

## RESEARCH METHODOLOGY

The 'Research Methodology' course is divided into three modules. Module A and module B will be taught by HBNI, and students will have to log in to [AnuVidya Portal](#) to access information. Once registered, they will be able to log in.<sup>1</sup> Module C will be taught by HRI.

- (1) Syllabus for Research methodology course in HBNI<sup>2</sup>, page 2-3
- (2) Model Question Paper and Answers for RM&RPE Exam conducted by HBNI,<sup>3</sup> page 4-17
- (3) Content for Research Methodology, Module C at HRI, page 18.

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<sup>1</sup>One can check the last year's (2024) course from the [youtube playlist](#)

<sup>2</sup>The syllabus may be modified on a regular basis by the HBNI.

<sup>3</sup>HBNI holds the copyright.

## **Syllabus for Research methodology course in HBNI**

In accordance with the guidelines issued by UGC regarding the implementation of the course on Research ethics and Publication ethics, a compulsory course on Research Methodology is proposed to be introduced in all CI/OCC of HBNI. The course will be of 40 lectures (4 credits) and will have three modules, as described below.

### **Module A: Research design and methods**

### **Module B: Research ethics and Publication ethics**

### **Module C: Computational and experimental methods**

The detailed syllabus of the module 1A and B given below.

#### **Module A: Research design and methods:**

- 1. Objectives and types of research:** Motivation and objectives - Research methods vs. Methodology. Types of research – Descriptive vs. Analytical; Applied vs. Fundamental; Quantitative vs. Qualitative; Conceptual vs. Empirical.
- 2. Research Formulation:** Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem - Literature review – Primary and secondary sources - reviews, treatise, monographs-patents - web as a source - searching the web - Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.
- 3. Research design:** Basic Principles - Need of research design - Features of good design – Important concepts relating to research design - Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis. Experimentation: Proper approach - Importance of recording observation, maintaining the records, sample history, transparency in data recording. Determining experimental and sample designs.
- 4. Writing thesis and research papers:** Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation – Layout, structure and Language of typical reports - Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation - Planning - Preparation - Practice - Making presentation - Use of visual aids - Importance of effective communication, Manuscript drafting based on ‘Experimental data and Literature Survey’. Where to publish?, impact factor of journals, citation databases, Metrics
- 5. Statistical treatment of data and errors:** Value of Statistics; Errors and Statistics - Limitation of analytical methods; Accuracy; Precision; Classification of errors; Minimisation of errors; Significant figures and computations; Standard Deviation; Normal Distribution; Comparison of results - student's t test; F-test; Chi Square test; propagation of errors.

## **Module B: Research ethics and Publication ethics**

**1. Research ethics:** Philosophy and ethics, Ethics with respect to Science and research, Intellectual honesty and research integrity, Scientific misconducts- fabrication, falsification and plagiarism, redundant publications- duplicate and overlapping publications, selective reporting and misrepresentation of data, Environmental impacts - Ethical issues - ethical committees – Commercialization.

**2. Publication ethics:** Definition, introduction and importance, Best practices, standards setting initiatives and guidelines, Conflict of interest, Publication misconduct, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, predatory journals and publishers, Copy right - Royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

## **Module C: Computational and experimental methods**

This module is CI/OCC specific and the syllabus can be specified by the CI/OCC. Typical topics covered as a part of this module could be

1. Computational methods: Mathematical modeling, Numerical methods of analysis,
2. Experimental methods: Principles of Instrumentation

## **References**

1. Science and methods by Henry Poincare, translated in English by Francis Maitland  
Source: <http://www.archive.org/details/sciencemethod00poinuft> (1914).
2. B.L. Garg, R. Karadia, F. Agarwal, and U.K. Agarwal, An introduction to Research Methodology. RBSA Publishers (2002).
3. C.R. Kothari, Research Methodology: Methods and Techniques. New Age International (2000).
4. S.C. Sinha, and A.K. Dhiman, Research Methodology, Ess Publications (2 volumes) (2002).
5. R. Paneer Selvam - Research Methodology, Prentice Hall India Learning Private Limited; Second edition (2013).
6. M. Anthony, A.M. Graziano, and M.L. Raulin, Research Methods: A Process of Inquiry, Allyn and Bacon (2009).
7. R.A. Day, How to Write and Publish a Scientific Paper, Cambridge University Press. (1992).

Model Question Paper and Answers for  
Research Methodology, Research and Publication Ethics (RM&RPE) Exam  
conducted by Homi Bhabha National Institute.

