

DEPARTMENT OF CIVIL ENGINEERING

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.

Module 2: Literature Review and Technical Reading, Attributions and Citations

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases: Web of Science, Google and Google Scholar, Effective Search: The Way Forward, Introduction to Technical Reading, Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Module 3: Intellectual Property Rights, Patents and Process of Patenting

Introduction to Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP, History of IP in India, Major Amendments in IP Laws and Acts in India.

Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention, Rights Associated with Patents, Enforcement of Patent Rights, Inventions, and Eligible for Patenting, Non-Patentable Matters, Patent Infringements, Avoid Public Disclosure of an Invention before Patenting.

Process of Patenting: Prior Art Search, Choice of Application to be Filed, Patent Application Forms, jurisdiction of filing patent application, Publication, Pre-grant Opposition, Examination, Grant of a Patent, Validity of Patent Protection, Post-grant Opposition, Commercialization of a Patent, Need for a Patent Attorney/Agent, can a Worldwide Patent be Obtained, Do I Need First to File a Patent in India, Patent Related Forms, Fee Structure, Types of Patent Applications, Commonly Used Terms in Patenting, National Bodies Dealing with Patent Affairs, Utility Models

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Module 4: Copyrights and Related Rights and Trademarks

Copyrights and Related Rights: Classes of Copyrights, Criteria for Copyright, Ownership of Copyright, Copyrights of the Author, Copyright Infringements, Copyright Infringement is a Criminal Offence, Copyright Infringement is a Cognizable Offence, Fair Use Doctrine, Copyrights and Internet, Non-Copyright Work, Copyright Registration, Judicial Powers of the Registrar of Copyrights, Fee Structure, Copyright Symbol, Validity of Copyright, Copyright Profile of India, Copyright and the word Publish, Transfer of Copyrights to a Publisher, Copyrights and the Word Adaptation, Copyrights and the Word Indian Work, Joint Authorship, Copyright Society, Copyright Board, Copyright Enforcement Advisory Council (CEAC), International Copyright Agreements, Conventions and Treaties, Interesting Copyrights Cases.

Trademarks: Eligibility Criteria, Who Can Apply for a Trademark, Acts and Laws, Designation of Trademark Symbols, Classification of Trademarks, Registration of a Trademark is Not Compulsory, Validity of Trademark, and Types of Trademark Registered in India, Trademark Registry, and Process for Trademarks Registration, Prior Art Search, and Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Module 5: Industrial Design, Geographical Indications and Case studies on Patents Industrial Designs: Eligibility Criteria, Acts and Laws to Govern Industrial Designs, Design Rights, Enforcement of Design Rights, Non-Protectable Industrial Designs India, Protection Term, Procedure for Registration of Industrial Designs, Prior Art Search, Application for Registration, Duration of the Registration of a Design, Importance of Design Registration, Cancellation of the Registered Design, Application Forms, Classification of Industrial Designs, Designs Registration Trend in India, International Treaties, Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI, Ownership of GI, Rights Granted to the Holders, Registered GI in India, Identification of Registered GI, Classes of GI, Non-Registerable GI, Protection of GI, Collective or Certification Marks, Enforcement of GI Rights, Procedure for GI Registration Documents Required for GI Registration, GI Ecosystem in India. Case Studies on Patents: Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent, IP Organizations in India, Schemes and Programs.

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Textbooks

1. 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>.
2. Intellectual Property A Primer for Academia by Prof. Rupinder Tewari and Ms. Mamta Bhardwaj.

Reference books

1. David V. Thiel —Research Methods for Engineers| Cambridge University Press, 978-1-107-03488- 4.
2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9.

COURSE ASSESSMENT DETAILS

Assessment Details (both CIE and SEE)

- The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.
 - The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50).
 - A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.
 - Continuous Internal Evaluation:
 - o Three-Unit Tests each of 20 Marks (duration 01 hour)
 - o First test at the end of 5th week of the semester
 - o Second test at the end of the 10th week of the semester
 - o Third test at the end of the 15th week of the semester
 - o Two assignments each of 10 Marks
 - o First assignment at the end of 4th week of the semester
 - o Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)
- At the end of the 13th week of the semester the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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- CIE methods /question paper is designed to attain the different levels of Bloom 's taxonomy as per the Outcome defined for the course.
- Semester End Examination: Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)
 - o the question paper will be set for 100 marks. Marks scored shall be proportionally reduced to 50 marks
 - o the question paper will have ten questions. Each question is set for 20 marks.
 - o There will be 2 questions from each module. Each of the two questions is under a module (with a maximum of 2 sub-questions).

The students must answer 5 full questions, selecting one full question from each module. Marks scored by the students will be proportionally scaled down to 50 marks.



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MODULE 1: INTRODUCTION

Syllabus

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.

MEANING OF RESEARCH

- Research refers to a careful, well-defined (or redefined) objective to the search for knowledge, or formulation of a theory that is motivated by a desire to discover the unknown and beneficial aspects of a specific subject so as to make an original contribution to expand the existing knowledge base.
- Research involves formulation of hypothesis or proposition of solutions, data analysis, and deductions; and ascertaining whether the conclusions fit the hypothesis.
- Research is a process of creating or formulating knowledge that does not yet exist. Thus, research is an art of scientific investigation.

OBJECTIVES OF ENGINEERING RESEARCH

The purpose of research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out the truth which is hidden and which has not been discovered as yet. Though each research study has its own specific purpose, we may think of research objectives as falling into several following broad groupings:

1. Exploratory or Formulative research studies: To gain familiarity with a phenomenon or to achieve new insights into it
2. Descriptive research studies: To portray accurately the characteristics of a particular individual, situation or a group
3. Diagnostic research studies: To determine the frequency with which something occurs or with which it is associated with something else. OR. To determine the causes of a problem or identify factors responsible for a condition.
4. Hypothesis-testing research studies: To test a hypothesis of a causal relationship between variables

The objective of engineering research is

- The objective of research is to discover answers to questions through the application of scientific procedures.

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- Research objectives can sometimes be convoluted and difficult to follow. Knowing where and how to find different types of information helps one solve engineering problems, in both academic and professional career.
- Lack of investigation into engineering guidelines, standards, and best practices result in failures with severe repercussions. As an engineer, the ability to conduct thorough and accurate research while clearly communicating the results is extremely important in decision making.
- The main aim of the research is to apply scientific approaches to seek answers to open questions, and although each research study is particularly suited for a certain approach
- The objectives of engineering research should be to develop new theoretical or applied knowledge and not necessarily limited to obtaining abilities to obtain the desired result.
- The objectives should be framed such that in the event of not being able to achieve the desired result that is being sought, one can fall back to understanding why it is not possible, because that is also a contribution toward ongoing research in solving that problem.

MOTIVATION IN ENGINEERING RESEARCH

The possible motives may be the result of one or more of the following desires:

- Studies have shown that intrinsic motivations like interest, challenge, learning, meaning, purpose, are linked to strong creative performance;
- Extrinsic motivating factors like rewards for good work include money, fame, awards, praise, and status are very strong motivators, but may block creativity. For example:

Research outcome may enable obtaining a patent which is a good way to become rich and famous.

- Influences from others like competition, collaboration, commitment, and encouragement are also motivating factors in research. For example: my friends are all doing research and so should I, or, a person that I dislike is doing well and I want to do better.
- Personal motivation in solving unsolved problems, intellectual joy, service to community, and respectability are all driving factors.

The following factors would be a mix of extrinsic and intrinsic aspects:

- Wanting to do better than what has been achieved in the world
- Improve the state of the art in technology
- Contribute to the improvement of society
- Fulfillment of the historical legacy in the immediate socio-cultural context.

Several other factors like government directives, funding opportunities in certain areas, and terms of employment, can motivate people to get involved in engineering research.

