GHOUSIA INSTITUTE OF TECHNOLOGY FOR WOMEN

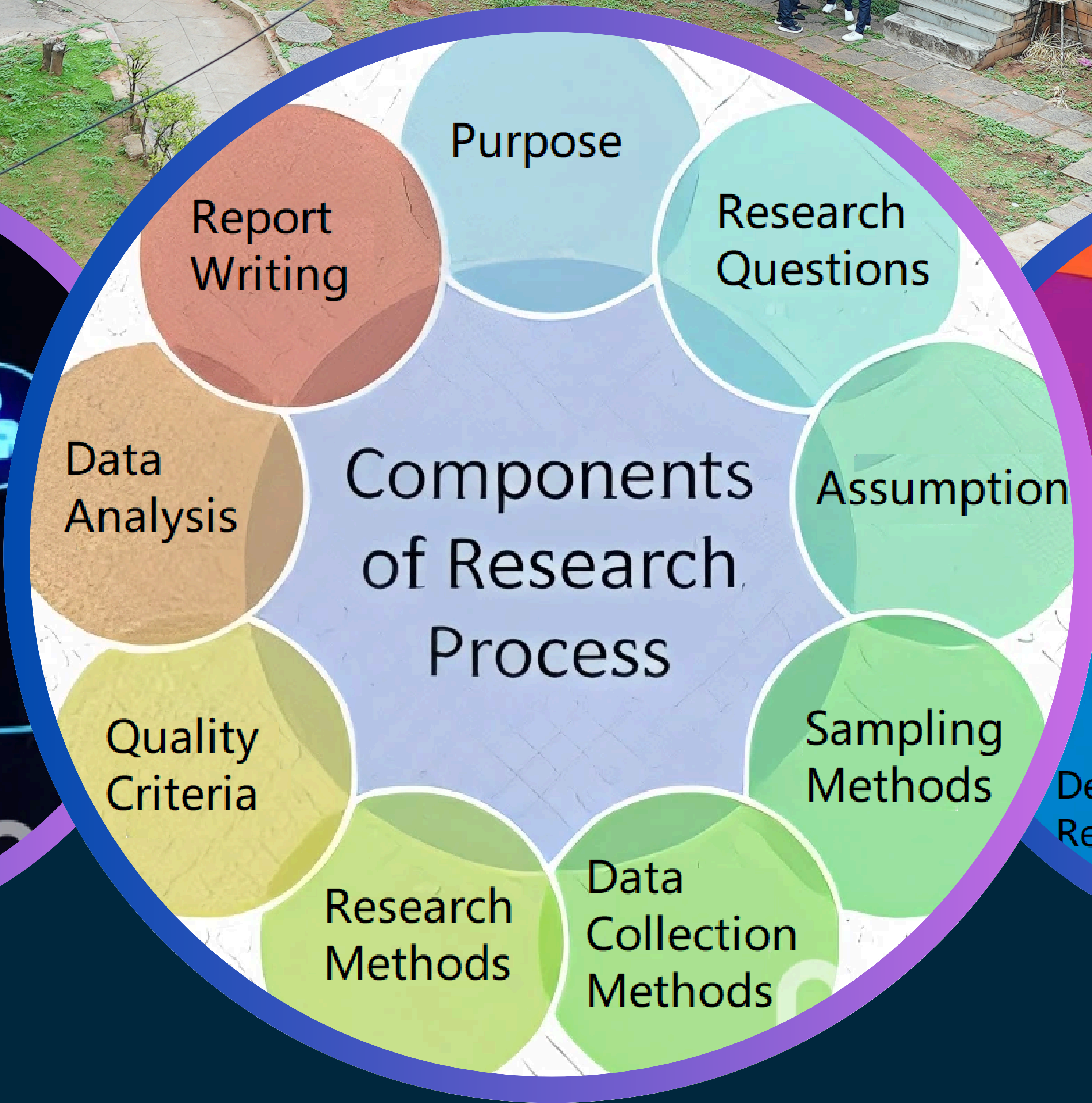
Near Dairy Circle, Hosur Road, Bengaluru-560029, KARNATAKA

Affiliated to VTU., Belagavi, Recognized by Government of Karnataka & A.I.C.T.E., New Delhi

BRMK557

RESEARCH METHODOLOGY & IPR

5TH SEMESTER B.E DEGREE



Research methodology is a systematic approach used to collect, analyze, and interpret data to solve a problem or gain insights. It ensures the validity and reliability of results through structured planning and scientific techniques. Intellectual Property Rights are legal protections granted to individuals or organizations for their original works, ideas, or inventions, ensuring exclusive rights to use, produce, and commercialize them for a certain period.Together, research methodology and IPR form the backbone of ethical and innovative academic and industrial research.

Dr.NAVEED
Assistant Professor

www.gitw.in | naveed.gce@gmail.com | 080-25536527

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RESEARCH METHODOLOGY & IPR

BRMK557

As per 2022 Scheme Syllabus Prescribed by V.T.U.

For

FIFTH SEMESTER

(Bachelor of Engineering)

Dr.NAVEED M.Tech., PhD.

Assistant Professor

Department of Computer Science & Engineering

V Semester

RESEARCH METHODOLOGY & IPR			
Course Code:	**BRMK557**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Objectives:

CO1. To Understand the knowledge on basics of research and its types.
CO2. To Learn the concept of Literature Review, Technical Reading, Attributions and Citations.
CO3. To learn Ethics in Engineering Research.
CO4. To Discuss the concepts of Intellectual Property Rights in engineering.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer methods (L) need not be only the traditional lecture methods, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video to explain various concepts on IPR.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher Order Thinking) questions in the class, which promotes critical thinking.
5. Introduce Topics in manifold representations.
6. Show the different ways to analyze the research problem and encourage the students to come up with their own creative ways to solve them.
7. Discuss how every concept can be applied to the real world - and when that's possible, it helps Improve the students' understanding.

Module-1 (8 Hours)

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.

Teaching- Learning Process	Chalk and talk method / PowerPoint Presentation.

Module-2 (8 Hours)

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.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3 (8 Hours)

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 Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of 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.

Teaching- Learning Process	Chalk and talk method / PowerPoint Presentation.

Module-4 (8 Hours)

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. Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Module-5(8 Hours)

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 Programmes**

Teaching- Learning Process	Chalk and talk method / PowerPoint Presentation

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test 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 course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Marks scored shall be proportionally reduced to 50 marks.

Course Outcomes (Course Skill Set)

At the end of the course, the student will be able to:

CO1. To know the meaning of engineering research.

CO2. To know the procedure of the literature Review and Technical Reading

CO3. To understand the fundamentals of the patent laws and drafting procedure

CO4. Understanding the copyright laws and subject matters of copyrights and designs

CO5. Under standing the basic principles of design rights

Suggested Learning Resources:

Textbook

1. Dr. Santosh M Nejakar, Dr. Harish Bendigeri "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4, Edition: 2023-24.

Reference Book:

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

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

MODULE-01 INTRODUCTION

Syllabus: *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.

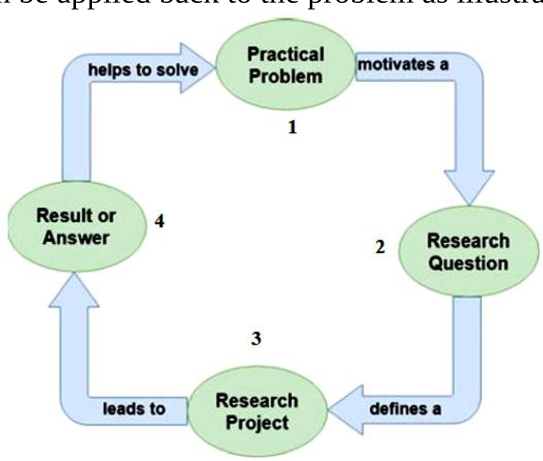
1.1 Introduction.

Research Methodology refers to the systematic approach used to identify, analyze, and solve research problems. It involves defining a research question, reviewing existing knowledge, selecting appropriate methods for data collection and analysis, and interpreting the results to generate new insights or solutions. In engineering, research methodology helps in innovating, optimizing systems, and addressing real-world challenges with scientific rigor. It ensures that the research is reliable, replicable, and contributes meaningfully to the field.

Intellectual Property (IP) refers to creations of the mind, such as inventions, designs, artistic works, and symbols, which are protected by law. In engineering and research, protecting IP through patents, copyrights, trademarks, and trade secrets ensures that the creators retain rights over their innovations. This encourages innovation, prevents unauthorized use, and supports commercialization. Understanding IP is crucial for researchers to safeguard their work and contribute responsibly to technological and societal advancement.

1.2 Meaning of Research:

Research is a careful, objective, and systematic process of investigating an unknown or lesser-known problem to expand existing knowledge or develop new insights. It is not just about collecting information but about making an original contribution to a specific field.
A research cycle in a simple, logical, and continuous loop that starts with a practical problem and ends with a solution that can be applied back to the problem as illustrated in the following figure.



The cycle begins when a practical problem is identified—something that needs to be fixed or improved in the real world. This problem motivates a research question, which is a focused and specific query that aims to understand or solve some aspect of the problem. Once the question is clear, it defines a research project, where researchers plan and carry out systematic investigations—using methods like experiments, surveys, or simulations—to find answers. This project leads to a result or answer, which is the outcome of the study.
Finally, the result is used to help solve the original practical problem, thereby completing the cycle and often revealing new problems, starting the process again. This model emphasizes how research is a structured and repeatable approach to solving real-life issues through inquiry, evidence, and analysis.
Example-01: A computer scientist notices that traditional sorting algorithms perform poorly when handling massive datasets in big data analytics platforms. This practical problem (Step 1) raises concerns about processing speed and efficiency, motivating the researcher to explore improvements. This leads to the formulation of a research question (Step 2): "How can sorting algorithms be optimized for better performance in large-scale data environments?" *With this clear question in mind, the researcher initiates a research project (Step 3), designing and experimenting with new algorithmic strategies, running simulations, and analyzing outcomes. After rigorous testing and refinement, the study yields a result or answer (Step 4)—a new algorithm that sorts data more efficiently than existing methods.*
This outcome is then applied to help solve the original problem, demonstrating how the research cycle—starting from a real-world issue and proceeding through questioning, investigation, and solution—contributes both to theoretical advancement and practical innovation in computer science.

Example-02: *A cybersecurity researcher identifies a practical problem (Step 1): traditional rule-based email filters are increasingly ineffective against modern, sophisticated phishing attacks. Concerned by the rise in online scams and the limitations of current solutions, the researcher is motivated to ask a research question (Step 2):* "Can a deep learning-based approach improve the detection of phishing emails compared to existing methods?" *With this question, the researcher sets up a research project (Step 3), collecting a large dataset of phishing and legitimate emails, extracting features, and designing a neural network model. Through training and testing, the model learns to distinguish phishing emails with greater accuracy. The result or answer (Step 4) is a high-performing AI-driven phishing detection system that significantly outperforms traditional filters.*
This outcome not only solves the initial problem but also contributes to the advancement of cybersecurity research, showcasing how a structured research cycle leads from a real-world issue to an impactful technological solution.

1.3 Engineering Research:

Engineering research, is a systematic and disciplined process aimed at discovering new knowledge or improving & understanding existing knowledge specifically in the field of engineering. Unlike general or purely scientific research, which often focuses on understanding fundamental principles without immediate application, engineering research is application-oriented—it is driven by real-world problems and aims to develop practical, innovative solutions that can be implemented to improve systems, technologies, or processes.

Engineering research is practical, problem-solving oriented, and closely tied to technological advancement. It combines theoretical understanding with experimentation and design to produce results that are not just informative, but usable in real-world engineering scenarios.

Example 1: Traffic Prediction using AI

A computer science engineering researcher observes that people often get stuck in unexpected traffic despite using maps. They begin a project to improve real-time traffic prediction using machine learning. By collecting data from GPS, road sensors, and past traffic patterns, they train a model that predicts congestion more accurately. This solution can be used in navigation apps. This is engineering research because it applies computing techniques to solve a real-world problem.