**Homi Bhabha National Institute**  
**Research Methodology, Research and Publication Ethics (RM&RPE)**  
**Course Examination**

Time allotted= 2.5 hrs.

Total marks 125

Answer key

**Q.1 Answer any five (each in one or two sentences)**

**[5X2=10]**

- I. What do you understand by 'Closed' and 'Open' questions. Give an example of each of them: **Closed questions have short typically one word answers, while open questions need long explanations, leading to more questions. E.g., closed question → What is the name of our galaxy?, Open question → How were galaxies formed?**
- II. Write two objectives of research: **(i) To discover new facts, (ii) To verify and test important facts, (iii) To analyse an event or process or phenomenon to identify the cause and effect relationship, (iv) To develop new scientific tools, concepts and theories to solve and understand scientific and non scientific problems**
- III. Write two motivations for research: **Desire to get a degree along with its consequential benefits, (ii) Desire to face challenges in solving the unsolved problems, that is the concern over practical problems, (iii) Desire to get intellectual joy doing some creative work**
- IV. What do you understand by research methodology? **Research methodology is a way to systematically solve the research problem, It may be understood as the science of studying how research is done scientifically.**
- V. What do you understand by Eureka Moment? Give an example: **Deep thinking leading to getting insight into an unsolved problem or a discovery, e.g., (i) Archimedes sitting in bathtub and discovering Archimedes Principle, (ii) Kekule dreaming of self devouring snake and proposing benzene ring structure**
- VI. What do you understand by hypothesis driven research ?. Give an example. **A hypothesis is a statement about the world that can be true or false and whose truth is being tested. A valid hypothesis must be falsifiable, meaning we should be able to show it to be false. When a hypothesis is valid, it meets the rules for being a hypothesis, whether it is true or false. If a hypothesis is invalid, it breaks the rules and should not be considered. Example → Eating two table spoons of olive oil twice a day decreases the odds of contracting heart disease**
- VII. Define research methods: **These are the various methods, procedures, schemes and algorithms used in research. They are essentially planned, scientific and value neutral. They include theoretical procedures, experimental studies, numerical schemes, statistical approaches, etc.**
- VIII. Define random and systematic errors: **Random error affects only a single measurement, while Systematic error affects all measurement data**

**Q.2 Answer any five (Very briefly in not more than 4 to 5 lines).**

**[5X5=25]**

- I. What are the different quadrants of research with respect to Basic and Applied research. Give an example of each of them.

Quest for Fundamental Understanding?	Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
	No		Pure applied research (Edison)
		No	Yes
		Considerations of Use?	

**Yes-No: Basic research viz., High energy physics, atomic theory, etc.**

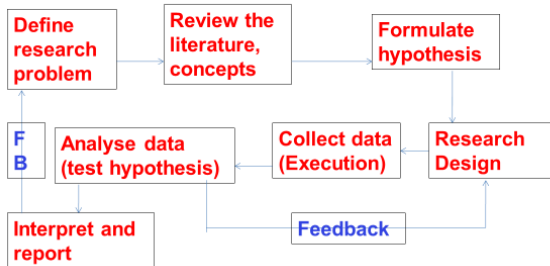
**No-Yes: Pure Applied viz., invention of telephone, telegraph, radio, etc.**

**Yes-yes: User inspired, viz., germ theory, functional materials, etc.**

- II. Write the names of 4 international peer reviewed journals and their impact factors, which you use for literature survey for your research work.
- III. Draw a flowsheet describing the steps necessary to effectively carry out research with the desired sequencing of these steps.

#### Research process

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



- IV. What do you understand by research design? How does it help in research? **A research design is an arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. It is the conceptual structure within which research is conducted, it constitutes the blue print for collection, measurement and analysis of data. It helps perform the chosen task easily and in a systematic way**
- V. What do you understand by principle of replication? In what way it helps in the outcome of a study? **Principle of replication: The experiment should be repeated more than once. This helps in improving the precision of the data, thereby reducing the random errors. The precision is quantified in terms of standard deviation defined as,**

$$s = \frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}$$

- VI. Explain the principle of local control in research, with an example. **Before and after with control design: (i) Select two areas (test and control). Measure the dependent variable in both areas for an identical time period before the treatment. (ii) Introduce the treatment in the test area only and measure the dependent variable in both for an identical time period after the introduction of treatment. (iii) determine the treatment effect by subtracting the change in dependent variable in the control area from the change in the same in test area. e.g., Effect of nutraceuticals on human health à Treat the sample population with the**

nutraceuticals, Do not treat the control population, Determine the nutrient concentration in both sample and control population