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TYPES OF ENGINEERING RESEARCH

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.
- Descriptive research also includes attempts to determine causes even though the variables cannot be controlled.
- On the contrary, in analytical research, already available facts for analysis and critical evaluation are utilized. Some research studies can be both descriptive and analytical

Applied versus Fundamental:

- Research can either be applied research or fundamental (basic or pure) research.
- Applied research seeks to solve an immediate problem facing the organization, whereas fundamental research is concerned with generalizations and formulation of a theory.
- Research concerning natural phenomena or relating to pure mathematics are examples of fundamental research.
- Research to identify social or economic trends, or those that find out whether certain communications will be read and understood are examples of applied research.
- The primary objective of applied research is to determine a solution for compelling problems in actual practice, while basic research is aimed at seeking information which could have a broad base of applications in the medium to long term.

Quantitative versus Qualitative:

- Quantitative research uses statistical observations of a sufficiently large number of representative cases to draw any conclusions
- While qualitative researchers rely on a few non representative cases or verbal narrative in behavioral studies such as clustering effect in intersections in Transportation engineering to make a proposition.

Conceptual vs. Empirical

- Conceptual research is that related to some abstract idea(s) or theory.
- It is generally used by philosophers and thinkers to develop new concepts or to reinterpret existing ones.
- On the other hand, empirical research relies on experience or observation alone, often without due regard for system and theory.
- It is data-based research, coming up with conclusions which are capable of being verified by observation or experiment. We can also call it as experimental type of research.

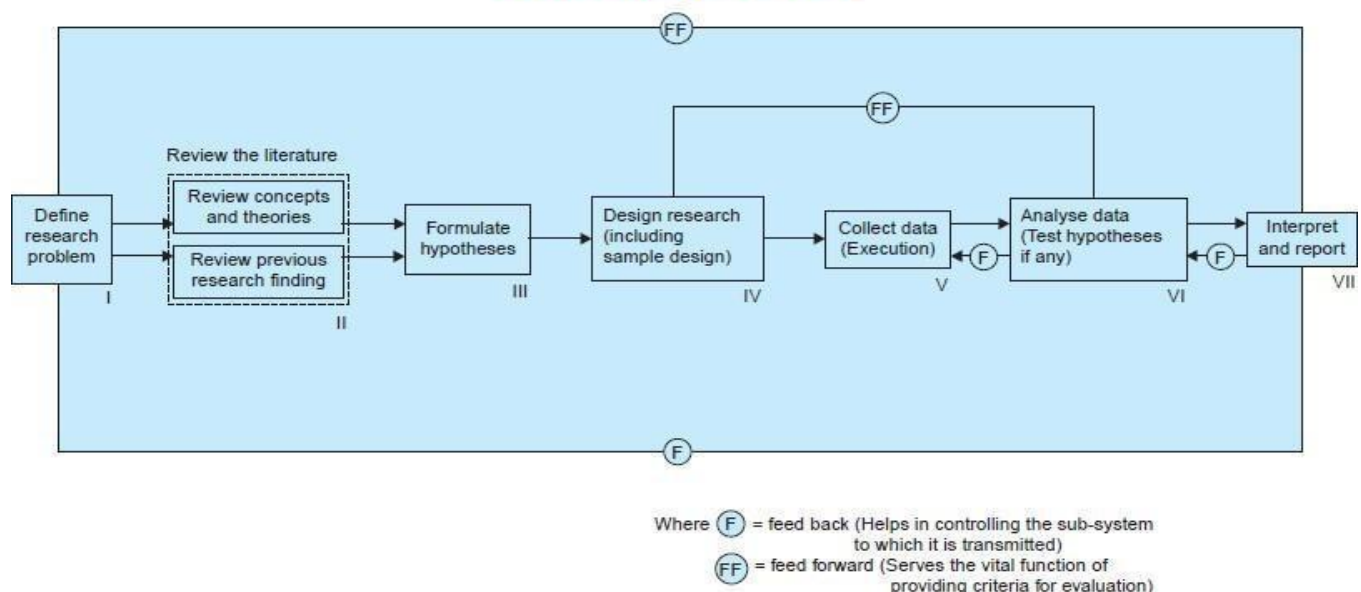
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- In such research it is necessary to get at facts first and actively to go about doing certain things to stimulate the production of desired information.
- In such a research, the researcher must first provide himself with a working hypothesis or guess as to the probable results. He then works to get enough facts (data) to prove or disprove his hypothesis.
- He then sets up experimental designs which he thinks will manipulate the persons or the materials concerned so as to bring forth the desired information.
- Such research is thus characterized by the experimenter's control over the variables under study and his deliberate manipulation of one of them to study its effects.
- Empirical research is appropriate when proof is sought that certain variables affect other variables in some way. Evidence gathered through experiments or empirical studies is today considered to be the most powerful support possible for a given hypothesis.

ENGINEERING RESEARCH PROCESS

Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps.

RESEARCH PROCESS IN FLOW CHART



The chart indicates that the research process consists of a number of closely related activities, as shown through I to VII. But such activities overlap continuously rather than following a strictly prescribed sequence

1. Formulating the research problem: There are two types of research problems, viz., those which relate to states of nature and those which relate to relationships between

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variables. At the very outset the researcher must single out the problem he wants to study, i.e., he must decide the general area of interest or aspect of a subject-matter that he would like to inquire into.

2. Extensive literature survey: Once the problem is formulated, a brief summary of it should be written down. It is compulsory for a research worker writing a thesis for a Ph.D. degree to write a synopsis of the topic and submit it to the necessary Committee or the Research Board for approval. At this juncture the researcher should undertake extensive literature survey connected with the problem.

3. Development of working hypotheses: After extensive literature survey, researcher should state in clear terms the working hypothesis or hypotheses. Working hypothesis is tentative assumption made in order to draw out and test its logical or empirical consequences. Hypothesis should be very specific and limited to the piece of research in hand because it has to be tested. The role of the hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track. It sharpens his thinking and focuses attention on the more important facets of the problem.

4. Preparing the research design: The research problem having been formulated in clear cut terms, the researcher will be required to prepare a research design, i.e., he will have to state the conceptual structure within which research would be conducted. The preparation of such a design facilitates research to be as efficient as possible yielding maximal information. In other words, the function of research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money.

5. Determining sample design: The researcher must decide the way of selecting a sample or what is popularly known as the sample design. In other words, a sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population. Sampling can be done choosing a particular unit, random unit selection, systematic pattern, homogenous group (stratified sampling), quota, cluster or area, multi stages and sequential.

6. Collecting the data: In dealing with any real life problem it is often found that data at hand are inadequate, and hence, it becomes necessary to collect data that are appropriate. There are several ways of collecting the appropriate data which differ considerably in context of money costs, time and other resources at the disposal of the researcher. Primary data can be collected either through experiment or through survey. If the researcher conducts an experiment, he observes some quantitative measurements, or the data, with the help of which he examines the truth contained in his hypothesis. But in the case of a survey, data can be collected by any one or more of the following ways by observation, through personal interview, through telephonic interview, by mailing the questionnaire etc

7. Execution of the project: It is a very important step in the research process. If the execution of the project proceeds on correct lines, the data to be collected would be adequate and dependable. The researcher should see that the project is executed in a systematic manner

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and in time. A careful watch should be kept for unanticipated factors in order to keep the survey as realistic as possible.

8. Analysis of data: After the data have been collected, the researcher turns to the task of analyzing them. The analysis of data requires a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences. The unwieldy data should necessarily be condensed into a few manageable groups and tables for further analysis. Thus, researchers should classify the raw data into some purposeful and usable categories.

9. Hypothesis-testing: After analyzing the data as stated above, the researcher can test the hypotheses, if any, he had formulated earlier. Do the facts support the hypotheses, or they happen to be contrary? This is the usual question which should be answered while testing hypotheses. Various tests, such as Chi square test, t-test, F-test, have been developed by statisticians for the purpose. The hypotheses may be tested using one or more of such tests, depending upon the nature and object of research inquiry. Hypothesis-testing will result in either accepting the hypothesis or in rejecting it.