Example 2: Energy-Efficient Data Centers

Data centers consume huge amounts of electricity. A researcher working in computer architecture analyzes processor usage patterns and proposes a smarter task-scheduling algorithm that reduces power consumption without affecting performance. This shows engineering research focused on optimization and sustainability.

Both examples illustrate how engineering research blends scientific understanding with technical design to optimize systems and directly benefit users and industries.

1.4 Objectives of Engineering Research

The main aim of engineering research is to find new and important problems and work on solving them, even if the final answer is not clear from the beginning. Researchers often start with an idea or guess based on experience or evidence and then test it through careful study. Some of the important objectives of engineering research are listed below.

S.No	Objective	Explanation
1	Innovation and Advancement	Developing new ideas, technologies, or methods to go beyond current knowledge and improve engineering fields.
2	Problem Solving	Finding practical and effective solutions to real-world problems using engineering knowledge.
3	Optimization	Making existing systems or products more efficient, cost-effective, and eco-friendly.
4	Knowledge Expansion	Understanding engineering topics better through study, experiments, and sharing results.
5	Interdisciplinary Collaboration	Working together with experts from other fields to solve complex and wide-ranging problems.
6	Education and Training	Helping students and engineers learn by sharing research findings through publications, teaching, and conferences.
7	Technological Transfer	Turning research results into useful tools, products, or services that can be used in real life by industries or the public.
8	Societal Impact	Improving daily life by addressing issues like infrastructure, healthcare, and sustainability through engineering solutions.
9	Quality and Safety Improvement	Enhancing the safety and quality of engineering systems and products, especially in sensitive areas like healthcare and transport.
10	Addressing Global Challenges	Solving worldwide problems such as climate change, public health crises, and resource shortages through innovative engineering research.

1.5 Motivation in Engineering Research.

Motivation is the driving force behind engineering research. It inspires researchers to explore new ideas, solve real-world problems, and contribute to the growth of knowledge and technology. People get motivated for different reasons, and these reasons are usually grouped into three types: intrinsic, extrinsic, or a mix of both.

Intrinsic motivation comes from within a person. It means doing research because you genuinely enjoy it, are curious, or want to learn and grow. You are not expecting any reward or recognition—you simply find the work interesting and satisfying. For example, a student who loves robotics may do research to improve robot functions purely out of personal passion.

Extrinsic motivation comes from outside influences, such as rewards, recognition, money, or job promotions. In this case, the researcher may not be deeply interested in the topic but is motivated by what they can gain from it. For example, someone may work on a research project just to get a promotion or to win a prize.

Mixed motivation is a combination of both intrinsic and extrinsic factors. A person may truly enjoy the research topic but is also influenced by rewards, career goals, or social appreciation. For instance, a researcher might work on a government-funded AI project because they are both passionate about artificial intelligence and want to gain recognition or career benefits from their work.

Intrinsic Motivation		
Motivating Factor	**Explanation**	**Example**
Curiosity and Intellectual Interest	A strong desire to learn and understand how things work.	A researcher explores solar energy systems out of curiosity and develops efficient solar panels.
Personal Fulfillment	Research gives a sense of satisfaction, joy, or personal growth.	An engineer works on environmental solutions to feel useful and fulfilled.
Passion for Technology	A deep interest and enjoyment in working with technology.	A student passionate about robotics builds smarter autonomous robots.

Extrinsic Motivation		
Motivating Factor	**Explanation**	**Example**
Career Development	Research helps in getting jobs, promotions, fame, and success.	A researcher files a patent and earns recognition, boosting their career.
Competitive Drive	Desire to stay ahead of others or be the best in the field.	A professor publishes faster to compete with colleagues from other institutes.
Influence from Others	Being motivated by what friends, peers, or rivals are doing.	A student starts a research project because their friends are doing well in that area.
Terms of Employment	Doing research because of job requirements, salary, or promotions.	An engineer does research to fulfill promotion criteria or to maintain job security.

Mixed Motivation		
Motivating Factor	**Explanation**	**Example**
Doing Better Than the World	Motivated by inner desire to excel and also gain external recognition.	A researcher tries to beat existing AI models to set a new standard and gain fame.
Improving the State of the Art	A personal drive to innovate, along with industry or public recognition.	An engineer improves encryption methods to push technology forward and gain industry respect.
Contributing to Society	A blend of purpose-driven work and social/official appreciation.	Designing affordable medical devices to help society while receiving awards or media attention.
Fulfilling Historical Legacy	Inspired by cultural roots and expectations from society.	A researcher continues family legacy in education while also gaining social honor.
Government Directives & Funding	Attracted by financial support but also aligned with personal research interest.	Working on a government-funded green energy project that also matches the researcher's passion.

1.6 Types of Engineering Research

Research may be classified into different types to better suit the purpose, approach, and outcome of the investigation. Each type serves a specific goal, whether it's to describe a situation, solve a problem, or build new knowledge. This classification helps researchers choose the right method and tools based on the nature of the question. The following are broad classification of research with live example.

1. Descriptive versus Analytical Research

Descriptive research is used to describe the features or conditions of a particular topic without changing or controlling anything. It helps us understand the current situation by collecting facts and reporting them as they are.

For example, if a researcher is studying student usage of online learning platforms in computer science, they may collect data on how many students use Coursera, NPTEL, or edX, how many hours they spend on each, and which features they use most. This is descriptive research because it shows the present usage pattern without explaining the reasons.

On the other hand, analytical research is used to examine data in detail to understand the causes behind a particular outcome. The same researcher may now look into why students prefer one platform over another. They may analyze how platform speed, content quality, or ease of use affects student satisfaction. This research involves comparisons and drawing conclusions based on existing data. So, while descriptive research answers "What is happening?", analytical research answers "Why is it happening?"

2. Applied versus Fundamental Research

Applied research focuses on solving specific real-world problems. In our example, the researcher may design a course recommendation system that helps students choose the best online courses based on their interests and past behavior. This research has a direct use and can be applied to improve the student learning experience.

Fundamental research, also called basic or pure research, is done to gain deeper theoretical understanding without immediate practical application. In the same topic, the researcher might study how different recommendation algorithms behave under varying conditions—like collaborative filtering vs. content-based filtering—just to better understand how they work. This research may not be used right away but can support future innovations in learning technologies.

3. Quantitative versus Qualitative Research

Quantitative research involves collecting and analyzing numerical data. It is used to find patterns or relationships using statistics. In the context of online learning platforms, the researcher might conduct a survey where students rate their satisfaction from 1 to 5. The researcher then calculates average scores, identifies trends, and uses graphs to present the findings. This is a clear example of quantitative research.

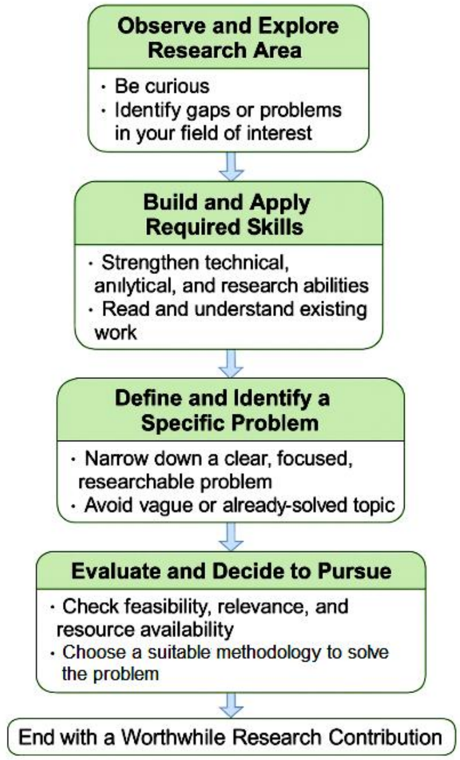
Qualitative research, on the other hand, focuses on collecting descriptive and non-numerical information. Here, the researcher might interview students to understand their personal experiences, challenges, and preferences while using online learning platforms. This type of research provides deep insights into the human side of learning and is helpful for understanding behavior, motivation, and feelings that numbers alone can't show.

The following table briefly summarizes the above.

Type of Research	Purpose	What It Does	Example
Descriptive	To describe a situation or behavior	Observes and records what is happening without explaining why	Tracking how many students use each online platform
Analytical	To understand reasons or causes	Analyzes data to explain why something is happening	Studying why students prefer one platform over another
Applied	To solve real-world problems	Develops practical solutions or tools	Creating a course recommendation system
Fundamental (Basic)	To gain deep theoretical knowledge	Builds understanding without immediate practical use	Studying how recommendation algorithms behave under different data types
Quantitative	To collect and analyze numerical data	Uses numbers, measurements, and statistics	Surveying students' satisfaction scores and analyzing them with charts
Qualitative	To explore experiences and opinions	Gathers detailed feedback using words, interviews, or open-ended questions	Interviewing students about their learning experience on different platforms

1.7 Finding and Solving a Worthwhile Problem

The journey of research begins with curiosity, grows through skills and observation, and results in real solutions through structured methods. The following represent some of the major steps followed to find and solve a worthwhile problem.



1. Observe and Explore Research Area

Finding a research problem is the starting point of any research activity. It involves noticing a gap, challenge, or inefficiency in the current systems, technology, or knowledge. A good research problem is one that is not fully solved and is important to users, industry, or society. This step often starts with observations, curiosity, and asking questions about how things can be improved.

Example: A computer science student notices that many students face issues finding relevant courses on online learning platforms. They wonder, "Why can't the system suggest courses based on the student's interests automatically?" This curiosity leads to a possible research problem.

2. Build & Apply Required Skills

To find and solve a research problem, a researcher needs a mix of technical, analytical, and soft skills. Important skills include critical thinking, creativity, technical knowledge of the subject, communication, and perseverance. The ability to read existing research, ask the right questions, and break down complex problems is essential.

Example: The student who identified the issue with course recommendations now needs to learn about machine learning algorithms, analyze user data, and communicate ideas clearly to begin building a solution.

3. Define & Identify a Specific Problem

Once the area of interest is selected, the next step is to narrow it down to a specific and manageable research problem. This means defining the scope of the problem clearly so that it can be solved within available time and resources. It also involves studying existing solutions to avoid duplicating efforts.

Example: The student defines the problem more clearly: "How can we use a student's past learning behavior to suggest the most suitable online course in real-time?"

4. Evaluate & Decide to Pursue

A worthwhile research problem should have the following characteristics:

- It should be original or innovative (not a copy of past work)
- It should be challenging but solvable
- It should have practical value or impact
- It should be based on clear objectives
- It should be researchable with available tools and methods

Example: The course recommendation system problem is worthwhile because it's useful for thousands of students, hasn't been fully solved in a personalized way, and can be approached using available AI techniques.

After identifying a problem, the researcher must decide whether or not to pursue it, based on interest, feasibility, available time, resources, and guidance. It's important to consider if the problem is within the researcher's ability and scope to address.

Example: The student checks if enough data is available, if they have the programming skills, and if they can complete it within a semester. After confirming, they decide to go ahead with the research.

Once the problem is chosen, the next step is to follow a research methodology, which is a step-by-step process used to solve the problem scientifically. This includes:

- Reviewing existing literature
- Forming hypotheses
- Collecting and analyzing data
- Designing and testing solutions
- Drawing conclusions and reporting findings

Example: The student begins by reading research papers on recommendation algorithms, collects user data from an online platform, trains a machine learning model, tests it for accuracy, and finally documents the results in a report or thesis.

1.8 Polya's Approach:

George Pólya (1887–1985) was a Hungarian mathematician known for his work in problem-solving and mathematical thinking. He proposed a four-step approach to solving problems: Understand, Explore, Implement, and Reflect. His method helps break complex problems into manageable steps. It is widely used in mathematics, science, and engineering research today.

1. Understand the Problem

First, make sure you really understand what the problem is about. Try to explain it in your own words. If needed, draw a diagram or note down important points. Ask yourself: *What exactly is being asked? Do I have all the information I need?*

Example: If you're trying to design a program to detect fake news, make sure you understand what fake news is, how it behaves, and what kind of data you have.

