studies involving data. Engineering ethics provides us with a rulebook; teaches us how to decide what is allowed and what is not.

Scientists make various choices regarding ethics and the impact of technology in various ways:

- By setting ethical standards up front, engineering scientists can influence the full benefits of advancing technology.
- Researchers can also tap into the power of design—the process of transforming needs into designs designed to meet those needs. Ethical decisions should be made to determine the importance and importance of the requirements while creating the process.
- Third, engineering scientists must choose different options to complete similar tasks.

Research findings often have negative side effects. It is the primary responsibility of scientists to ensure that the hazards/risks associated with the technology they develop are minimized and to evaluate safer alternatives.

The design should have a centralized security where possible or have security features and a variety of independent security measures to avoid danger, or, if Yes, a control system in case the main system fails.

Types of research Misconduct

Research ethics involves treating others fairly, being honest about methods and results, repeating results as much as possible to avoid mistakes, protecting the health of research, ensuring safety in the laboratory, etc. includes.

To avoid inaccuracies, the research should be peer-reviewed before it is published. Research fraud described in Section Search Documents may include:

(i) Fabrication: Fabrication is the creation of documents or a test of knowledge in the belief that the person understands the results of the analysis. or the test is OK but will not be able to wait for results due to time pressure from the supervisor or user.

(ii) Falsification (falsification of information): Falsification refers to the misrepresentation or misinterpretation of an information or test, or the making, respectively, of illegal changes to support a hypothesis, even if actual data from experimental data suggest otherwise. Fraud and fabrication of information and results undermines engineering research, introduces false information into the database, undermines the trust of stakeholders, undermines cost increases, hinders scientific progress, and causes real and avoidable delays in technological development.

Data errors can also occur due to poor testing or inaccurate measurements. The image of engineering scientists as objective seekers of truth is often tarnished by the discovery of information about fraud. While researchers want to continue working on published data that could become part of research papers, they can avoid this bad practice by always trying to reproduce results.

(iii) Plagiarism (excluding the use of someone else's work): Plagiarism is manifest when a person uses or reuses another work (including parts) (text, document, table, picture, diagram or content) as it appears in his work. emerges out. Thank you. Copying or reusing one's own published work is called self-plagiarism, which is bad practice in the scientific literature. Although the increase in search terms on the Internet seems to encourage plagiarism in some cases, it can also be detected by software packages.

How are supervisors, reviewers or editors alerted to plagiarism?

1. Original author comes to know and informs everyone concerned.

2. Sometimes a reviewer finds out about it during the review process.
3. Or, readers who come across the article or book, while doing research.

(iv) **Other types of research bias:** Significant deviations from accepted behavior can be interpreted as research bias. In cases where deception and harm are in question, fraud is considered to have taken place. Sooner or later moral violations will occur. Submitting an article to two different journals at the same time is also a violation of the copyright. Another problem is that when there are errors in the text or published content, these errors are usually not made public for public access unless a competent researcher presses them to create the error and provide a good resemblance to the correct version, which is not always available. Primary research goal.

How can we warn reviewers, reviewers or editors about plagiarism? Article

(i) The Secretary-General informs and informs all concerned. Section

(iii) Or readers who come across articles or books during research.

Although there are many free and paid materials for school leave, they are not criminal, they only get Similar score in content analysis, similarity index of published content and unpublished content.

However, a similar score does not guarantee that the document is free of plagiarism. Whether the content is plagiarism should be evaluated by human eyes. It is important to look at individual ratings of sources, not overall results. Setting a parameter to a parameter of maximum similarity means under-utilizing the tool. Patchwork plagiarism is difficult to measure.

There are some simple and ethical ways to avoid the same thing in the next post. Sometimes some published content is good for a research paper; maybe it can make a connection or strengthen a claim. Printed material is provided for fair use purposes. People do not create scientific results out of nothing. However, important points can be explained in your own words, so there is no need for copying.

It is important to emphasize the importance in all this. However, the mention of a source does not mean that a sentence (or sentence) in the main content can be repeated. Researchers should practice writing in such a way that readers can distinguish the author's ideas or conclusions from other sources. This practice allows people to decide whether they are overusing or relying on the content of available information.

Ethical Issues Related to Authorship

Academic writing includes communicating the learning work, criticizing its findings, and promoting the reputation of peers, as well as the role of accepting responsibility for work details. It forms the basis of performance appraisal, promotion, and other accolades.

Some important research and ethical issues related to the writing of research papers are described below:

- Research scores in published research are achieved through three main methods: writing, writing, and written verification. Authorship creates responsibility and builds credibility. An individual is listed as an author only if they have made significant contributions to the design, interpretation, or writing of the data.
- Such “guests” or “awards” (given to authors who have contributed little or no contribution to the work) will make contributions from genuine employees, have a negative impact on enrollees' seniority, and morality is important. Red flags of false research.
- In some cases, the authors of the study made a collaborative effort, called writing support activities, to increase the chances of employment or promotion of university teachers or students takes advantage of the "relationship" with administrators, and administrators benefit from the article without having to take any action on it.
- Sometimes participants give consent because there is no conflict of interest in the organization. Some co-authorships may be called ghost co-authoring. It is important to disclose all people involved in the research so that the assessment can be based on research results and whether there are conflicting issues.
- In another form of ambiguous writing, some scholars write alone, collaboratively, as a co-author, with no real collaboration other than less reading and editing, and no real review of previous work. This effort is only through recognition. So, readers cannot explain the lack of "write “confirmation.
- All registered authors are solely responsible for the entire content of the research article, so they should be aware of what the author is sending to the journal.
- Their consent must be sought for content, and they agree to post it. In cases of abuse, such as a typo, where the perpetrator is easy to find, the necessity of authors' responsibility is not always clear. It's interesting to be able to analyze revenue to be sure and determine each author's

level of responsibility.

- Double posting is an important ethical issue regarding posting and joining two forums at the same time. The motivation is to increase the ability to advertise and reduce the time spent on advertising.
- Prestigious journals are expected to publish originals, i.e. material that has not been published elsewhere and that negatively impacts submissions.

Case studies for each of the ethical issues related to authorship mentioned:

1. ***Guest/Gift Authorship:*** Case Study: In a research paper on renewable energy, a professor's name is included as an author despite minimal involvement. The professor provided general advice but didn't contribute to the research design, data collection, or writing. This inclusion dilutes the contributions of the primary researchers.
2. ***Career-Boost Authorship:*** Case Study: A junior researcher is listed as a coauthor in multiple publications led by a senior colleague. The junior researcher's contributions are minor, but the senior colleague aims to boost their career prospects by associating them with numerous publications.
3. ***Career-Preservation Authorship:*** Case Study: An administrative head of a department is added as a coauthor in multiple research papers despite minimal involvement. The administrator benefits from authorship due to their position, creating an ethical concern regarding the true contribution to the research.
4. ***Ghost Coauthorship:*** Case Study: A company executive, who provided critical insights for a research project, is intentionally omitted from the list of authors due to a conflict of interest within the organization. This omission hides a significant contributor's involvement.
5. ***Reciprocal Gestures without Collaboration:*** Case Study: Two researchers agree to include each other as coauthors in their papers without substantial collaboration. They provide minimal input, essentially engaging in reciprocal authorship gestures, which misrepresent their individual contributions.
6. ***Double Submission:*** Case Study: A group of researchers submits a manuscript to two different journals simultaneously to increase their chances of publication. However, this practice violates ethical guidelines as reputable journals expect original work and discourage such simultaneous submissions.