10. Generalizations and interpretation: If a hypothesis is tested and upheld several times, it may be possible for the researcher to arrive at generalization, i.e., to build a theory. As a matter of fact, the real value of research lies in its ability to arrive at certain generalizations

11. Preparation of the report or the thesis: Finally, the researcher has to prepare the report of what has been done by him. Writing of report must be done with great care keeping in view the following:

- The layout of the report should be as follows: (i) the preliminary pages; (ii) the main text, and (iii) the end matter.
- In its preliminary pages the report should carry title and date followed by acknowledgements and foreword. Then there should be a table of contents followed by a list of tables and list of graphs and charts, if any, given in the report.
- The main text of the report should have the following parts:
 - (a) Introduction: It should contain a clear statement of the objective of the research, and an explanation of the methodology adopted in accomplishing the research. The scope of the study along with various limitations should also be stated in this part.
 - (b) Summary of findings: After introduction there would appear a statement of findings and recommendations in non-technical language. If the findings are extensive, they should be summarized.
 - (c) Main report: The main body of the report should be presented in logical sequence and broken down into readily identifiable sections.
 - (d) Conclusion: Towards the end of the main text, researchers should again put down the results of his research clearly and precisely. In fact, it is the final summing up.
- At the end of the report, appendices should be enlisted in respect of all technical data. Bibliography, i.e., list of books, journals, reports, etc., consulted, should also be given in the end. Index should also be given specially in a published research report.

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FINDING AND SOLVING A WORTHWHILE PROBLEM

- A researcher may start out with the research problems stated by the Supervisor or posed by others that are yet to be solved. Alternately, 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.
 - Research scholars are faced with the task of finding an appropriate problem on which to begin their research. Skills needed to accomplish such a task at the outset, while taking care of possible implications are critically important but often not taught
 - Once the problem is vaguely identified, the process of literature survey and technical reading would take place for more certainty of the worthiness of the intended problem.
 - However, an initial spark is ideally required before the process of literature survey may duly begin.
 - Sometimes, an oral presentation by somebody which is followed by asking questions or introspection provides this perspective which reading papers do not.
 - At other times, a development in another subject may have produced a tool or a result which has direct implications to the researcher's subject and may lead to problem identification.
 - A worthwhile research problem would have one or more attributes.
 - It could be non-intuitive/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, a new result which would start off a new subject or an area, provides a new method or improves upon known methods of doing something which has practical applications, or a result which stops further work in an area.
 - The researcher has to be convinced that the problem is worthwhile before beginning to tackle it because best efforts come when the work is worth doing, and the problem and/or solution has a better chance of being accepted by the research community.
 - Not all problems that one solves will be great, and sometimes major advancements are made through solutions to small problems dealt with effectively. Some problems are universally considered hard and open, and have deep implications and connections to different concepts.
 - The reality is that most researchers in their lifetime do not get into such problems. However, hard problems get solved only because people tackle them.
 - The question a researcher has to grapple with whether the time investment is worth it given that the likely outcome is negative, and so it is a difficult personal decision to make.
 - At the same time, even in the case of failure to solve the intended hard problem, there may be partial/side results that serve the immediate need of producing some results for the dissertation. George Pólya (1887–1985) suggested a 4-step procedure for mathematical problem-solving, which is relevant to engineering researchers as well.
- The recommended steps to solve a research problem are

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- Understand the problem, restate it as if it's your own, visualize the problem by drawing figures, and determine if something more is needed.
- One must start somewhere and systematically explore possible strategies to solve the problem or a simpler version of it while looking for patterns.
- Execute the plan to see if it works, and if it does not then start over with another approach. Having delved into the problem and returned to it multiple times, one might have a flash of insight or a new idea to solve the problem.
- Looking back and reflecting helps in understanding and assimilating the strategy and is a sort of investment into the future.

ETHICS IN ENGINEERING RESEARCH

- Ethics generally refers to a set of rules distinguishing acceptable and unacceptable conduct, distinguishing right from wrong as such
- Most people learn such norms in their formative years, but moral development continues through different stages of growth. Although everyone recognizes some common ethical norms, but there is difference in interpretation and application.
- Ethical principles can be used for evaluation, proposition or interpretation of laws. Although ethics are not laws, but laws often follow ethics because ethics are our shared values.
- International norms for the ethical conduct of research have been there since the adoption of the Nuremberg Code in 1947.
- According to Whitbeck, the issues related to research credit dates back to the establishment of the British Royal Society (BRS) in the seventeenth century to refine the methods and practices of modern science. This event altered the timing and credit issues on the release of research results since BRS gave priority to whoever first submitted findings for publication, rather than trying to find out who had first discovered.
- Whitbeck raised two simple but significant questions to address the tricky issue of authorship in research:
 - o Who should be included as an author and
 - o The appropriate order of listing of authors.
- In an increasingly interconnected world, the issue of co-authorship is very relevant to all researchers. There are issues around individuals who may be deeply involved during the conduct of the research work, but may not contribute in the drafting phase
- 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 way the work is undertaken.

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ETHICS IN ENGINEERING RESEARCH PRACTICE

- Technological developments raise a whole range of ethical concerns such as privacy issues and data related to surveillance systems, and so 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 because there is impact on humans. Certain practices may be acceptable to certain people in certain situations, and the reasons for unacceptability may be perfectly valid.
- We have unprecedented access to data today, and unprecedented options for analysis of these data and consequences in engineering research related to such data. Are there things that are possible to do with this data, that we agree we should not do?
- Engineering ethics gives us the rule book; tells us, how to decide what is okay to do and what is not. Engineering research is not work in isolation to the technological development taking place.
- Researchers make many choices that matter from an ethical perspective and influence the effects of technology in many different ways:
 - o By setting the ethically right requirements at the very outset, engineering researchers can ultimately influence the effects of the developed technology.
 - o Influence may also be applied by researchers through design (a process that translates the requirements into a blueprint to fulfill those requirements). During the design process, decision is to be made about the priority in importance of the requirements taking ethical aspects into consideration.
 - o Thirdly, engineering researchers have to choose between different alternatives fulfilling similar functions.
- Research outcomes often have unintended and undesirable side effects. It is a vital ethical responsibility of researchers to ensure that hazards/risks associated with the technologies that they develop, are minimized and alternative safer mechanisms are considered.
- If possible, the designs should be made inherently safe such that they avoid dangers, or come with safety factors, and multiple independent safety barriers, or if possible a supervisory mechanism to take control if the primary process fails.

TYPES OF RESEARCH MISCONDUCT

Engineering research should be conducted to improve the state-of-the-art of technologies. Research integrity encompasses dealing fairly with others, honesty about the methods and results, replicating the results wherever possible so as to avoid errors, protecting the welfare of research subjects, ensuring laboratory safety, and so forth. In order to prevent mistakes, peer reviews should take place before the research output is published.

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There may be different types of research misconduct as described, which can be summarized as follows:

- **Fabrication** (Illegitimate creation of data): Fabrication is the act of gathering data or experiments with a belief of knowledge about what the conclusion of the analysis or experiments would be, but cannot wait for the results possibly due to timeline pressures from supervisor or customers.
- **Falsification** (Inappropriate alteration of data): Falsification is the misrepresentation or misinterpretation, or illegitimate alteration of data or experiments, even if partly, to support a desired hypothesis even when the actual data received from experiments suggest otherwise.

Falsification and fabrication of data and results, hamper engineering research and cause false empirical data to percolate in the literature, wreck trustworthiness of individuals involved, incur additional costs, impede research progress, and cause actual and avoidable delays in technical advancement.

Misleading data can also crop up due to poor design of experiments or incorrect measurement practices.

- **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. Verbatim copying or reusing one's own published work is termed as 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) 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.

Although there are many free tools and also paid tools available that one can procure institutional license of, one cannot conclusively identify plagiarism but can only get a similarity score which is a metric that provides a score of the amount of similarity between already published content and the unpublished content under scrutiny.

However, a low similarity score does not guarantee that the document is plagiarism free. It takes a human eye to ascertain whether the content has been plagiarized or not.

It is important to see the individual scores of the sources, not just the overall similarity index. Setting a standard of a maximum allowable similarity index is inadequate usage of the tool. Patchwork plagiarism is more difficult to evaluate.