2. Explore Strategies

Next, think of different ways to solve the problem. Look for patterns, similar problems you've solved before, or methods that might work. Don't just jump into the first idea—consider your options.

Example: You might think about using a machine learning model, a keyword-matching system, or a combination of both to detect fake news.

3. Implement the Plan

Choose the best strategy and try it out. Start building your solution and see if it works. If it doesn't, don't worry—go back, try another plan, and keep improving. Trial and error is part of the process.
Example: You decide to implement a machine learning algorithm. If it doesn't give good results, you try improving the training data or testing another algorithm.

4. Reflect and Learn

Once you've solved the problem (or tried your best), take time to look back. What worked? What didn't? What could be improved next time? This reflection helps you grow and solve future problems better.
Example: After completing your fake news detector, you evaluate the results and think about how you could improve accuracy or make the system faster.

1.9 Ethics in Engineering Research

Ethics in engineering research is essential because it ensures that the work done by researchers is trustworthy, respectful, and responsible. Ethical research protects the rights, safety, and dignity of all participants, especially in studies involving human subjects. It also helps maintain the integrity and credibility of scientific knowledge by discouraging practices like plagiarism, data falsification, and fabrication. Without ethical guidelines, research outcomes could be misleading or even harmful to society, technology, and the environment.
Moreover, ethics promotes fairness in recognition and collaboration, making sure that all contributors are properly credited and that competitive pressure doesn't lead to dishonest behavior. In today's world, where engineering research often involves sensitive data, AI, human interaction, or environmental impact, following ethical standards is more important than ever. It helps researchers make decisions that are not only technically correct but also socially and morally sound, ensuring that research serves the greater good.
In short, ethics is the foundation that builds trust between researchers, society, and the scientific community, and it is vital for sustainable progress in engineering and technology.
The importance of ethics in research has a strong historical background. One of the key milestones was the Nuremberg Code established in 1947, after World War II. This code was a response to unethical human experiments carried out by Nazi doctors. It laid down principles like informed consent, which means that people involved in research must agree to participate voluntarily and fully understand the risks. Another major influence was the British Royal Society, formed in the 1600s, which helped set standards for giving credit to researchers. It introduced the idea that the first to publish findings should be given priority, helping to maintain fairness in recognition and publication. These historical events highlight how ethical thinking has developed over time to ensure research is carried out with honesty, respect, and responsibility.

1.10 Differences between Research Ethics and Responsible Conduct of Research (RCR):

In engineering research, it's important to understand the difference between research ethics and responsible conduct of research (RCR), even though they are closely related.
Research ethics refers to the moral rules that guide the outcome and impact of research. It ensures that the research is fair, honest, respectful, and considers how the results might affect people or society.
For example, when developing autonomous (driverless) cars, research ethics involves asking important questions such as: Are we designing this technology safely? Could it be misused? Are we protecting people’s lives and rights? These are ethical concerns about how the final product will be used in the real world.
On the other hand, responsible conduct of research is about how the research work is carried out from start to finish. It focuses on integrity during the research process, such as avoiding data manipulation, giving proper credit to team members, managing projects honestly, and collaborating ethically.
In the same driverless car project, responsible conduct means: Are the researchers working with cyber security experts to avoid hacking? Are they openly sharing risks with the public and authorities? Are all contributors being acknowledged fairly?
In short, research ethics is about doing the right thing with the results, while RCR is about doing the right thing while conducting the research. Both are essential for building public trust, ensuring safety, and advancing engineering in a way that benefits society responsibly.

1.11 Ethics in Engineering Research Practice:

Ethics in engineering research is not limited to the lab or academic settings—it also plays a major role when engineers apply their knowledge to real-world technologies. Engineering researchers have a responsibility to ensure that the technologies they develop are used in ways that are safe, fair, and respectful of people's rights. This includes being careful about privacy, safety, and long-term impact on society. Ethical awareness helps guide the design, development, and decision-making process in technology. It includes the following aspects.

i) Ethical Concerns in Technological Developments:

As technology grows, ethical concerns like data privacy and surveillance become more important. Computer science engineers must protect users' personal data and get clear consent before using it.
For example, a traffic app using location data should not share it with advertisers without permission. Even convenient tools like facial recognition can raise issues if they are biased or inaccurate. Ethical practices help ensure technology is fair, safe, and respects user rights.

ii.) Ethical Decision-Making in Technological Choices:

Engineering research involves making key decisions that affect how technology will function in the real world. These decisions should always be guided by ethical thinking from the very beginning. Engineers can ensure ethical practices by setting rules, designing responsibly, and selecting the best alternatives. At the start, they can set ethical requirements to protect users.
For example, voice assistants like Alexa should only record when activated, ensuring privacy. During development, they can influence the design by prioritizing features that protect people—like adding automatic braking in AI-based driving systems. When choosing between options, they should go for the one with the least harm—such as using secure, encrypted cloud storage

over cheaper, less safe options. These choices help build trustworthy and responsible technologies.

iii) Minimizing Unintended Consequences

Even well-planned technologies can sometimes cause unexpected problems. It's the engineer's ethical responsibility to think ahead and reduce these risks by using safe designs, backup systems, and careful planning. This helps protect both users and society.

Example: A team creates a machine learning program to help with hiring. If the data it learns from is biased, it might unfairly favor certain groups. To act ethically, the team should check for bias early, use fair data, and let humans review decisions to make sure everyone is treated equally.

1.12 Types of Research Misconduct:

In engineering research, maintaining honesty, fairness, and integrity is essential. The goal is to create useful and reliable technologies that advance society. However, when researchers behave unethically or break the rules of good scientific conduct, it is called research misconduct.

This includes actions like making up data, changing results dishonestly, copying others' work without credit, and violating publication rules. These actions can damage trust, mislead future research, and delay progress. The following represent some of the common types of research misconduct.

1. Fabrication

Fabrication is when a researcher makes up or invents data or results that were never actually observed or tested. This is a serious violation of research ethics because it presents false findings as if they are true.

Example: Suppose a computer science student is working on a project that involves testing the performance of a new data compression algorithm. Due to lack of time or pressure from deadlines, they skip the actual testing and instead write fake results showing their algorithm is faster and more efficient.

Side Effects: This type of misconduct leads to false knowledge being published, which may mislead other researchers, waste resources, and slow down real progress. It also harms the reputation of the researcher and the institution, and makes it harder for honest work to stand out.

2. Falsification

Falsification involves changing, modifying, or misrepresenting data or results to fit the desired conclusion, even though the original data says something different. This includes altering figures, code, or results in a way that hides the truth.

Example: Imagine a researcher tests a machine learning model for spam detection and the model performs poorly. But to make the results look good, they adjust the output to show higher accuracy than what was actually achieved.

Side Effects: Falsification damages the trust others place in published work. It results in incorrect findings, which may be cited by others and spread errors across the research community. It also leads to wasted time and money trying to build on unreliable data.

3. Plagiarism

Plagiarism means copying someone else's words, code, ideas, or research without giving them proper credit. It includes using published content, figures, or even your own previously submitted work (self-plagiarism) without citation.

Example: A student working on a research paper copies several paragraphs from an online article on cloud computing but does not cite the source. Or, they reuse their old assignment from a previous semester without mentioning it's reused work.
Side Effects: Plagiarism violates intellectual honesty, and if discovered, can lead to academic penalties, damaged reputation, and rejection of papers or projects. It also disrespects the original author's work and discourages genuine innovation.

4. Deception and Fraud

Deception and fraud refer to intentionally misleading others by engaging in dishonest research practices. This includes actions like submitting the same paper to multiple journals, hiding mistakes, or claiming credit for someone else's work.
Example: A researcher submits the same AI paper to two journals at once to increase chances of publication, which is against publication rules. Or, if a developer finds a serious bug in their published app but hides it from users and reviewers to avoid criticism.
Side Effects: Fraudulent actions undermine trust in the research community, create publication barriers for others, and can cause long-term damage to both the researcher's career and public trust in science. If errors remain uncorrected, they continue to mislead future work.

1.13 Ethical Issues Related to Authorship.

Unethical authorship practices, though sometimes done with good intentions, can lead to serious consequences. Honest and fair recognition is essential for maintaining trust, responsibility, and respect in engineering and academic research. The following represent some of the common ethical issues related to authorship.

1. Gift or Guest Authorship

Gift or guest authorship happens when someone is listed as a coauthor on a research paper even though they did not make any real contribution to the work. This practice gives credit to someone who hasn't earned it, which is unfair to those who actually did the work. It can mislead readers about who is responsible for the content and weakens the value of true authorship. For example, adding a professor's name to a student's software development paper just to impress others can harm the credibility of both the research and the people involved.

2. Career-Boost Authorship

Career-boost authorship involves adding someone—usually a junior researcher or student—as a coauthor simply to help them get a job or promotion, even if their contribution was minimal. While it may seem helpful, it distorts the record of who did what, leading to unfair academic advantages and damaging the trust others place in the publication. For instance, if a faculty member includes a student on a published AI research paper despite minimal involvement, it sends the wrong message about merit and fairness.

3. Career-Preservation Authorship

This occurs when a researcher includes department heads or other senior figures as coauthors to maintain a good relationship or receive favors in return. This is problematic because it gives authorship credit to someone who didn't contribute meaningfully, which reduces transparency and fairness. For example, listing the dean as a coauthor on a research paper about data privacy without their involvement can lead to biased recognition and reward systems within institutions.

4. Ghost Coauthorship

Ghost coauthorship is when someone who contributed significantly to the research is left out of the author list, often due to internal conflicts or personal interests. This hides their involvement and can affect the accuracy and integrity of the published work. For example, if a researcher helps write most of a machine learning paper but is excluded because of workplace politics, readers may never know about their contribution or reach out for clarification, limiting the transparency of the study.

5. Reciprocal Authorship

In reciprocal authorship, two researchers agree to include each other as coauthors on their papers, even with little or no real collaboration. This can inflate their publication records dishonestly and damage the credibility of their research. For instance, if two engineers working on unrelated topics add each other's names to boost their CVs, it undermines the value of authorship and leads to inflated reputations not based on merit.

6. Misrepresentation of Sole Authorship

Some authors wrongly present their work as being done entirely by themselves, even when others played important roles. By doing so, they take full credit and only mention collaborators in the acknowledgments. This misleads readers and fails to properly recognize those who contributed. For example, if a student writes a paper on app security using another teammate's analysis but claims sole authorship, it creates confusion and denies the teammate their rightful credit.

7. Authorial Accountability

All authors listed on a paper are responsible for the content and should be aware of and agree to the submission. Problems arise when one author commits misconduct, such as falsifying data, and the others are unaware. Without clear communication and defined roles, it's hard to know who is accountable. This can harm innocent coauthors and affect everyone's reputation, especially in group projects like developing new software tools or AI models.

8. Double Submission

Double submission refers to submitting the same research paper to two different journals at the same time. While some do this to speed up publication, it violates journal policies and wastes reviewers' and editors' time. It also risks both journals rejecting the paper, which affects the researcher's credibility. For example, submitting a cloud computing research article to two conferences simultaneously can lead to blacklisting from both, harming the author's publication record.

Brief summary:

Type	Description	Example	Impact
Gift Authorship	Adding someone who didn't contribute	Adding a professor to a student's app project	Unfair credit, misleads readers
Career-Boost Authorship	Listing juniors to help their career	Including a student with minimal input on an AI paper	Distorts academic record
Career-Preservation	Adding seniors for favors or good relations	Including dean in a data privacy paper for future support	Biased recognition, lack of fairness
Ghost Authorship	Leaving out someone who contributed	Excluding a teammate who wrote most of an ML paper	Hides true contributors, reduces transparency
Reciprocal Authorship	Mutual inclusion without real collaboration	Two researchers list each other on unrelated papers	Inflated reputation, undermines credibility
Misrepresented Sole Authorship.	Claiming full credit despite major help	Student uses teammate's work but claims full authorship	Denies credit to real contributors
Authorial Accountability	All authors must agree and share responsibility	One author falsifies data; others unaware	Blame shared, harms innocent coauthors
Double Submission	Submitting the same paper to multiple journals	Sending same cloud computing paper to two conferences	Wastes time, damages publishing reputation

QUESTION BANK.