VII. Explain Q-test for testing of outlier in a set of data. **Dixon's Q test:** (i) Arrange the measured data in increasing order:  $x_1, x_2 < x_3 < \dots < x_n$ , either  $x_1$  or  $x_n$  may be outlier,  $Q = (x_2 - x_1) / (x_n - x_1)$  for  $x_1$ , or  $Q = (x_n - x_{n-1}) / (x_n - x_1)$  for  $x_n$ , (ii) Compare the Q value with  $Q_{crit}$  for n measurements from table for particular confidence level. (iii) If  $Q > Q_{crit}$ ,  $x_1$  or  $x_n$  is outlier with respective confidence level

VIII. Landau never formulated research problems for his students. Give your opinion about whether he was right in doing so or not and why?

**Q.3.** A ball is dropped to floor from same height six times on a tile having matte finish. The height reached by the bouncing ball in cm, is 138, 139, 137, 135, 137, and 138. Similar exercise is done at another spot in the same floor but the tile has glossy finish. The height reached by the bouncing ball in cm are, 140, 139, 138, 142, 139, 140. Carry out a statistical analysis of the data (determine mean and standard deviation) and comment if the finish of the tiles (matte/glossy) has an effect on the average height reached by the bouncing ball, using 95.4 % confidence level ( $\sigma=2$ ).

[15]

	<b>M a t t e (cm)</b>	<b>G l o s s y (cm)</b>
	138	140
	139	139
	137	138
	135	142
	137	139
	138	140
<b>mean</b>	137.3	139.7
<b>s.d. (sigma)</b>	1.4	1.4
<b>lower limit (mean - 2 sigma)</b>	134.6	136.9
<b>upper limit (mean + 2 sigma)</b>	140.1	142.4

The average heights reached in two cases are within  $2\sigma$  and hence it can be concluded that the finish of the tile (matte/glossy) has no significant effect on the heights of the ball bounced from tiles of different types within 95.4 % confidence.

**Q4. Fill in the Blanks:** (the answers are highlighted)

[10x1=10]

1. A patent gives a person the exclusive right to **stop(prevent)** others from using, the patented invention without the permission of the patent holder, from the date of filing the patent application.
2. **Trademark** is used in the course of trade to distinguish goods (or products) to help a consumer to link the goods (or products) to their origin (manufacturer, producer, authorised seller).
3. Trade Secret is any information that is of importance to the person or organisation which the person or organisation keeps away from the public, that gives **commercial** advantage to the trade secret holders over others.
4. Geographical indication, in relation to goods, means an indication which identifies a product as originating or manufactured in the **region** of a country, or a territory or locality in that territory, where a given quality, reputation, quality or other characteristic of such goods is essentially attributed (associated) to its geographical origin.
5. Industrial Design Registration protects novel **aesthetic** features of shapes, configuration, or pattern of lines or colors, applied to any finished article of manufacture that appeals to and are judged solely by the eye.
6. For an invention to be patentable it must first satisfy the condition that it should be patentable **subject** matter and then satisfy the conditions of novelty, inventive step and industrial applicability (usefulness, utility).
7. IPR Holders may allow others to use their IPR by licensing, or by **assignment (selling)**.
8. A PCT Application must be filed within **twelve** months of the priority date of filing a patent application.
9. The term of a patent in a country is **Twenty** years from the date of filing of the provisional application.
10. If an inventor files a PCT Application, then the inventor may file the patent application in all the PCT Member Countries within **thirty / thirty one** months of the priority date of the same patent application.

**Q5. True or False Justify your answer in one sentence**

[10x1=10]

1. Copyright protects ideas and facts. **False**
2. Patent protects the non-functional features and aesthetics aspects of a product. **False**



3. A mineral discovered for the first time by someone can be the subject matter for patent protection. **False**
4. Licensing of any Intellectual Property Rights amounts to giving up the ownership of the intellectual property rights. **False**
5. Assignment of any Intellectual Property Rights amounts to giving up the ownership of the intellectual property rights. **True**
6. While conducting research, the researcher may present his/ her work in a conference and then file patent / design registration. **False**
7. A PCT Patent Application is equivalent to getting a patent granted in various countries around the world with a single patent application. **False**
8. While conducting research, it is adequate to conduct literature search only in databases related to journals and books. **False**
9. A patent and design registration obtained in India is automatically valid in Bangladesh as the diplomatic relationship between the two countries is very friendly. **False**
10. The World Intellectual Property Organisation (WIPO) grants patents that are enforceable in all the countries which are members of WIPO. **False**