There are simple and ethical ways to avoid a high similarity count on an about to be submitted manuscript. Sometimes, certain published content is perfect for one's research paper, perhaps

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in making a connection or fortifying the argument presented. The published material is available for the purpose of being used fairly.

One is not expected to churn out research outcomes in thin air.

However, whatever is relevant can be reported by paraphrasing in one's own words, that is, without verbatim copy.

One can also summarize the relevant content and naturally, the summary invariably would use one's own words. In all these cases, citing the original source is important. However, merely because one has cited a source, it does not mean that one can copy sentences (or paragraphs) of the original content verbatim.

A researcher should practice writing in such a way that the reader can recognize the difference between the ideas or results of the authors and those that are from other sources. Such a practice enables one to judge whether one is disproportionately using or relying on content from existing literature.

- Other Aspects of Research Misconduct: Serious deviations from accepted conduct could be construed as research misconduct. When there is both deception and damage, a fraud is deemed to have taken place. Sooner or later ethical violations get exposed. Simultaneous submission of the same article to two different journals also violates publication policies.

Another issue is that when mistakes are found in an article or any published content, they are generally not reported for public access unless a researcher is driven enough to build on that mistake and provide a correct version of the same which is not always the primary objective of the researcher.

ETHICAL ISSUES RELATED TO AUTHORSHIP

- Academic authorship involves communicating scholarly work, establishing priority for their discoveries, and building peer-reputation, and comes with intrinsic burden of acceptance of the responsibility for the contents of the work. It is the primary basis of evaluation for employment, promotion, and other honors.

- There is several important research conduct and ethics related issues connected to authorship of research papers and are summarized herewith in the context of engineering research.

- Credit for research contributions is attributed in three major ways in research publications: by authorship (of the intended publication), citation (of previously published or formally presented work), and through a written acknowledgment (of some inputs to the present research).

- Authorship establishes both accountability and gives due credit. A person is expected to be listed as an author only when associated as a significant contributor in research design, data interpretation, or writing of the paper. Including —guestl or —giftl (co-authorship bestowed on someone with little or no contribution to the work) authors dilutes the contribution

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of those who did the work, inappropriately inflates credentials of the listed authors, and is ethically a red flag highlighting research misconduct.

- Sometimes, the primary author dubiously bestows co-authorship on a junior faculty or a student to boost their chances of employment or promotion, which can be termed as Career-boost authorship.

- There is also an unfortunate malpractice of co-authorship that can be described as —Career-preservation authorship, wherein a head of the department, a dean, a provost, or other administrators are added as Coauthors because of quid pro quo arrangement wherein the principal author benefits from a —good relationship with the superiors and the administrator benefits from authorship without doing the required work for it. Sometimes, an actual contributor abstains from the list of authors due to no disclosed conflict of interest within the organization. Such co-authorships can be termed as ghost co-authorship. Full disclosure of all those involved in the research is important so that evaluation can happen both on the basis of findings, and also whether there was influence from the conflicts.

- In another type of questionable authorship, some researchers list one another as coauthors as a reciprocal gesture with no real collaboration except minimal reading and editing, without truly reviewing the work threadbare.

- Some authors, in trying to acquire a sole-authored work, despite relying on significant contribution to the research work from others, recognize that effort only by an acknowledgment, thereby misrepresenting the contributions of the listed authors.

- The unrecognized author is therefore, unavailable to readers for elaboration.

- All listed authors have the full obligation of all contents of a research article, and so naturally, they should also be made aware of a journal submission by the corresponding author.

- It is imperative that their consent is sought with respect to the content and that they be agreeable to the submission.

- In case of misconduct like inappropriate authorship, while the perpetrator is easier to find, the degree of appropriate accountability of the coauthors is not always obvious. Being able to quantify the contributions to appropriately recognize and ascertain the degree of associated accountability of each coauthor, is appealing.

- Double submission is an important ethical issue related to authorship, which involves submission of a paper to two forums simultaneously. The motivation is to increase publication possibilities and possibly decrease time to publication. Reputed journals want to publish original papers, i.e., papers which have not appeared elsewhere, and strongly discourage double submission.

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MODULE 2: LITERATURE REVIEW AND TECHNICAL READING, ATTRIBUTIONS AND CITATIONS

Syllabus

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases: Web of Science, Google and Google Scholar, Effective Search: The Way Forward, Introduction to Technical Reading, Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books, Dissertations, Dedication or Acknowledgments.

LITERATURE REVIEW AND TECHNICAL READING

- The primary goal of literature review is to know the use of content/ideas/approaches in the literature to correctly identify the problem that is vaguely known beforehand, to advocate a specific approach adapted to understanding the problem, and to access the choice of methods used.
- It also helps the researcher understand clearly that the research to be undertaken would contribute to something new and innovative.
- The quality of such review can be determined by evaluating if it includes appropriate breadth and depth of the area under study, clarity, rigor, consistency, effective analysis.

NEW AND EXISTING KNOWLEDGE

- New knowledge in research can only be interpreted within the context of what is already known and cannot exist without the foundation of existing knowledge.
- The new knowledge can have vastly different interpretations depending on what the researcher's background, and one's perception of that new knowledge can change from indifference to excitement (or vice versa), depending on what else one knows.
- The significance can normally be argued from the point of view that there is indeed an existing problem and that it is known by looking at what already exists in the field.
- The existing knowledge is needed to make the case that there is a problem and that it is important.
- One can infer that the knowledge that is sought to be produced does not yet exist by describing what other knowledge already exists and by pointing out that this part is missing so that what we have is original. To do this, one again needs the existing knowledge: the context, the significance, the originality, and the tools.
- Normally, one finds this knowledge by reading and surveying the literature in the field that was established long ago and also about the more recent knowledge which is in fact always changing.

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- With this foundation in place, the new knowledge that one will make will be much more difficult to challenge than without that strong foundation in place which is ensured with lots of references to the literature.
- Often, but not always, the textbooks contain the older established knowledge and the research papers the newer work. Reading the textbooks on one's topic provide the established knowledge and the background to be able to read the newer work usually recorded in the research papers
- The research paper is written for other researchers out on the edge of knowledge and it assumes that the reader already knows a lot in that field
- The review process must explain how a research item builds on another one. An effective review of literature ensures a firm foundation for advancing knowledge, facilitates theoretical growth, eliminates areas that might be of interest, and opens new avenues of possible work
- Generally, a good literature survey is the first expectation of a supervisor from the research student, and when done well can create a good impression that the state of art in the chosen field is well understood
- A good literature review would not draw hasty conclusions and look into the individual references to determine the underlying causes/assumptions/mechanisms in each of them so as to synthesize the available information in a much more meaningful way
- A good literature survey is typically a two-step process as enumerated below:
 - o Identify the major topics or subtopics or concepts relevant to the subject under consideration.
 - o Place the citation of the relevant source (article/patent/website/data, etc.) in the correct category of the concept/topic/subtopic
- It could be that as one is reading and comes across something that one considers to be very important for one's work. Naturally, one highlights that section or underlines it, or put an asterisk in the margin, so that one could come back to it later. Effectively, one is saying that it is important and hence the marking so as not to forget it.
- A comprehensive literature survey should methodically analyze and synthesize quality archived work, provide a firm foundation to a topic of interest and the choice of suitable research methodologies, and demonstrate that the proposed work would make a novel contribution to the overall field of research.

ANALYSIS AND SYNTHESIS OF PRIOR ART

- After collecting the sources, usually articles, intended to be used in the literature review, the researcher is ready to break down each article and identify the useful content in it, and then synthesize the collection of articles (integrate them and identify the conclusions that can be made from the articles as a group).
- A researcher should analyze the relevant information ascertained in below table by undertaking the following steps:
 - o Understanding the hypothesis,
 - o Understanding the models and the experimental conditions used,
 - o Making connections,

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- o Comparing and contrasting the various information, and
- o Finding out the strong points and the loopholes.