5-Marks Questions

1. Define engineering research. How is it different from scientific research? Give one example.
2. Explain intrinsic and extrinsic motivation in engineering research with suitable examples.
3. Briefly describe the four steps in Polya's problem-solving methodology.
4. Differentiate between research ethics and responsible conduct of research with one example.
5. What is fabrication in research misconduct? Explain with an example and its impact.
6. List and explain any two ethical issues related to authorship in research.
7. Explain descriptive and analytical research with a common computer science example.
8. Why is it important to identify and solve a worthwhile research problem?
9. What are the main objectives of engineering research? Write any four.
10. What is plagiarism? How can it affect the credibility of research?

10-Marks Questions

1. Explain the research cycle in engineering research with two live examples from computer science.
2. Discuss the various types of engineering research: descriptive vs analytical, applied vs fundamental, quantitative vs qualitative with examples.
3. Describe the concept of motivation in engineering research. Compare intrinsic, extrinsic, and mixed motivations with examples.
4. What are the key ethical issues in engineering research practice? Explain with suitable examples from technology development.
5. Discuss the common types of research misconduct (fabrication, falsification, plagiarism, deception). Explain each with a computer science-related example.
6. Elaborate on the ethical issues related to authorship. Explain at least five unethical practices with examples.
7. Explain the step-by-step process of identifying and solving a worthwhile research problem. Illustrate with a live example from online education platforms.
8. Write a detailed note on the historical background and significance of ethics in engineering research.
9. Describe the importance of intellectual property (IP) in research. How does it benefit engineers and society?
10. With reference to Polya's approach, explain how researchers can effectively tackle complex engineering problems.

MODULE-02 LITERATURE REVIEW

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.*

2.0 Introduction

A literature review and technical reading are essential in research because they help a researcher understand what has already been studied, identify gaps, and build a strong foundation for new work. By reviewing existing studies, a researcher avoids repeating past mistakes, ensures their work is original, and learns the best methods to apply.

Technical reading sharpens the ability to extract useful information from complex research papers, datasheets, and algorithms, which is necessary to understand the state-of-the-art technologies in the field.

For example, in computer science engineering, a student developing a new machine learning algorithm must first review previous models, analyze their strengths and weaknesses, and read technical papers carefully to decide which techniques can be improved. Without this process, the research may lack direction, be less credible, and fail to contribute something meaningful.

2.1 New and Existing Knowledge

Existing knowledge: It is the foundation on which all research is built. It includes the theories, methods, and findings already available in a field, and its significance lies in preventing researchers from repeating what has already been done while guiding them to focus on unexplored areas.

New research is always built on what is already known. Without existing knowledge, new ideas have no foundation. By understanding existing knowledge, researchers achieve the objective of identifying gaps, selecting appropriate methods, and ensuring their work is aligned with the current state of the field.

Its scope is broad, covering textbooks, published research papers, patents, and technical documentation that together form a reliable base for any new study. The necessity of existing knowledge is clear—without it, research would lack direction, risk duplication, and fail to gain credibility.

For example, a researcher studying online education must first review existing platforms like Coursera, edX, and Udemy to understand their features, usability, and limitations.

New Knowledge: It is the original contribution a researcher makes to advance the field. Its significance lies in creating progress—solving problems, improving current technologies, and opening new opportunities for development. The objective of producing new knowledge is to address gaps identified in existing work, develop innovative ideas, and offer practical solutions that benefit both academia and society.

Its scope includes any novel theories, models, methods, or technologies that did not exist before. The necessity of generating new knowledge is critical because, without innovation, fields like computer science would stagnate.

For instance, after analyzing current online education platforms, the same researcher may develop an AI-based system that personalizes course recommendations based on each student's learning pace and performance.

2.2 Analysis and Synthesis of Prior Art:

Analysis: It involves carefully examining each collected source—such as research papers, patents, or technical reports—to find important ideas, methods, and results. The goal is to understand the main hypothesis, models, and experimental setups, and then compare them to identify strengths, weaknesses, and patterns.

For example, a computer science student researching image compression techniques would review existing algorithms, see which perform best for high-resolution images, and note issues like quality loss for larger files.

A critical mindset is important here—claims that seem too perfect, like an algorithm claiming 100% spam detection accuracy, must be verified by checking datasets, methods, and references. Evaluating the reliability of each source (author's credentials, references, and journal quality) ensures that only trustworthy information is used.

Synthesis: It comes after analysis and focuses on combining the insights from multiple sources to see the bigger picture. This step helps identify gaps, unresolved problems, or areas for improvement.

For example, after comparing several image compression methods, the same student might realize that none are optimized for streaming applications, creating an opportunity to develop a new solution.

Synthesis also means organizing sources by categories or topics, making connections, and understanding how different studies build on each other.

By analyzing carefully and synthesizing results, researchers identify opportunities for innovation while building a strong foundation for their own work.

2.3 Bibliographic Databases:

Bibliographic databases are specialized collections that provide indexing and summaries (abstracts) of research articles from scholarly sources. They help researchers quickly find citation details and brief descriptions of published studies, saving time and effort during a literature search. However, depending on only one database can limit the quality of research because each database has its own strengths and weaknesses. To get comprehensive results, researchers should search across multiple databases instead of relying on just one.

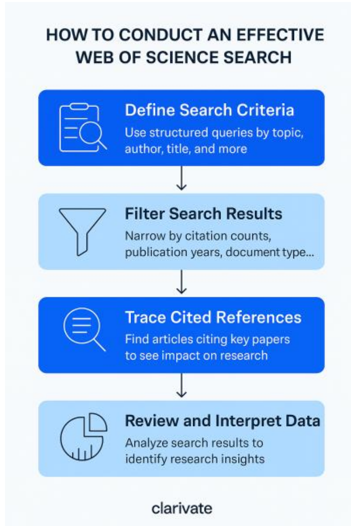
Example: A computer science student working on artificial intelligence might use IEEE Xplore to find technical papers, Scopus for broader citations, and Google Scholar for quick searches.

By combining these sources, the student ensures they gather a wider and more reliable set of articles rather than missing important studies that might not appear in a single database.

2.4 Web of Science

Web of Science is a widely used research platform (formerly called ISI or Thomson Reuters) that provides access to multiple scholarly databases and advanced search tools. It is typically available through institutional subscriptions and helps researchers locate academic materials on specific topics by allowing searches through fields such as title, topic, author, or institution using a dropdown menu.

Users can refine their searches by adding keywords, placing phrases in quotation marks, or using filters like date, language, type of material (e.g., peer-reviewed journals), and citation count. One of its valuable features is the *"Cited Reference Search,"* which enables researchers to track articles that have cited an earlier publication, making it easier to see how an idea has been used, modified, or extended over time. The process involved in web science search is illustrated in the following flow chart.



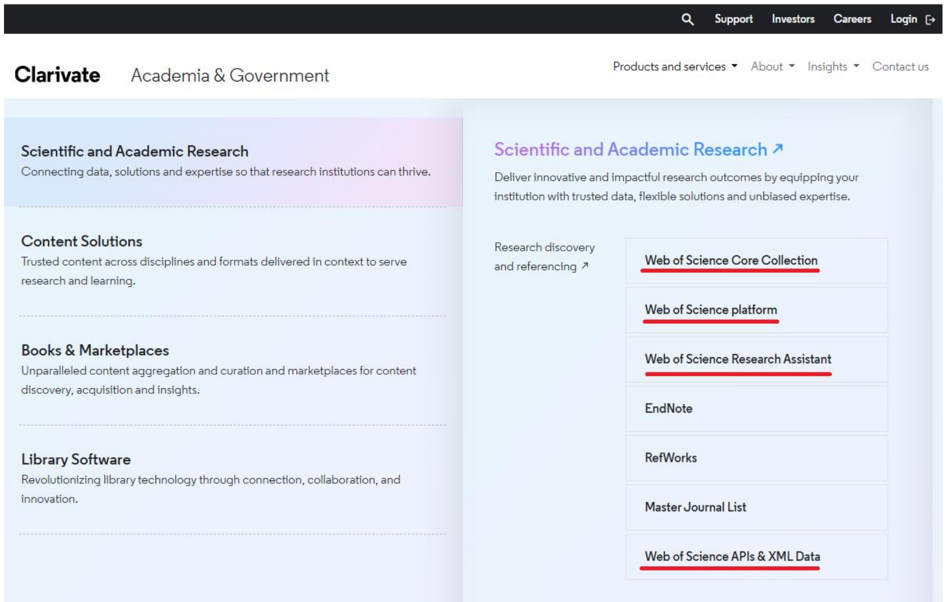
For example, a computer science student studying blockchain applications in cybersecurity could use Web of Science to find all articles on this topic, sort them by the number of citations to identify the most influential studies, and narrow results to recent peer-reviewed journals published in the last five years.

Each search result provides key details like the paper's title, authors, journal name, volume, issue, publication year, keywords, and an abstract. This allows the student to quickly decide whether downloading the full paper is worthwhile. By using structured search options and refinement tools, Web of Science ensures that the researcher spends time only on the most relevant and high-quality sources.

The following link may be used for referring web science platform managed by Clarivate

https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/

Web of Science is a widely respected research platform, but it has some limitations. It requires a paid institutional subscription, making it inaccessible to individuals without university or organizational support. Its coverage focuses mainly on journals indexed by Clarivate, which means some newer, regional, or open-access publications may be excluded, potentially limiting the diversity of available research.



2.5 Google and Google Scholar:

Google is often a good starting point for general searches because it provides quick access to a wide range of freely available information, such as reports from government agencies, organizations, or companies. However, it has major limitations—it searches the entire internet without quality control, so the reliability of results is uncertain. Additionally, it offers only basic search and filtering options, making it harder to narrow down to the most relevant academic sources.

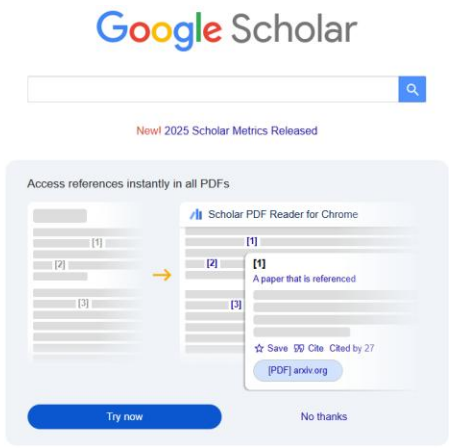
Google Scholar is a free and widely accessible tool that helps researchers find scholarly articles, theses, and conference papers across many disciplines. It allows users to track citations, see how often a paper has been referenced, and quickly access related studies. Many times, it also links to free PDF versions of pay walled articles, saving costs. Features like author profiles, citation export in multiple formats, alerts for new research, and the ability to save and organize articles make it useful for managing references. Additionally, it covers materials from different countries and languages, giving researchers a broad view of global academic work.

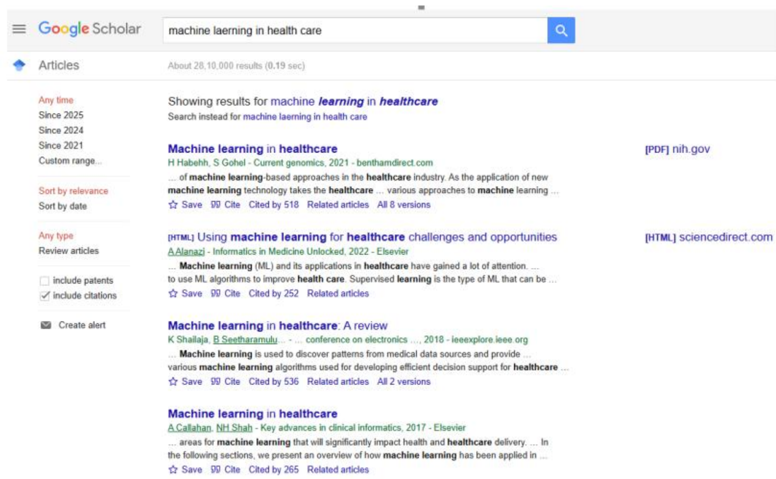
Still, it also has its drawbacks. Some items may appear academic but are not reliable sources, and not all publishers allow their content to be indexed, which means the database is not fully comprehensive. Its search refinement tools are limited compared to specialized academic databases

For best outcomes, researchers should not rely only on Google or Google Scholar. Academic databases like IEEE Xplore, Scopus, or PubMed offer higher-quality and more precise results because they include peer-reviewed materials, better filtering tools, and subject-specific indexing.