	Source 1	Source 2	...	Source M
Topic 1		✓		
Topic 2	✓			✓
⋮				
⋮				
Topic N	✓	✓		

- A literature survey grid of N topics and M sources is shown above to help crystallize the information in different categories.
- It is always good to be suspicious of the claims made in the sources that have been thoroughly reviewed, especially in the case of tall claims.
- If one is amenable to easily accept whatever is available in the literature, one may find it difficult to go beyond it in one's own work and may also fail to carefully analyze with a suspicious bent of mind one's own results subsequently.
- The goal of literature survey is to bring out something new to work on through the identification of unsolved issues, determine the problems in the existing models or experimental designs, and present a novel idea and recommendations.
- No matter where one gets the available information, one needs to critically evaluate each resource that the researcher wishes to cite. This methodology analyzes available materials to determine suitability for the intended research.
- Relying on refereed articles published in scholarly journals or granted patents can save the researcher a lot of time.
- Here are a few criteria that could help the researcher in the evaluation of the information under study:
 - o Authority: What are the author's credentials and affiliation? Who publishes the information?
 - o Accuracy: Based on what one already knows about the topic or from reading other sources, does the information seem credible? Does the author cite other sources in a reference list or bibliography, to support the information presented?
 - o Scope: Is the source at an appropriate comprehension or research level?

BIBLIOGRAPHIC DATABASES

- —Bibliographic databases|| refer to —abstracting and indexing services|| useful for collecting citation-related information and possibly abstracts of research articles from scholarly literature and making them available through search.

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- Performing simultaneous searches through such large databases may allow researchers to overtly rely on any one database and be limited by the intrinsic shortcoming of any one of them for quality research.
- A researcher should be able to quickly identify the databases that are of use in the idea or problem that one wishes to explore.

Web of Science

- Web of Science (formerly known as ISI or Thomson Reuters) includes multiple databases, as well as specialized tools.
- It is a good search tool for scholarly materials requiring institutional license and allows the researcher to search in a particular topic of interest, which can be made by selection in fields that are available in drop down menu such as title, topic, author, address, etc.
- The tool also allows sorting by number of citations (highest to lowest), publication date.
- Put quotes around phrases, add more keywords, or use the —Refine Results|| panel on the left to narrow down the search by keyword, phrases in quotation marks, type of material such as peer-reviewed journal articles, date, language, and more.
- —Cited reference search|| option enables a researcher to trace articles which have cited a formerly published paper. Using this element, it is possible to find how a familiar idea has been applied, improved, or extended subsequently.
- A structured search like this that enables narrowing and refining what one is looking for is effective to ensure that the results throw up relevant sources and time spent in studying those is likely to be well utilized.
- Based on the researcher's need the search result can be broadened or narrowed down using the built-in fields provided in this website.
- When clicked on any of the search results, this website provides the title of the paper, authors, the type of journal, volume, issue number and year of publication, abstract, keywords, etc., so that the researcher has enough information to decide if it is worthwhile to acquire the full version of the paper.

Google and Google Scholar

- Google is a great place to start one's search when one is starting out on a topic. It can be helpful in finding freely available information, such as reports from governments, organizations, companies, and so on. However, there are limitations:
 - o It's a —black box|| of information. It searches everything on the Internet, with no quality control—one does not know where results are coming from.
 - o There are limited search functionality and refinement options.
- Google Scholar limits one's search to scholarly literature. However, there are limitations:
 - o Some of the results are not actually scholarly. An article may look scholarly at first glance, but is not a good source upon further inspection.

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- o It is not comprehensive. Some publishers do not make their content available to Google Scholar.
- o There are limited search functionality and refinement options.
- There are search operators that can be used to help narrow down the results. These help one to find more relevant and useful sources of information.
- Operators can be combined within searches. Here are some basic ones that one can use:
 - o OR - Broadens search by capturing synonyms or variant spellings of a concept.
 - o Brackets/Parentheses () - Gather OR'd synonyms of a concept together, while combining them with another concept.
 - o Quotation marks — || - Narrow the search by finding words together as a phrase, instead of separately.
 - o Site - limits the search to results from a specific domain or website.
 - o File type - limits the search to results with a specific file extension one could look for pdf's, PowerPoint presentations, Excel spreadsheets, and so on.
- The Search Tools button at the top of the Google results gives you a variety of other options, such as limiting the results by date.
- To find the best resources on a topic, one should search in academic databases, in addition to Google.
- Databases provide access to journal articles and conference proceedings, as well as other scholarly resources.
- One gets more relevant and focused results, because they have better quality control and search functionality. One should choose a database based on subject area, date coverage, and publication type. Interfaces vary between databases, but the search techniques remain essentially the same.

EFFECTIVE SEARCH: THE WAY FORWARD

- A scholarly publication is one wherein the published outcome is authored by researchers in a specific field of skill. Such work cites all source contents used and is generally peer reviewed for accuracy and validity before publication.
- Essentially, the audience for such works is fellow experts and students in the field. The content is typically more complex and advanced than those found in general magazines.
- While most of the engineering researchers need to refer articles that appear in scholarly journals, books or other peer-reviewed sources, there is also substantially useful content in more popular publications. These are informal in approach and aim to reach many readers including both the experts in the field and also amateurs, but the content focuses on news and trends in the field.
- Research outcomes are not typically first disseminated here but are usually meant for general reading. A researcher should use all search tools for comprehensive search.
- A researcher must consider what type of information is needed, and where it could be found. Not all information is available online. Some information is only available in print.

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- It can take time for scholarly and peer-reviewed information to be published. One might not be able to find scholarly information about something currently being reported in the news. The information may not be available, or studies on a topic of interest to the researcher have not occurred.
- Searching is an iterative process:
 - o Experiment with different keywords and operators
 - o Evaluate and assess results, use filters
 - o Modify the search as needed; and
 - o When relevant articles are found, look at their citations and references.
- After the search is complete, the researcher needs to engage in critical and thorough reading, making observation of the salient points in those sources, and summarize the findings.
- A detailed comparison and contrast of the findings is also required to be done.
- This entire process may be needed to be done multiple times.
- The conclusion of the entire process of literature survey includes a summary of the relevant and important work done, and also the identification of the missing links and the challenges in the open problems in the area under study.
- One must note that the literature survey is a continuous and cyclical process that may involve the researcher going back and forth till the end of the research project.
- It is very important to not lose sight of the purpose of an extensive search or literature survey, for it is possible to spend a very significant amount of one's time doing so and actually falsely think that one is working hard.
- Nothing will come of it unless one is an active reader and spends sufficient time to develop one's own ideas build on what one has read.
- It is not as if literature survey ends and then research begins, for new literature keeps appearing, and as one's understanding of the problem grows, one finds new connections and related/evolving problems which may need more search.

INTRODUCTION TO TECHNICAL READING

- It is obvious that the number of papers relevant to a particular researcher is very few, compared to the actual number of research papers available from peer-reviewed technical sources.
- It is also important to know where to read from; relying on refereed journals and books published by reputed publishers is always better than relying on easily available random articles off the web.
- While reading an engineering research paper, the goal is to understand the technical contributions that the authors are making. Given the abundance of journal articles, it is useful to adopt a quick, purposeful, and useful way of reading these manuscripts.
- It is not the same as reading a newspaper. It may require rereading the paper multiple times and one might expect to spend many hours reading the paper.
- Amount of time to be spent will get ascertained after an initial skimming through the paper to decide whether it is worth careful reading.

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- There will also be papers where it is not worth reading all the details in the first instance. It is quite possible that the details are of limited value, or simply one does not feel competent to understand the information yet.
- Start out the skimming process by reading the title and keywords (these are anyways; probably what caught the initial attention in the first place). If on reading these, it does not sufficiently seem to be interesting; it is better to stop reading and look for something else to read.
- One should then read the abstract to get an overview of the paper in minimum time. Again, if it does not seem sufficiently important to the field of study, one should stop reading further.
- If the abstract is of interest, one should skip most of the paper and go straight to the conclusions to find if the paper is relevant to the intended purpose, and if so, then one should read the figures, tables, and the captions therein, because these would not take much time but would provide a broad enough idea as to what was done in the paper.
- If the paper has continued to be of interest so far, then one is now ready to delve into the Introduction section to know the background information about the work and also to ascertain why the authors did that particular study and in what ways the paper furthers the state of the art.
- The next sections to read are the Results and Discussion sections which is really the heart of the paper. One should really read further sections like the Experimental Setup/Modeling, etc., only if one is really interested and wishes to understand exactly what was done to better understand the meaning of the data and its interpretation.
- A researcher will always need to be searching for the relevant literature and keeping up to date with it. If one is busy with a small project, the advisor might just give a single important paper to read. But with a larger one, you will be searching for one's own literature to read. For this one will need a strategy as there is just too much work out there to read everything.