Example: *A computer science student researching machine learning in healthcare may start with Google to find government health reports and public datasets, then use Google Scholar to locate related scholarly articles, and finally move to IEEE Xplore to find peer-reviewed technical studies for accurate and in-depth information.*

https://scholar.google.com/





2.6 Effective Search the Way Forward:

Conducting an effective search is a vital step in any research process, especially in technical fields like engineering. Scholarly publications—such as peer-reviewed journal articles and academic books—are trusted sources written by experts and meant for researchers and students. These works include references and undergo review for accuracy.

For example, a computer science student exploring artificial intelligence should refer to journals like IEEE or Springer for reliable information.

However, useful content can also come from informal sources like blogs, magazines, or company reports, which provide insights into current trends. A student might read a tech blog to learn about the latest AI tools before diving into academic papers for deeper understanding.

Searching effectively requires multiple steps. Researchers must try different keywords and combinations, apply search filters (like date, author, or publication), and refine their search strategies. A good habit is to check the references in a useful article to find other relevant sources.

For example, if a paper on neural networks cites several foundational papers, following those citations can expand your understanding of the topic.

Not all valuable information is online—some may be in print or delayed in publication. Once the search is complete, researchers must critically read, compare ideas, and identify knowledge gaps. Literature review is not a one-time task—it continues throughout the project. As new studies emerge or understanding deepens, more searching may be needed. Ultimately, effective searching and reading lay the foundation for producing strong, original research.

2.7 Introduction to Technical Reading

Reading technical research papers—especially in engineering—is very different from reading news articles or casual blog posts. Since only a few of the available research papers are directly relevant to any one researcher, it's important to read efficiently and with a clear purpose. Below is a step-by-step strategy to make technical reading more effective:

Step 1: Choose the Right Sources

Start by identifying trusted sources such as peer-reviewed journals, conference proceedings, or books from reputed publishers like IEEE, Springer, or Elsevier. Avoid random blogs or unverified articles from the internet. For example, a computer science student researching blockchain should first look into journals like *IEEE Transactions on Computers*.

Step 2: Skim the Title and Keywords

Look at the paper's title and keywords. If these terms don't seem relevant or interesting to your topic, it's best not to spend time on that paper.

Step 3: Read the Abstract

If the title and keywords look promising, the next step is to read the abstract. This short summary gives a quick idea about the research question, methods, and results. If it still seems useful, continue reading.

Step 4: Check the Conclusion

Before going into full detail, jump to the conclusion. This helps to understand what the authors ultimately found and whether their results matter to your topic. If the findings relate to your research interest, proceed further.

Step 5: Review Figures, Tables, and Captions

Quickly scan the paper's figures, tables, and their captions. These visuals can provide a broad understanding of the data and experiments without reading the entire text. For instance, a machine learning paper might show accuracy comparisons between models, which can help you decide its relevance.

Step 6: Read the Introduction

Now read the introduction to understand the background, the problem being solved, and why this study was done. This section often connects the study with existing work in the field.

Step 7: Focus on Results and Discussion

This is the heart of the paper. Understand what was found and how the authors interpreted their findings. If this section is strong, the paper is likely very useful.

Step 8: Dive into Methods (Optional)

Only if you need detailed insight into how the work was done—for example, to replicate or expand upon the study—should you read the methodology section in depth.

Step 9: Keep Reading Regularly

As a researcher, stay updated by regularly scanning new papers. If you are working on a small project, your guide or supervisor may suggest one or two key papers. But for bigger projects, you'll need to search and manage your own reading list using this strategy.

Summary:

Step	Action	Purpose	Example
1	Choose trusted sources	Ensure information is credible and peer-reviewed	Use IEEE, Springer, Elsevier—not random web articles
2	Skim title and keywords	Quickly judge topic relevance	"Blockchain in supply chain" catches your interest
3	Read the abstract	Get an overview of the paper's goals and methods	Summary mentions smart contracts—continue reading
4	Check the conclusion	Understand final results and their value	Conclusion says 30% improvement in speed—relevant to you
5	Review figures, tables, captions	Grasp core data and trends quickly	Accuracy chart compares models visually
6	Read the introduction	Understand background, problem, and motivation	Shows what gap in research the paper addresses
7	Focus on results and discussion	Analyze findings and their interpretation	Explains why their model outperforms others

Step	Action	Purpose	Example
8	Read methods section (optional)	Learn detailed implementation (if needed)	Review training setup if replicating an ML model
9	Stay updated and repeat the process	Keep pace with evolving literature	Use alerts or regular searches to track new papers

2.8 Conceptualizing Research

Creating a strong research objective is one of the most important and challenging parts of doing research. A good research goal must aim to generate new knowledge that is original, meaningful, and accepted by other experts in the field. It should not only be interesting but also practical and solvable using available tools, techniques, and methods.

To create such a research objective, a researcher must already understand what has been done before—that means reading a lot of existing research papers, journals, and books. In fact, by the time a researcher is ready to define a proper research objective, they have already become very knowledgeable, almost like an expert at the edge of the subject.

For example, imagine a student in computer science who wants to work on improving face recognition algorithms. They can't simply start building something new—they need to understand what techniques already exist, such as convolutional neural networks (CNNs), and what limitations those methods have (like bias or poor accuracy in low light). Only then can they clearly identify a significant problem (e.g., poor recognition in real-time video), collect relevant knowledge to solve it, and finally propose a new solution (perhaps using a hybrid model combining CNNs with transformers). This is the process of conceptualizing a research idea.

However, not all research is large-scale like a Ph.D. project. For smaller projects (like a semester research assignment), students might not have the time or resources to become experts on their own. In such cases, guidance from a supervisor or an experienced researcher becomes important. Supervisors can quickly suggest the key papers or problems worth working on, saving students a lot of time and helping them focus their efforts.

In short, to conceptualize meaningful research, it must combine three things:

i. A relevant problem,
ii. The required knowledge to address it, and
iii. A clear approach or method.

And the best way to develop this understanding is by consistently reading and exploring the literature in the chosen field.

2.9 Critical and Creative Reading:

Reading a research paper is not just about accepting whatever the authors have written—it's about reading with a questioning mind. A good researcher must be critical, always asking:

Did the authors solve the right problem? Are there simpler or better solutions they missed? Are the assumptions they made realistic? Is the reasoning logical, or is there a flaw?

This process is called critical reading. It involves carefully checking if the data used actually supports the conclusions, and whether the information was collected and interpreted properly.

For example, suppose you're reading a paper on a new algorithm for detecting fake news using AI. As a critical reader, you would question whether the dataset used is balanced (covering all types of fake and real news), whether the evaluation metrics were fair (like accuracy or F1-score), and whether there are biases or assumptions that limit its application. You might even discover that the authors didn't test the algorithm in real-world scenarios, which is a major gap.

While it's often easy to find flaws or mistakes in a paper, it is much harder to do creative reading. Creative reading is about going beyond what is written. Instead of just finding problems, you ask:

What more can be done with this work? Can this method be applied in another area? Can I modify this idea to solve a different problem? This type of reading helps generate new research ideas and opens paths for innovation.

Using the same example, while reading about the fake news detection algorithm, creative thinking might lead you to consider using the model in another domain—like detecting spam emails or analyzing customer reviews for authenticity. Or you may think of extending the algorithm to work on voice data instead of text. This kind of thinking pushes research forward.

In short, critical reading helps you evaluate the quality and correctness of the paper, while creative reading helps you think of new directions and future work based on it. Both are essential for meaningful research, especially in fields like computer science, where ideas evolve quickly and innovation is key.

2.10 Taking Notes While Reading

For any researcher, good writing begins with good reading—and the key link between reading and writing is taking notes. As the saying goes, *"The faintest writing is better than the strongest memory."* This is especially true in research, where important ideas, definitions, or questions can easily be forgotten without proper notes.

While reading a research paper, it's helpful to highlight or jot down key points, definitions, technical terms, and even your doubts or criticisms. Many students write notes in the margins of printed papers or use digital tools like Mendeley, EndNote, or Zotero to annotate PDFs.

For example, suppose a computer science student is reading a paper on using machine learning to detect malware. While reading, they might note down the algorithm used (e.g., Random Forest), key features analyzed (like file size, API calls), and the dataset used. They might also note a question: *"Why was the F1-score low even with a high accuracy?"* or a criticism: *"The dataset seems outdated; maybe try a newer one."*

After reading, it's good practice to summarize the paper in a few sentences—what it aimed to do, what methods were used, and what was concluded. Then, the reader should also think critically: *Did the paper introduce a new idea, apply an existing method to a new domain, or combine different ideas in a novel way?* This kind of reflection helps in understanding the technical contribution and in comparing it with other papers in the same field.

By keeping organized notes, the researcher saves time later when writing a thesis, report, or review paper, since they already have a personalized summary and key takeaways ready. It's a habit that pays off greatly in the long run.

2.11 Reading Mathematics and Algorithms:

Mathematics plays a central role in engineering research. Many important advancements—especially in areas like artificial intelligence, cryptography, and signal processing—are built on strong mathematical foundations. For an engineering researcher, especially in computer science or electronics, it's nearly impossible to avoid dealing with mathematical formulas, derivations, or algorithms. These parts of a technical paper are not just optional extras—they're often the **core** of the paper and should not be skipped or quickly skimmed.

To understand the problem the researchers are solving, one must read the math or the algorithm step by step. This detailed reading helps in grasping how the solution works and why it was designed a certain way.

For example, if a student is reading a research paper on a new sorting algorithm, it's essential to follow how the algorithm works, what its time complexity is, and in which cases it performs better or worse than traditional methods like Merge Sort or Quick Sort.

Even if the student thinks the algorithm is correct, real understanding comes from trying to implement it. They might code it in C++ and find unexpected errors or cases where it doesn't behave as intended. This practical step helps validate whether the algorithm is genuinely useful or needs adjustments. It also deepens the student's understanding of both the logic and the practical issues involved in applying theoretical knowledge to real-world problems.
So, when reading a research paper with mathematics or algorithms, one should take time, revisit each step carefully, and even test it through code—because that's where true learning happens.

2.12 Reading a Datasheet.

Reading a datasheet is an essential skill for researchers in all fields of engineering, including Computer Science**,** Electronics**,** Mechanical**,** Civil**,** Chemical and others. A datasheet is a technical document that provides comprehensive information about a specific component, material, or system. It helps engineers understand key specifications, features, limitations, and safe usage guidelines before integrating the component into their research or projects.
*For example, a Computer Science engineering student working on an embedded system or IoT project may need to use a microcontroller like the ESP32 or Raspberry Pi***.** *The datasheet for such a device would provide vital details such as memory size, processing power, GPIO pin configurations, communication protocols supported (like Wi-Fi or Bluetooth), and power requirements.* Without referring to the datasheet, the student might miss crucial details that could result in system failure or inefficient design.

Similarly, a mechanical engineer selecting a stepper motor for automation, or a civil engineer choosing a type of cement or structural steel, would rely on datasheets for properties like torque, tensile strength, environmental durability, and operating conditions.

The process of reading a datasheet usually begins with skimming to get an overview—such as looking at the summary, features, and use cases. If relevant, the researcher proceeds to examine specific details like performance graphs, electrical or mechanical limits, timing diagrams, or pin configurations, depending on the field.
For computer science, especially in hardware-related domains, understanding timing diagrams, truth tables, and interface specifications becomes crucial.
These documents often include diagrams, tables, and technical terminology that require careful interpretation. Proper reading helps in informed decision-making during component selection, system integration, coding for hardware, or design implementation**.**
Overall, understanding datasheets helps researchers avoid design errors**,** improve safety**,** and enhance research efficiency, regardless of their branch, making it a universally important skill in technical research.

2.13 Attributions and Citations: Giving Credit Wherever Due.

Attribution is the practice of giving proper credit to the original developer of an idea, image, diagram, code, or any content we include in our own work. It is a broad and essential principle in academic writing that covers citations, references, and acknowledgments. By attributing work to its original author, you show integrity and honesty in our research.
For example, if we include a diagram developed by another researcher in our project, we should mention something like, "This diagram is adapted from the work of Dr. Smith (2018)." This makes it clear to the reader that the idea or visual was not created by us and gives credit to the right person.
Citation refers specifically to mentioning someone else's idea, method, or findings directly within our work. It usually appears in the body of our text with an in-text reference, indicating the source of the content we have used. Citations help support our arguments, acknowledge original contributions, and prevent plagiarism.

For instance, in a computer science research paper, we might write, "The Apriori algorithm is widely used for association rule mining (Agrawal & Srikant, 1994)." This citation should also link to a full reference at the end of our paper, which would provide complete publication details of the cited work.

Reference is the detailed information about the sources we cited in our work. It appears at the end of your document in a section often titled "References" or "Bibliography." Each citation in the text must match a reference entry so readers can locate the original source.

For the earlier example, the reference would be: Agrawal, R., & Srikant, R. (1994). Fast algorithms for mining association rules. In Proceedings of the 20th International Conference on Very Large Data Bases (VLDB), 487–499.

Accurate referencing builds credibility and allows others to explore our sources.

Acknowledgment is the section of our work where we thank those who helped us during our research journey but are not listed as authors. This includes guides, mentors, funding bodies, institutions, or even technical staff. It shows appreciation for support, whether academic, emotional, or resource-related.

A typical acknowledgment might read, "I sincerely thank Dr. XTZ for her valuable feedback and guidance throughout the project. I also acknowledge the support of the AI Research Lab at XYZ University for providing computing resources."

Including acknowledgments not only expresses gratitude but also reflects professional courtesy and transparency.

2.14 Functions of Citation

Citations in research serve three important purposes that go beyond just giving credit.

1. Verification Function:

Citations allow readers to check the accuracy of the information we've used. When we cite a source, others can go back to the original document to confirm whether our interpretation is correct or not. This helps avoid misleading claims or misrepresentation of ideas.
Example: If we claim that "80% of AI-based hiring tools show bias," and cite a published research article, a reader can verify whether the original study supports that statistic or if we misunderstood it.

2. Acknowledgment Function:

Citations are a way to give credit to the original authors who contributed ideas or findings that we are building upon. These citations help researchers gain recognition in their field, which is often important for career growth, securing grants, or job promotions.
Example: Citing a popular algorithm like ResNet by He et al., 2015 in our deep learning paper acknowledges their foundational work, and helps us connect our research to a broader academic community.

3. Documentation Function:

Citations also serve as a record of how knowledge has developed over time. They allow readers to track the history of an idea or technology and understand how it evolved.
Example: If we're studying the evolution of mobile networks, citing papers from 1G, 2G, up to 5G technologies shows the timeline and progress in the field.

2.15 Types and Issues Related to Citation

While citations are essential for academic integrity, there are certain citation practices that can be problematic or even unethical.

1. Spurious Citations:

These occur when an author includes a citation that is unnecessary or unrelated to the content, just for the sake of adding a reference. This can mislead readers and clutter the work with irrelevant sources.
Example: Citing a paper on climate change in a paragraph discussing encryption algorithms—just to increase the reference count—is a spurious citation.

2. Biased Citations:

This happens when authors intentionally cite friends, colleagues, or known individuals regardless of relevance, or ignore important contributions from others due to personal bias. Such practices harm the objectivity and fairness of academic writing.
Example: A researcher might avoid citing a rival's excellent work on a topic, just to not give them credit, even though the work is relevant and should be acknowledged.

3. Self-Citations:

Authors may cite their own previously published papers. This is acceptable as long as the earlier work is relevant and helps the reader understand the current research better. Excessive or irrelevant self-citation, however, can be viewed negatively.
Example: If we've previously published a study on image classification and now we're expanding on that in a new paper, citing our earlier work is justified.

4. Coercive Citations:

Sometimes, journal editors pressure authors to add citations from their own journal to artificially boost the journal's impact factor. This is unethical and compromises the integrity of scholarly publishing.
Example: An editor might say, "We'll accept our article if we add three citations from their journal," even if those papers are unrelated to our topic.
These functions and citation practices demonstrate how important proper citation is in maintaining transparency, fairness, and credibility in academic research. Using citations ethically helps build trust in our work and supports the academic community.

2.16 Impact of Title and Keywords on Citations:

Titles on Citations: The title of a research paper plays a very important role in how often the paper is read, downloaded, and cited by other researchers. A well-chosen title helps others understand what the paper is about and increases the chances of the paper being found during a literature search. Since the title is often the first thing a reader sees, it acts like a marketing tool for the paper. It should be informative enough to represent the main subject of the research and interesting enough to grab attention.
There are different aspects that influence how a title affects citations. These include the type of title, its length, and specific elements like punctuation or regional names. For instance, longer titles that mention the research method or main findings usually attract more citations. On the other hand, titles with question marks, colons, or that mention a specific geographic location tend to get fewer citations. Also, papers with result-focused titles are cited more than those with method-focused titles.

***Example**: A paper titled "Improving Energy Efficiency in Smart Homes Using IoT Devices" is more likely to be found and cited than a vague or unclear title like "Smart Living: A New Way", because the former clearly shows the topic, method, and outcome.*

Choosing the right kind of title is, therefore, essential to improve the paper's visibility and academic impact.
Keywords on Citations: Keywords are another vital part of a research paper that help it get discovered by readers and search engines. These are words or phrases that summarize the main ideas and subject of the research. When selected carefully, keywords make it easier for journals, digital libraries, and indexing services to categorize the paper correctly and recommend it to the right audience.
Using at least two strong and relevant keywords in the title or abstract increases the chances of the paper being found through search tools. This can lead to more downloads and higher citation

rates. Keywords help researchers find our work when they search for information on a particular topic. Therefore, it's important to choose keywords that accurately reflect the content and field of the paper. Without proper keywords, even good research might go unnoticed because it won't appear in the right search results.

Example: *If a Computer Science research paper is about using machine learning to predict heart disease, relevant keywords could be: "machine learning," "heart disease prediction," "healthcare data," "classification algorithm." These keywords help others working in healthcare AI or data science find the paper easily.*

2.17 Knowledge Flow through Citation:

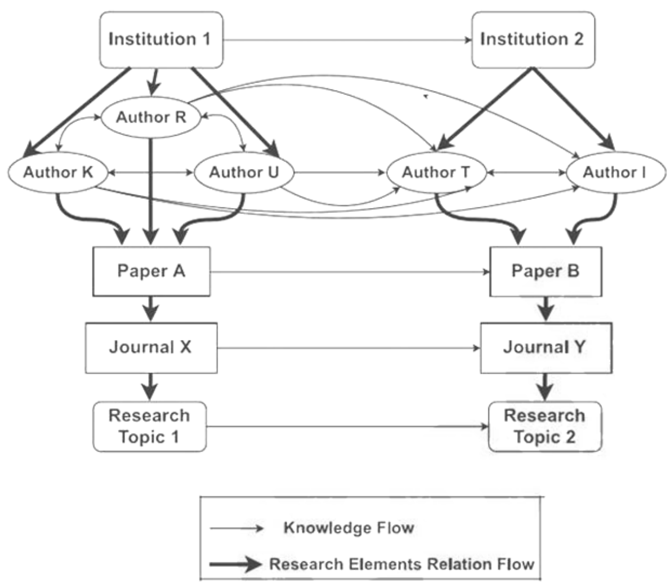
Knowledge flow across different research components:

In the research community, especially in engineering, knowledge flows from one researcher to another through various channels like books, research articles, thesis, patents, presentations, and even informal discussions. Among all these, citations in published papers are the most formal and traceable way to transfer knowledge.

When a researcher cites a previous work, it shows that the current research builds upon earlier findings. This creates a visible link of knowledge transfer**,** which helps new researchers understand what has already been done and what gaps still exist.

In engineering research, papers, journals, and thesis are key sources of such citation-based knowledge transfer.

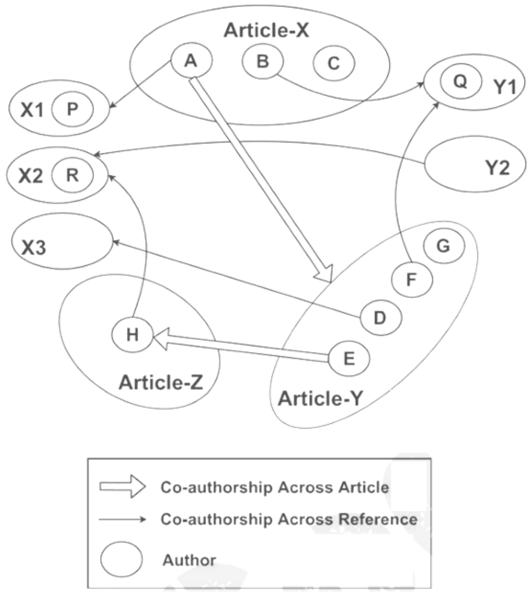
*For example, if Paper A presents an innovative idea and Paper B builds on that idea by citing Paper A, we can say that knowledge has "flowed" from Paper A to Paper B. This citation not only connects two ideas but also connects the authors**,** institutions**,** and research topics involved as illustrated in the following fig.*



The diagram illustrates how knowledge flows across different research components such as institutions, authors, papers, journals, and research topics. Researchers from two institutions—Institution 1 and Institution 2—collaborate through authors like K, R, U, T, and I. For instance, Authors K, R, and U (from Institution 1) co-authored Paper A, while Authors T, I, and R (from Institution 2) contributed to Paper B. These papers are published in different journals (Journal X and Journal Y) and contribute to different research topics (Topic 1 and Topic 2). Thick arrows in the diagram represent the flow of knowledge, such as through citation or idea sharing, while thin arrows show relationships like co-authorship or institutional affiliation. This visual clearly captures how collaborative efforts and citation networks help in transferring knowledge across people, institutions, and research areas.

Co-authorship and citation relationships:

The diagram illustrates how co-authorship and citation relationships connect different research articles and authors. In the figure, three main articles—Article X, Article Y, and Article Z—are connected through shared authorship and references as illustrated in the following fig.



- Article X is written by Authors A, B, and C.
- Article Y is authored by D, E, F, G, and A—showing that Author A has contributed to both Article X and Article Y, forming a co-authorship across articles (shown with thick double-line arrows).
- Article Z is co-authored by H and E, linking Article Y and Z through Author E.

The figure also includes five references:

- X1, authored by A and P, shows that Author A cited their own previous work, indicating self-citation.
- X2, authored by H and R, connects to Authors in Article Z and Article Y, suggesting co-authorship across reference citations (thin arrows).
- X3, by Author D, is a self-citation for Article Y.
- Y1, authored by Q, B, and F, shows that Authors B and F are being cited in Article Y—establishing a shared authorship and reference.
- Y2, authored by R, is cited by Article Y and connects to Author R, who is also connected to X2.

In summary, this figure demonstrates how citations and shared authorship create complex networks of collaboration and knowledge sharing. It highlights:

- Co-authorship links across multiple articles.
- Authors citing their own or each other's work.
- Overlapping references that strengthen research connections.

Such a visualization helps researchers understand how ideas evolve and how collaborations influence the development of knowledge across fields.

2.18 Citing Datasets:

In today's engineering research, the use of datasets has become just as critical as citing published research articles. Citing datasets properly is essential because data is often the foundation of experimental evidence and helps justify research findings. Just like traditional citations, data citations give proper credit to the original developers and contributors of the dataset. They also ensure transparency and traceability, allowing other researchers to find and reuse the data for further research.