CONCEPTUALIZING RESEARCH

- The characteristics of a research objective are that it must have new knowledge at the center and that it must be accepted by the community of other researchers and recognized as significant.
- Besides being original and significant, a good research problem should also be solvable or achievable. This requirement already asks us to think about the method and the tools that could be used to obtain that new knowledge.
- Now, the significance and the originality and all the theory that we read and tools and methods that we need to take on a problem, all of these normally come from the existing recorded literature and knowledge in the field.
- Coming up with a good research objective, conceptualizing the research that meets all of these requirements is a tough thing to do. It means that one must already be aware of what is in the literature. That is, by the time one actually has a good research objective, one is probably already an expert at the edge of knowledge else it is difficult to say with confidence that one has a good research objective.
- So, when working at the research (Ph.D) level, one needs to be prepared to become that expert, one needs to be continually reading the literature so as to bring together the three parts:

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- o Significant problem,
- o The knowledge that will address it, and
- o A possible way to make that new knowledge.
- How these three aspects would come together will be different for every person doing research and it will be different in every field, but the only way to be that expert is by immersing oneself in the literature and knowing about what already exists in the field.
- However, if one is working on a research project that is of a smaller scope, then conceptualizing the research is possibly too tough to do, and one does not have the time that it takes to become that expert at the edge of knowledge.
- In this case, the researcher needs the help of someone else, typically the supervisor who may already be an expert and an active researcher in that field, and may advise on what a good research objective might be.
- An established researcher in any field should be able to immediately point to the landmark literature that one should read first. Otherwise one would need to spend a lot of time reading the literature to discover.

CRITICAL AND CREATIVE READING

- Reading a research paper is a critical process. The reader should not be under the assumption that reported results or arguments are correct. Rather, being suspicious and asking appropriate questions is in fact a good thing.
- Have the authors attempted to solve the right problem? Are there simpler solutions that have not been considered? What are the limitations (both stated and ignored) of the solution and are there any missing links? Are the assumptions that were made reasonable? Is there a logical flow to the paper or is there a flaw in the reasoning? These need to be ascertained apart from the relevance and the importance of the work, by careful reading.
- Use of judgmental approach and boldness to make judgments is needed while reading.
- Flexibility to discard previous erroneous judgments is also critical.
- Additionally, it is important to ascertain whether the data presented in the paper is right data to substantiate the argument that was made in the paper and whether the data was gathered and interpreted in a correct manner.
- Critical reading is relatively easy. It is relatively easier to critically read to find the mistakes than to read it so as to find the good ideas in the paper. Anyone who has been a regular reviewer of journal articles would agree to such a statement.
- Reading creatively is harder, and requires a positive approach in search. In creative reading, the idea is to actively look for other applications, interesting generalizations, or extended work which the authors might have missed? Are there plausible modifications that may throw up important practical challenges? One might be able to decipher properly if one would like to start researching an extended part of this work, and what should be the immediate next aspect to focus upon.

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TAKING NOTES WHILE READING

- A researcher reads to write and writes well only if the reading skills are good.
- The bridge between reading and actually writing a paper is the act of taking notes during and shortly after the process of reading.
- There is a well-known saying that the faintest writing is better than the best memory, and it applies to researchers who need to read and build on that knowledge to write building on the notes taken.
- Many researchers take notes on the margins of their copies of papers or even digitally on an article aggregator tool.
- In each research paper, there are a lot of things that one might like to highlight for later use such as definitions, explanations, and concepts.
- If there are questions of criticisms, these need to be written down so as to avoid being forgotten later on. Such efforts pay significantly when one has to go back and reread the same content after a long time.
- On completing a thorough reading, a good technical reading should end with a summary of the paper in a few sentences describing the contributions.
- But to elucidate the technical merit, the paper needs to be looked at from comparative perspective with respect to existing works in that specific area.
- A thorough reading should bring out whether there are new ideas in the paper, or if existing ideas were implemented through experiments or in a new application, or if different existing ideas were brought together under a novel framework.
- Obviously, the type of contribution a paper is actually making can be determined better by having read other papers in the area.

READING MATHEMATICS AND ALGORITHMS

- Mathematics is often the foundation of new advances, for evolution and development of engineering research and practice. An engineering researcher generally cannot avoid mathematical derivations or proofs as part of research work.
- In fact, these are the heart of any technical paper. Therefore, one should avoid skimming them.
- By meticulous reading of the proofs or algorithms, after having identified the relevance of the paper, one can develop sound understanding about the problem that the authors have attempted to solve.
- Implementation of an intricate algorithm in programming languages such as C, C++ or Java is prone to errors.
- And even if the researcher is confident about the paper in hand, and thinks that the algorithm will work, there is a fair chance that it will not work at all. So one may wish to code it quickly to check if it actually works.

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READING A DATASHEET

- Researchers in different fields of engineering will need to read certain types of documents. For example, mechanical and civil engineers would need to read drawings related to mechanical parts and buildings. Researchers in the field of electronics need to read datasheets.
- On occasions, researchers in other fields may also need to incorporate a certain electronic part in which case careful reading of the datasheet is imperative.
- The same principles like initial skimming of the datasheet are required to ascertain whether further careful reading is needed.
- Datasheets are instruction manuals for electronic components, which (hopefully) details what a component does and how one may use it. Datasheets enable a researcher (or a working professional) to design a circuit or debug any given circuit with that component.
- The first page of the datasheet usually summarizes a part's function and features, basic specifications, and usually provides a functional block diagram with the internal functions of the part.
- A pin out provides the physical location of a part's pins, with special mark for pin 1 so that the part can be correctly plugged into the circuit. Some parts also provide graphs showing performance versus various criteria (supply voltage, temperature, etc.), and safe region for reliable operation which should be carefully read and noted by the researcher.
- One should be also in the lookout for truth tables which describe what sort of inputs provide what types of outputs, and also timing diagrams which lay out how and at what speed data is sent and received from the part.
- Datasheets usually end with accurate dimensions of the packages a part is available in. This is useful for printed circuit board (PCB) layout. When working with a new part, or when deciding which part to use in the research work, it is recommended to carefully read that part's datasheet to come up with a bit of shortcut that may potentially save many hours later on.

ATTRIBUTES AND CITATION: Giving credits wherever due

- Academic writing, by definition, must follow certain rules and conventions.
- Among the most important of these are the rules and conventions about citing, referencing, attributing, and acknowledging the works of others.
- That means giving proper credit wherever due.
- Citing is the practice of quoting from, referring to other authors' works and ideas in the text of our work in such a way that the context is clear to the reader.
- Referencing is the listing of the full publication details of a published work that is cited so as to give background information to the readers.
- Acknowledgment in research publications indicates contributions to scientific work.
- However, acknowledgment, attributions, and citations differ in the manner of their application

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CITATIONS: FUNCTIONS AND ATTRIBUTES

- Citations (references) credit others for their work, while allowing the readers to trace the source publication if needed.
- Any portion of someone else's work or ideas in papers, patents, or presentations must be used in any new document only by clearly citing the source.
- This applies to all forms of written sources in the form of texts, images, sounds, etc. and failure to do may be considered plagiarism
- When a bibliography of previously published patents or papers is placed in the new works of a researcher, a connection is established between the new and previous work.
- As per relevance to context, the researcher provides due credit through the use of a citation.
- Citations help the readers to verify the quality and importance of the new work and justification of the findings. It is a way to tell readers that certain material in the researcher's present work has come from another source and as an ethical responsibility; appropriate credit has been given to the original author or writer.
- Materials that can be cited include journal papers, conference proceeding, books, theses, newspaper articles, websites, or other online resources and personal communication.
- Preferably, citations should be given at the end of a sentence or the end of a paragraph as can be seen even in this particular paragraph. Citation must contain enough details so that readers can easily find the referenced material.
- A researcher needs to cite each source twice:
 - (i) in-text citation, in the text of the article exactly where the source is quoted or paraphrased, and
 - (ii) a second time in the references, typically at the end of the chapter or a book or at the end of a research article
- LaTeX, a document preparation system often used by engineering researchers to automatically format documents that comply with standard formatting needs, is very effective to track and update citations
- There are three main functions of citation:
 - (i) Verification function: Authors have a scope for finding intentional or unintentional distortion of research or misleading statements. Citation offers the readers a chance to ascertain if the original source is justified or not, and if that assertion is properly described in the present work
 - (ii) Acknowledgment function: Researchers primarily receive credit for their work through citations. Citations play crucial role in promotion of individual researchers and their continued employment. Many reputed organizations and institutes provide research funding based on the reputations of the researchers. Citations help all researchers to enhance their reputation and provide detailed background of the research work.
 - (iii) Documentation function: Citations are also used to document scientific concepts and historical progress of any particular technology over the years

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- Citations are the currency that authors would wish to accumulate and the technical community gives them credit for these contributions. When other authors make citations, they honor those who initiated the ideas
 - Authors should cite sources to indicate significance of the work to the reader. Relevant citations help authors develop an easily understandable argument and prevent the need to navigate through work irrelevant to the reader's interest areas
 - There are certain cases when references do not fulfill the actual goal of citations and acknowledgments, and thus do not benefit the reader.
 - o Spurious citations: In certain cases, when citation is not required or an appropriate one is not found, if the author nevertheless goes ahead with including one anyways, it would be considered as a spurious citation
 - o Biased citations: When authors cite the work of their friends or colleagues despite there being no significant connection between the two works, or when they do not cite work of genuine significance because they do not wish to give credit in the form of citation to certain individuals, then such actions can be classified as biased citations.
- Self-citations: There is nothing wrong in citing one's prior work if the citation is really relevant. Self-citation of prior papers is natural because the latest paper is often a part of a larger research project which is ongoing
- o Coercive citations: Despite shortcomings, impact factors remain a primary method of quantification of research. One side effect is that it creates an incentive for editors to indulge in coercion to add citations to the editor's journal

IMPACT OF TITLES AND KEYWORDS ON CITATION

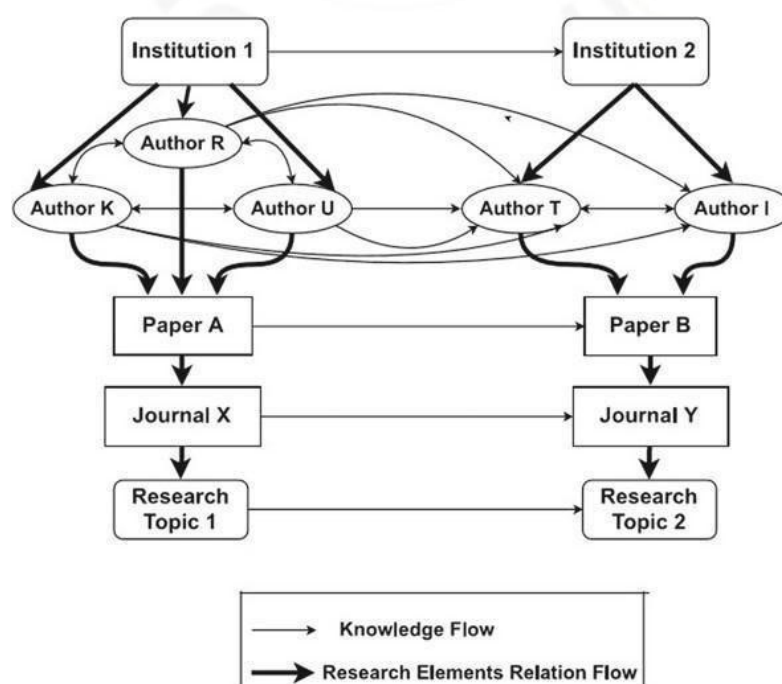
- The citation rate of any research paper depends on various factors including significance and availability of the journal, publication types, research area, and importance of the published research work.
- Other factors like length of the title, type of the title, and selected keywords also impact the citation count. Title is the most important attribute of any research paper.
- It is the main indication of the research area or subject and is used by researcher as a source of information during literature survey.
- Title plays important role in marketing and makes research papers traceable.
- A good title is informative, represents a paper effectively to readers, and gains their attention. Some titles are informative but do not capture attention of readers, some titles are attractive but not informative or related to the readers' research area.
- The download count and citation of a research paper might be influenced by title.
- There are three different aspects which provide a particular behavior to the title:
 - o Types of the title,
 - o Length of the title, and
 - o Presence of specific markers

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- Longer titles mainly include the study methodology and/or results in more detail, and so attract more attention and citations
- In general, titles containing a question mark, colon, and reference to a specific geographical region are associated with lower citation rates, also result-describing titles usually get citations than method-describing titles.
- Additionally, review articles and original articles usually receive more citations than short communication articles.
- At least two keywords in the title can increase the chance of finding and reading the article as well as get more citations.
- Keywords represent essential information as well as main content of the article, which are relevant to the area of research. Search engines, journal, digital libraries, and indexing services use keywords for categorization of the research topic and to direct the work to the relevant audience.

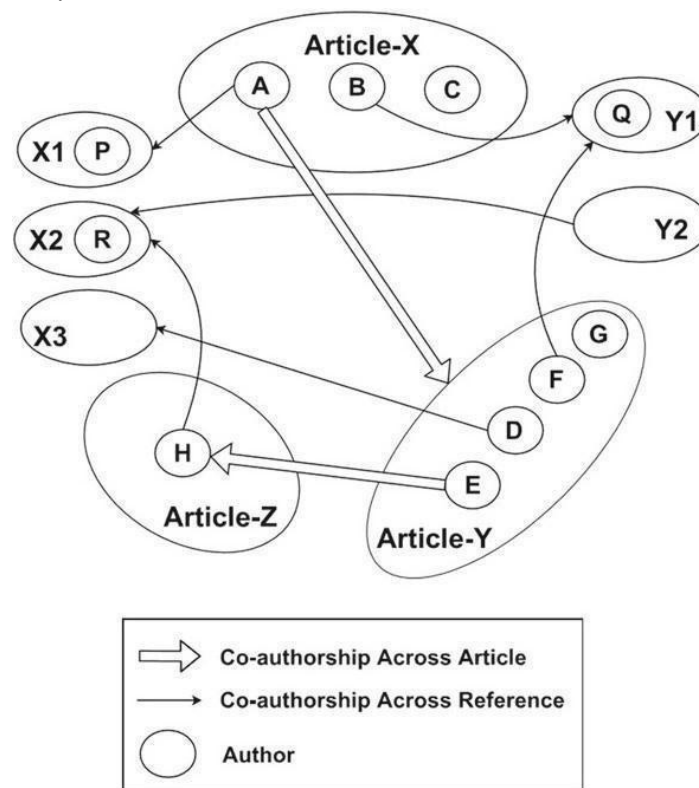
KNOWLEDGE FLOW THROUGH CITATION

- Knowledge flows through verbal communications, books, documents, video, audio, and images, which plays a powerful role in research community in promoting the formulation of new knowledge.
- In engineering research, knowledge flow is primarily in the form of books, thesis, articles, patents, and reports. Citing a source is important for transmission of knowledge from previous work to an innovation
- Knowledge flow happens between co-authors during research collaboration, among other researchers through their paper citation network, and also between institutions, departments, research fields or topics, and elements of research



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- If paper A is cited by paper B, then knowledge flows through citation networks across institutions.
- The complex interdisciplinary nature of research encourages scholars to cooperate with each other to grab more advantages through collaboration, thereby improving quality of the research
- The below figure shows a relationship between co-authorship and different types of citations. Three articles (X, Y, and Z) and five references (X1, X2, X3, Y1, and Y2) of article X and Y, respectively, are considered. A, B, and C are authors of article X, and D, E, F, G, and also A are authors of article Y. Article Z has two authors H and E. References X1, X2, X3, Y1, and Y2 have authors (A, P), (H, R), (D), (Q, B, F), and (R), respectively.