A good data citation should include details that identify the dataset clearly, such as the title, source, contributors, publication or access date, and a reliable link. Even if the online link becomes invalid in the future, the citation should include enough descriptive information so others can still locate the dataset.

However, citing data can be tricky, especially when datasets are large, come from multiple contributors, or are funded by different organizations. In such cases, researchers must ensure that they have proper permission to use the data and that legal ownership or usage rights are respected.

For example, the citation: Weather Data, Indian Meteorological Department (IMD), Bengaluru, India (August 2022): [Accessed: 10 Jan 2023] Retrieved from https://mausam.imd.gov.in/

clearly shows the source, access date, and link. It helps the reader verify the dataset used in the research.

Another example is: Kumar, R. (2021). [Field experiment on soil moisture levels]. Unpublished raw data.

which refers to raw data that may not be publicly available but is acknowledged for its contribution to the research. This method ensures the original data creators are credited, and readers are informed of the sources behind the conclusions in a research work.

2.19 Styles for Citations:

Citation styles are essential in academic and research writing because they ensure consistency, credibility, and clarity in how sources are referenced. They help readers identify, locate, and verify the sources of information, data, and ideas used in a paper. Using standardized citation formats—like IEEE, ASCE, APA, or ASTM—not only gives proper credit to original authors but also avoids plagiarism, which is a serious ethical violation in research.

Each discipline often follows a preferred citation style that reflects its communication needs—for instance, IEEE is widely used in engineering and computer science for its concise numerical referencing, while APA is common in social sciences for its emphasis on the date of publication. Proper citation styles also make the work more professional and easier to follow, helping readers trace the evolution of ideas, compare methods, or explore related studies. In summary, citation styles are a vital part of responsible scholarship, supporting academic integrity and facilitating the smooth flow of knowledge.

The following represent brief summary of common citation styles—specifically ASCE, IEEE, APA, and ASTM—presented in table format for different types of sources such as books, journal articles, conference papers and websites:

1. IEEE Style (Engineering):

For books: In the IEEE style, book citations are formatted with the author's initials followed by the surname, then the book title in italics, followed by the publisher, city, and year of publication.

Example: [1] D. Knuth, *The Art of Computer Programming***,** Addison-Wesley, Boston, 1997.

For journal articles: IEEE style includes the author's initials and surname, article title in quotes, journal name in italics, volume number, issue number, page range, and year.

Example: [2] A. Rezi, "Array processing," *IEEE Trans. Signal Process.*, vol. 12, no. 3, pp. 22–30, 2015.

For conference paper: the format includes the author's initials and surname, the paper title in quotes, the conference name in italics, location, year, and page numbers.

Example:[3] M. Kumar, "AI Trends," in *Proc. ICML*, New York, 2023, pp. 45–50.

For websites: IEEE format lists the organization or author, the title in quotes, the full URL, and the access date in parentheses.

Example: [4] IEEE, "Ethics in AI," https://www.ieee.org/ai-ethics.html (accessed Jan. 10, 2025).

2. ASCE Citation Style (commonly used in Civil Engineering)

For books: References begin with the author's surname followed by their initials, year in parentheses, the title in italics, the publisher, and city of publication.

Example: Smith, J. (2005). *Concrete Technology*. Wiley, NY.

For journal articles: The citation includes the author's surname and initials, year, article title in quotes, journal name in italics, volume number with issue in parentheses, and the page range.

Example:Johnson, L. (2014). "Climate Change Dialogue." *ASCE J. Env. Eng.*, 140(4), 1–160.

For conference paper: Citations follow a similar format, including the author's name, year, paper title in quotes, conference name in italics, location (city and state), and pages.

Example: Brown, T. (2018). "Urban Drainage Modeling." *ASCE EWRI Conf.*, Chicago, IL, 35–40.

For web: Citations, ASCE includes the author or company name, year, the title in quotes, the full URL, and the access date in parentheses.

Example: Blade Cleaning Services (2015). "Problems in HVAC." http://www.bladecleaning.com (Accessed Oct. 29, 2016).

IEEE (Engineering/CS)			
Books	**Journals**	**Conferences**	**Websites**
[1] A. Author, Book Title, Publisher, City, Year. Ex: [1] D. Knuth, The Art of Computer Programming, Addison-Wesley, Boston, 1997.	[2] A. Author, "Title," Journal Name, vol. X, no. Y, pp. xx–yy, Year. Ex: [2] A. Rezi, "Array processing," IEEE Trans. Signal Process., vol. 12, no. 3, pp. 22–30, 2015.	[3] A. Author, "Title," in Proc. Conf. Name, Location, Year, pp. xx–yy. Ex: [3] M. Kumar, "AI Trends," in Proc. ICML, New York, 2023, pp. 45–50.	[4] Name of Site, "Title," URL (accessed Date). Ex: [4] IEEE, "Ethics in AI," https://www.ieee.org/ai-ethics.html (accessed Jan. 10, 2025).
ASCE (Civil Engg.)			
Author Surname, Author Initial. (Year). *Title*. Publisher, City. Ex: Smith, J. (2005). *Concrete Technology*. Wiley, NY.	Author Surname, Author Initial. (Year). "Title." *Journal Name*, Volume(Issue), Pages. Ex: Johnson, L. (2014). "Climate Change Dialogue." *ASCE J. Env. Eng.*, 140(4), 1–160.	Author Surname, Author Initial. (Year). "Title." *Conference Name*, City, State, Pages. Ex: Brown, T. (2018). "Urban Drainage Modeling." *ASCE EWRI Conf.*, Chicago, IL, 35–40.	Author or Company Name (Year). "Title." http://URL (Accessed Date). Ex: Blade Cleaning Services (2015). "Problems in HVAC." http://www.bladecleaning.com (Accessed Oct. 29, 2016).

2.20 ACKNOWLEDGMENT

In engineering research, it is important to recognize and appreciate the help and contributions of others, even if they are not listed as authors. This recognition is done through the acknowledgment section of a research paper. Acknowledgments are used to thank people, institutions, or organizations who supported the work in various ways—by providing funding, technical assistance, data, lab space, or even valuable suggestions.

This section is typically placed at the end of the research paper or as a footnote, especially if no specific format is prescribed by the journal or conference. It creates a clear picture of the relationships and collaborations involved in the research process.

For example, a lab assistant who helped with experiments, or a colleague who reviewed the paper and gave helpful feedback, may not be co-authors, but their role should still be recognized.

It is very important to acknowledge.

Because giving proper credit—even for minor contributions—shows academic honesty and encourages a culture of transparency and gratitude. It also highlights the collaborative nature of scientific work, which often involves many people working behind the scenes. This is especially crucial in engineering, where research often depends on access to expensive equipment, teamwork, and external grants or sponsorships.

Acknowledgment also builds credibility and trust with readers and funding bodies. It gives visibility to supporting institutions and helps track contributions of various stakeholders.

Example:"The authors sincerely thank Dr. Ramesh K. for his insightful feedback on the simulation results. We also acknowledge the Department of Electronics, ABC Institute of Technology, for providing lab equipment and resources. This work was partially supported by the AICTE Research Grant (Grant No. AICTE/2023/Innovate/1462)."

2.21 What Should Be Acknowledged:

When writing a research paper, thesis, or technical report, it is important for every author to understand what contributions should be formally acknowledged. Acknowledgment is a way of showing academic honesty, transparency, and gratitude to those who helped make the research possible. The following represent different stages of acknowledgments.

***1. Quotations and Paraphrasing**:* In engineering and technical writing, direct quotations are rare, but if we use exact sentences or phrases from another source, we must enclose them in quotation marks and clearly cite the source. This is known as a direct quotation.

If we summarize or rewrite someone else's idea in our own words (called indirect quotation or paraphrasing), we must still acknowledge the original author and the year.

Example:Direct: "The strain gauge technique is one of the most reliable methods for stress analysis" (Smith, 2019).
Indirect: Smith (2019) described the strain gauge method as a highly reliable tool for stress evaluation.

2. Acknowledging People and Technical Support: We must acknowledge anyone who contributed scientifically or technically to the research—even if they are not co-authors. This includes those who participated in discussions, provided valuable feedback, shared insights, or helped in the experimental or analytical work (like lab assistants, students, technicians, or programmers).

Example:"We thank Mr. Arjun Kumar for assisting with the simulation coding and Ms. Neha R. for her help with the tensile strength testing in the materials lab."

We typically do not acknowledge individuals who helped in non-research ways (like moral support, typing, or printing)—unless it's a thesis, where broader acknowledgments are more common.

3.Acknowledging Funding and Grants: If your work was supported by a funding agency or grant, it is mandatory to acknowledge that source. This includes mentioning the organization's name, the type of funding, and the grant number, if applicable. Failing to do so can lead to loss of current or future funding.

Example:"This research was supported by the Indian Council of Scientific Research (ICSR) under Grant No. ICSR/ENGR/2023/0456."

4. Use of External Facilities and Resources: If your research used laboratories, software, or other facilities not owned by your institution, you should also thank those institutions or centers.

Example:"We gratefully acknowledge the Nano Fabrication Facility at the National Institute of Technology, Trichy, for providing access to their cleanroom environment."

5.Acknowledging Prior Presentations of Results: If your findings were previously presented as a poster, abstract, or conference paper, this should also be acknowledged to maintain transparency.

Example:"Preliminary results from this study were presented at the International Conference on Mechanical Systems (ICMS 2023), held in New Delhi, India, from July 10–12, 2023."

This helps readers understand the publication history of your results and avoid any concerns of duplication.

6.Acknowledgment Ethics – What to Avoid: It is considered inappropriate to thank reviewers of the journal during submission. Many technical journals discourage this practice, as it could be seen as a way to influence or flatter reviewers, which compromises the objectivity of peer review.

Avoid this:"We thank the anonymous reviewers for their valuable comments." (Instead, such thanks can be added later after the paper is accepted.)

2.22 Acknowledgments in Books/ Dissertations:

In academic books and dissertations, a dedicated acknowledgment page is typically placed right after the table of contents. This section is more detailed and extensive compared to the short acknowledgment statements commonly seen in journal articles or conference papers. It allows the researcher to formally thank all individuals and institutions who contributed in any way to the successful completion of the research work.

Writing this section requires thoughtful consideration about who should be acknowledged and in what order. Usually, appreciation is expressed to the main supervisor, co-supervisor, laboratory colleagues, faculty members, technical and administrative staff, and sometimes family and friends for their emotional support. It's important that the tone remains professional and that overly emotional or flowery language is avoided. The length of acknowledgments typically depends on the type of document. In journal articles, they are usually one or two sentences. In technical reports, they may be a paragraph, and in theses or dissertations, acknowledgments are often longer and more detailed.

Example:"I would like to express my heartfelt gratitude to my project guide, Prof. XYZ, for her expert guidance, constant motivation, and support throughout the project on intelligent traffic prediction using deep learning.
I also extend my sincere thanks to Dr. XYZ, Head of the Department of Computer Science Engineering, for providing academic support and encouragement.
I am thankful to our respected Principal, Dr. XYZ, for offering a stimulating research environment at our institute.
I acknowledge all the teaching faculty members of the department for sharing their subject knowledge, which helped in shaping the direction of my project.
Special thanks to the lab assistant Mr. xyz and the technical staff for their timely help during system testing and data

collection.
I am also grateful to my friends for their cooperation and moral support during challenging times.
Last but not least, I deeply thank my parents and family members for their unwavering encouragement, patience, and faith in me throughout this journey."

This type of acknowledgment reflects professionalism and sincere appreciation, recognizing both academic and personal support in a structured and meaningful way.