CITING DATASETS

- The nature of engineering research has evolved rapidly and now relies heavily on data to justify claims and provide experimental evidences and so data citations must fetch proper credit to the creator of the dataset as citations of other objects like research articles.
- Data citations should have provisions to give credit and legal attribution to all contributors, enable identification and access, while recognizing that a specific style may not apply to all data.
- Ascertaining the ownership of data can be a complicated issue especially with large datasets, and issues of funding can also make it a difficult matter.
- A researcher should obtain necessary permission for using data from a particular source.
- Citations related to datasets should include enough information so that a reader could find the same dataset again in the future, even if the link provided no longer works.

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- It is proper to include a mixture of general and specific information to enable a reader to be certain that the search result is the same dataset that was sought.

Examples:

1. Historical Data, Sotavento (Wind Farm), Corunna, Spain (July 2016): [Accessed: 4 Oct] 2016] Retrieved from <http://www.sotaventogalicia.com/en/real-time-data/historical>
2. Deb, D (2016). [Personnel survey]. Unpublished raw data.

STYLES FOR CITATION

- Citation styles differ primarily in the order, and syntax of information about references, depending on difference in priorities attributed to concision, readability, dates, authors, and publications.
- Some of the most common styles for citation
ASCE style (American Society of Civil Engineers)

Template for books:

Author Surname, Author Initial. (Year Published). Title. Publisher, City, Pages Used.

Example:

Wearstler, K., and Bogart, J. (2004). Modern glamour. Regan Books, NY.

Template for websites:

Author Credentials / Company Name (Year Published). 'Title'. <http://Website URL> (Oct. 10, 2013).

Example:

Blade cleaning services (2015): <http://www.bladecleaning.com/problematica> (29 Oct, 2016).

Template for journal publications:

Author Surname, Author Initial. (Year Published). 'Title'. Publication Title, Volume number(Issue number), Pages Used.

Example:

Johnston, L. (2014). "How an Inconvenient Truth Expanded The Climate Change Dialogue abd Reignited An Ethical Purpose in The United States". 1-160.

IEEE style (Institute of Electrical and Electronics Engineers)

Chapter in an edited book

[1] A. Rezi and M. Allam, "Techniques in array processing by means of transformations," in Control and Dynamic Systems, Vol. 69, Multidimensional Systems, C. T. Leondes, Ed. San Diego: Academic Press, 1995, pp. 133-180.

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ACKNOWLEDGMENT AND ATTRIBUTION

- Acknowledgment section is a place to provide a brief appreciation of the contribution of someone or an organization or funding body to the present work.
- If no particular guideline is available for the intended publication, then it can be introduced at the end of the text or as a footnote.
- Acknowledgment is a common practice to recognize persons or agencies for being responsible in some form or other for completion of a publishable research outcome.
- Acknowledgment displays a relationship among people, agencies, institutions, and research. In some case, certain individuals may help in the research work but may not deserve to be included as authors. As a sign of gratitude, such contributions should be acknowledged
- Acknowledgments and attributions are also very important in the publications of journal or conference papers. Giving proper credit wherever it is due is very important and even if the contribution is minor, it should not be neglected.
- In engineering research, acknowledgments are meant for participating technicians, students, funding agency, grant number, institution, or anyone who provide scientific inputs, shared unpublished results, provided equipment, or participated in discussions.

WHAT SHOULD BE ACKNOWLEDGED

- Every author should know that what should/should not be acknowledged.
- Author should acknowledge quotation, ideas, facts, paraphrasing, funding organization, oral discussion or support, laboratory, and computer work.
- Quotation: In technical writing such as in the field of engineering, quotes are used very rarely. Quotations are of two types:
 - o Direct quotations are used when author use actual words or sentences in the same order as the original one. Author should use quotation marks for the words or sentences with proper acknowledgment.
 - o Indirect quotation summarizes or paraphrases the actual quote. In such cases, it is important to acknowledge with proper name and date.
- Authors should acknowledge people who give appropriate contribution in their research work. Non-research work contributions are not generally acknowledged in a scientific paper but it may be in a thesis. Persons must be acknowledged by authors, who gave a scientific or technical guidance, take part in some discussions, or shared information to author. Authors should acknowledge assistants, students, or technicians, who helped experimentally and theoretically during the research work.
- If the researcher received grant from a funding agency and if those funds were used in the work reported in the publication, then such support should always be acknowledged by providing full details of the funding program and grant number in the acknowledgment section. The authors should also gratefully acknowledge use of the services and facilities of any center or organization with which they are not formally affiliated to.
- An example of acknowledgment of grant received is as follows:

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Acknowledgments:

This research work was funded in part by the Extra Mural Research Funding 2014–17 (Individual Centric) of the Department of Science and Technology (DST), Govt. of India.

- Many technical journals explicitly discourage authors to thank the reviewers in their article submissions. This could be construed as favoritism or an attempt to encourage reviewers to accept their manuscript for reasons other than scientific merit.
- Acknowledging that results have been presented elsewhere: If the results were presented as an abstract in a journal, then there should be a suitable citation. If the results were presented as part of scientific meeting, symposium, or other gathering, then some relevant information should be provided.
- At the very least, the name of the gathering and year should be cited. Other helpful items include the location of the gathering (city and state or country) and the full date of the occasion.
- By acknowledging all help received in one's research work, the author(s) demonstrate integrity as a researcher, which in turn encourages continued collaboration from those who helped out in different ways.
- Failure to acknowledge funding may result in the discontinuation of current funding and/or ineligibility to receive future funding for a certain number of years or indefinitely.

ACKNOWLEDGEMENTS IN BOOKS / DISSERTATION

- A page of acknowledgments is usually included at the beginning of a thesis/ dissertation immediately following the table of contents.
- These acknowledgments are longer than the one or two sentence statements in journal papers or articles in conference proceedings.
- These detailed acknowledgments enable the researcher to thank all those who have contributed in completion of the research work. Careful thought needs to be given concerning those whose inputs are to be acknowledged and in what order.
- Generally, one should express appreciation in a concise manner and avoid emotive language.
- The following are often acknowledged in these types of acknowledgments: main supervisor, second supervisor, peers in the lab, other academic staff in the department, technical or support staff in the department, colleagues from other departments, other institutions, or organizations, former students, family, and friends

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Sample Acknowledgement in Thesis:

I wish to express my sincere appreciation to my supervisor Prof. Gang Tao for the useful comments, remarks and encouragement throughout this thesis work. Furthermore, I wish to express my thanks to Prof. Jacob Hammer for introducing me to the topic and for the support along the way. Also, I like to thank my peers in the Adaptive Control Lab such as Yu Liu and Shan-shan Li, who have shared their precious time during many lively technical discussions. I would like to thank my family members who have supported me throughout this journey in many different ways.

DEDICATION OR ACKNOWLEDGEMENTS

- Dedication is almost never used in a journal paper, an article in conference proceedings, or a patent, and it is used exclusively in larger documents like books, thesis, or dissertations.
- While acknowledgments are reserved for those who helped out with the book in some way or another (editing, moral support, etc), a dedication is to whomever the author would like it to be dedicated to, whether it is the author 's mother, the best friend, the pet dog, or Almighty God. And yes, it is possible to dedicate something to someone while also mentioning them in the acknowledgments.
- For example, one may dedicate a book to one 's spouse, but acknowledge them for being the moral support and putting up with when one gets stressed.
- The acknowledgments in technical books can be sometimes as brief as the ones in journal articles.
- The acknowledgment section of a technical report may be a paragraph that is longer than a journal paper but shorter than dissertations.
- Generally, the length of the acknowledgment may have some correlation with the length of the document.