2.23 Dedication:

In academic and technical writing, dedication and acknowledgment serve different purposes and are used in different types of documents. Dedication is typically found only in longer works like books, theses, or dissertations—it is not used in journal papers, conference articles, or patents**.** A dedication is a personal note from the author**,** expressing deep appreciation or emotional connection to a specific person or entity. It could be addressed to a spouse, parent, friend, mentor, pet etc**,** depending on what the author feels is most meaningful.
On the other hand, an acknowledgment is a formal section where the author gives credit to individuals or organizations who directly contributed to the completion of the research or writing. This might include technical help, guidance, feedback, funding, or emotional support. It is perfectly acceptable to mention someone in both the dedication and acknowledgment sections. For instance, an author may dedicate the thesis to a spouse and also acknowledge them for their moral support during stressful times**.**

Example: This work is dedicated to my beloved parents, who have always believed in me and to my mentor, who inspired my interest in Artificial Intelligence.

QUESTION BANK:

5-MARK QUESTIONS

1. Define bibliographic databases and explain their importance in research.
2. List any five search operators used in Google/Google Scholar and explain their use.
3. Differentiate between citation and reference with suitable examples.
4. Why is it important to take notes while reading technical literature?
5. State the key attributes that affect the citation rate of a research paper title.
6. What is meant by critical and creative reading? Give one example of each.
7. What should be included in an acknowledgment section of a research paper?
8. Explain the necessity of citing datasets with a suitable example.
9. Briefly describe the purpose of the conclusion in a literature review process.
10. What are the different styles of citation? List any three with examples.

10-MARK QUESTIONS

1. Explain the step-by-step process of reading a technical research paper effectively.
2. Discuss the functions and types of citation with examples.
3. Write a detailed note on the impact of titles and keywords on the citation rate of research articles.
4. Explain the importance and process of taking notes while reading technical literature.
5. Discuss in detail the significance of proper acknowledgment and attribution in academic writing.
6. What is the role of Web of Science in literature search? Explain its features with an example.
7. Elaborate on the structure and importance of reading mathematical content and algorithms in engineering papers.
8. Illustrate knowledge flow through citation using a network diagram or example.
9. Differentiate between direct quotation, indirect quotation, and paraphrasing. Why is each important in research writing?
10. Explain various citation styles (IEEE, ASCE) for books, journals, conferences, and websites in tabular form.

Model Question Paper-1 with effect from 2022-23 (CBCS Scheme)

USN | | | | | | | | | |

Fifth Semester B.E. Degree Examination

Subject Title: Research Methodology and Intellectual Property Rights

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

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

		Module -1	***Bloom's Taxonomy Level**	**COs**	**Marks**
Q.01	a	Explain Research Flow cycle with a Neat Diagram	L2	1	7
	b	What are three broad categories of developing and accessing Research	L1	1	6
	c	Explain the three different types of Research? Give distinct examples of each.	L2	1	7
		OR			
Q.02	a	List the different types of Research misconduct ?Provide examples for each	L2	1	7
	b	What are the objectives of Engineering Research and its motivation?	L1	1	6
	c	Give a detailed description of Ethics and Ethical practices in Research	L2	1	7
		Module-2			
Q. 03	a	What are the primary goals of Literature Review?	L1	2	7
	b	How does new and existing Knowledge contribute to Research	L3	2	7
	c	What are datasheets enumerate their comtemts?	L2	2	6
		OR			
Q.04	a	Explain the terms critical reading and creative reading?	L1	2	7
	b	Explain the term citation? Describe the functions of citation?	L1	2	6
	c	Explain the knowledge flow process through a citation network?	L1	2	7
		Module-3			
Q. 05	a	Define the term patent?	L1	3	5
	b	Write a brief history of Patents	L2	3	8
	c	What are different patent applications and how are they commercialized	L2	3	7
		OR			
Q. 06	a	What are the inventions eligible for patenting and which are the matters considered as non patentable?	L2	3	10
	b	Explain through a flow chart the major steps involved in patenting	L1	3	10
		Module-4			
Q. 07	a	What is a copyright and write its classes	L2	4	5
	b	Explain what are the two exclusive rights owned by copyright owners ?	L1	4	5
	c	What is the role of Register of copyrights and the powers given to the Board of Copyrights?	L2	4	10
		OR			
Q. 08	a	What is a trademark? List the advantages a owner of the trademark gain through its registration	L2	4	10
	b	Explain the steps involved in Trademark Registrations using a flowchart	L1	4	10
		Module-5			
Q. 09	a	Explain in detail what is Industrial Design (ID)	L1	5	6
	b	Summarize the Non Protectable Industrial Designs in India	L2	5	4
	c	Describe the Registration process for Industrial Design with a flow chart	L2	5	10
		OR			

Q. 10	a	Define the term Geographical Indicators (GI)?What are the rights given ti GI holders	L1	5	10
	b	Discuss the case study of Apple Vs Samsung	L2	5	5
	c	Discus the case study of Basmati Patent	L2	5	5

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.

Model Question Paper-1 with effect from 2022-23 (CBCS Scheme)

USN | | | | | | | | | |

Fifth Semester B.E. Degree Examination

Research Methodology & Intellectual Property Rights (IPR)

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

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

		Module -1	***Bloom's Taxonomy Level**	**Marks**
Q.01	a	Define the term research and explain the research flow cycle with a relevant diagram.	L1	7
	b	What are the three broad categories of developing and accessing knowledge in research? Explain with a diagram.	L1	7
	c	What are the key ethical issues related to authorship? Explain each one.	L1	6
		OR		
Q.02	a	Discuss the different types of engineering research. Clearly point out the differences between all of them with examples.	L2	10
	b	List the different types of research misconduct and provide a brief explanation for each one.	L3	10
		Module-2		
Q. 03	a	What are the primary goals of conducting a literature review in academic research?	L1	7
	b	How does the new and existing knowledge can contribute to the research process? Explain with relevant points.	L2	8
	c	What are datasheets and write their contents?	L2	5
		OR		
Q.04	a	Explain the various steps involved in the critical and creative reading process.	L1	8
	b	Define the term Citation. Describe the three functions of Citation.	L1	5
	c	Explain how knowledge flows through a citation network using a flow diagram.	L1	7
		Module-3		
Q. 05	a	What types of inventions are eligible for patenting, and which matters are considered non-patentable?	L2	10
	b	Explain the major steps involved in the process of filling patent applications using a flow chart.	L1	10
		OR		
Q. 06	a	Explain the different types of patent applications.	L1	8
	b	What strategies are involved in the commercialization of a patent?	L2	7
	c	What are utility models, and how do they differ from patents?	L1	5

Module-4				
Q. 07	a	Define the term Copyright and write its classes.	L1	5
	b	What are the two exclusive rights owned by the copyright owner? Explain briefly.	L2	5
	c	What are the roles and functions of the copyright board and the copyright society in administering copyright laws and regulations?	L2	10
OR				
Q. 08	a	What are the key eligibility criteria that a mark must meet to qualify for trademark protection? List advantages that a proprietor gains through trademark registration	L2	10
	b	Using a flowchart, explain the steps involved in the process of Trademarks Registration.	L3	10
Module-5				
Q. 09	a	Briefly explain the overview of Industrial Design (ID). Summarize the Non-Protectable Industrial Designs in India.	L1	10
	b	Discuss the Design registration procedure by using a flowchart.	L2	10
OR				
Q. 10	a	Define Geographical Indications (GI) with an example. What are the rights granted to GI holders?	L1	10
	b	Summarize the IPR-related activities the Department for Promotion of Industry and Internal Trade (DPIIT) undertakes.	L3	10

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of question.

Model Question Paper-2 with effect from 2022-23 (CBCS Scheme)

USN

Fifth Semester B.E. Degree Examination

Research Methodology & Intellectual Property Rights (IPR)

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

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

			*Bloom's Taxonomy Level	Marks
		Module -1		
Q.01	a	Define engineering research and list its aims and objectives.	L1	7
	b	What are the factors that motivate you to do engineering research? Briefly explain	L2	7
	c	Compare descriptive research versus analytical research with examples.	L2	6
		OR		
Q.02	a	What is the meaning of ethics and why is it important in the practice of engineering research?	L1	7
	b	Write a note on the following research misconduct (i) Falsification (ii) plagiarism.	L2	8
	c	What are three ways to credit the research contributions? Explain	L2	5
		Module-2		
Q. 03	a	How does the existing knowledge can contribute to the research process? Explain with relevant points.	L2	5
	b	What are the key features of the bibliographic database of the Web of Science (WoS), and how is it commonly used in research?	L1	7
	c	List and explain the Importance of Note-taking while reading research papers.	L1	8
		OR		
Q.04	a	What types of citations fail to achieve their goal and do not benefit the reader? Explain.	L2	8
	b	Illustrate using a flowchart, how collaboration in a Co-authorship network can improve the flow of knowledge in the research.	L3	6
	c	Explain the most common styles for citation used by engineers during research, and provide an example.	L1	6
		Module-3		
Q. 05	a	Describe Intellectual Property Rights (IPR) and list its types.	L1	6
	b	Define the term patent and what are the conditions that must be met for obtaining patent protection?	L2	8
	c	What are Patent Infringements? Explain its two categories of Infringements.	L1	6
		OR		

Q. 06	a	Explain the following major steps involved in the process of patent registration. *(i)* Prior Art Search (ii) Choice of Application to be Filed (ii) Pre-grant Opposition	L2	10
	b	In which circumstances Indian residents are not required to file a patent application first in India to get patent protection in another country? Explain.	L3	6
	c	Name the four national bodies dealing with patent affairs	L2	4
		Module-4		
Q. 07	a	What are the key considerations and tests for determining fair use doctrine under copyright law? Explain with examples.	L2	5
	b	Using a Flow chart, explain the important steps involved in the process of Copyright Registration.	L2	9
	c	What were the key events and circumstances surrounding the copyright dispute between photographer David Slater and the macaques in Indonesia in 2011? Explain.	L2	6
		OR		
Q. 08	a	What are the different categories of trademarks recognized under Indian law, and tabulate the famous trademark types with examples	L2	10
	b	Explain by using a process flowchart, the steps involved in trademark registration.	L2	10
		Module-5		
Q. 09	a	Describe the enforcement of Industrial Design Rights.	L1	5
	b	Explain the classification of Industrial Designs and design registration trends in India.	L1	7
	c	Explain registered Geographical Indications (GI) in India with the tabulate of examples.	L2	8
		OR		
Q. 10	a	Explain the Identification of Registered Geographical Indications (GI) items. What are the common methods used to project GI in India.	L1	10
	b	Using a flowchart, explain the process of GI registration.	L2	10

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.

CBCS SCHEME

USN 1ME21CS017

21RMI56

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

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

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

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

OR

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

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

Module-2

3 a. How do researchers distinguish between new and existing knowledge during a literature review? **(10 Marks)**

b. How can researchers effectively use search engines to find relevant literature in their fields? **(10 Marks)**

OR

4 a. What challenges do researchers commonly face when reading mathematical content or algorithm? **(10 Marks)**

b. What is impact of Title and Keywords on Citations? Explain Citation based knowledge flow. **(10 Marks)**

Module-3

5 a. What is definition of Intellectual Property (IP)? In what way does Intellectual Property contribute to economic growth and cultural development in a society? **(10 Marks)**

b. Discuss the history of Intellectual property in India. **(10 Marks)**

OR

6 a. Explain the step by step process of obtaining a patent. From the initial idea to the grant of the patent. **(10 Marks)**

b. What are the commonly used terms in the field of patenting and how do they contribute to effective communication in this domain. **(10 Marks)**

Module-4

7 a. Explain the criteria that an original work must meet to quality for copyright protection. **(10 Marks)**

b. Explain the process of copyright registration? What are the benefits for the copy right holders? **(10 Marks)**

OR

8 a. Explain the process of Trademark registration. (10 Marks)

b. Explain the classification system for trademarks and its role in categorizing different types of marks. (10 Marks)

Module-5

9 a. Explain the process of Industrial design registration. (10 Marks)

b. Explain the famous case law between Apple Inc Vs Samsung Electronics Co. related with Industrial Design rights. (10 Marks)

OR

10 a. Which specific acts, laws and rules govern geographical indications in India? Give some examples of well known geographical indications registered in India. (10 Marks)

b. How would you describe the overall ecosystem and significance of geographical indications in India? (10 Marks)

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