#### **Q 6. Case Study**

**[5]**

Four PhD students Krish, Pratham, Jivika and Pritha set out on an expedition across Rajasthan. They carried several bottles of water with them. However, as they were travelling in summer across the dry desert, the water they were carrying got over. There were no shops in the neighbourhood from where they could purchase bottles of water. After returning to BARC, they decided to work on developing a porous material which could absorb at least 200 times its weight of water. So instead of water bottles, they would carry these special materials with water stored in them. Pritha suggested that the material should be edible so that the water could be sucked and then the material can be eaten to satisfy both thirst and hunger (**file patent as these are functional features**). They developed a starch-based material with extensive water absorbing capacity (**file patent as it is functional feature**). Experiments were done to test the water absorbing capacity (**file patent as it is a functional matter**). Further, with minimum sucking in the mouth, the water can be extracted from the material (**file patent as it is a functional feature**). The developers also plan to add some flavours so that the product can be sold in various flavours (**may file patent as a functional feature or keep as a trade secret if this cannot be reverse engineered**). They developed a special process to obtain the appropriate porosity, softness and rigidity so that it could be shaped to take a form one desires (**file patent as it is a functional feature; the distinct shapes can be fined as industrial designs registration to protect the non-functional features**). They tested the safety of the product for human consumption. Pratham decided to name this product as

“ThungerQuench”...a combination of thirst and hunger quencher (file trademark). Jivika decided to shape this product in the form of an attractive bottle (file industrial designs registration). Krish wrote a poem on this product and the four of them decided to create and record a swinging tune to popularise the product (file copyright). In addition to the product being called “ThungerQuench”, it also has an additional qualifier called “FlavBahar” (trademarks).

Please answer each of these questions in not more than 4 sentences objectively.

1. List the features of this product and suggest the appropriate IPR Tool to protect each of them.
2. “Tremor” event in Mumbai is due commence on 16<sup>th</sup> June 2022. What should Krish, Pratham, Jivika and Pritha do to ensure that the innovative features of their product are protected before they launch their product in the “Tremor” festival? They should ensure that all patent and design registrations are filed before the date of the event. The copyright and trademarks may be filed before, during or after the event
3. While planning to protect their inventions in India and in other countries what are the 3 essential steps they should bear in mind? (for patent, they should file i) file the complete specification in India within 12 months of the priority date; ii) file a PCT Application within 12 months of priority date; iii) file the patent applications in the countries outside India within 30/31 months of priority date if they have filed a PCT Application; or file foreign patent applications within 12 months of the priority date if they have not filed a PCT Application as per the Paris Convention.
4. They have to procure the starch from a special supplier. The processing of the starch is also to be done in a specific manner, for which they do not have the equipment. They have to get the processing done from a company in Jodhpur City. What should they do to protect their intellectual property? (Sign confidentiality agreements and contracts with the incorporation of confidentiality clauses)
5. They are planning to set up a business in due course. They may need to take a bank loan or go to a financial institution to borrow money. How can they use their innovations and the related IPR to get some loan? (They can mortgage the IPR with the financial institutions and take loan against the IPR)

**Q. 7. Answer all questions**

**[10X2=20]**

- I. State the names of at least five branches of Philosophy.

Branches of Philosophy: Metaphysics, Epistemology, Ethics, Aesthetics, Logic, Axiology

- II. What is meant by integrity in research?

Research integrity relates to the performance of research to the highest standards of professionalism and rigour, and to the accuracy and truth of the research record in publications and elsewhere. Good research practice includes research ethics in the

proposal and experimentation phase, as well as publication ethics in its analysis and dissemination

### III. What is data falsification and what are its implications?

Experiments are performed but the outcome of the experimentation is manipulated. It is manipulation of research materials, equipment, processes, and modifying or omitting of data results in such a way that the research is not accurately represented in the research records

### IV. Why do scientists indulge in Scientific Misconduct?

Scientists indulge in misconduct due reasons like: Academic and career pressure, Personal ambitions, Publish or Perish mentality, Careless methodology, Grants pressure, Cultural differences, Conflicts of interest, and Poor mentoring

### V. What led to the establishment of the Nuremberg Code of medical ethics and why was it so called?

During the Second World War, Nazi medical doctors conducted inhuman experiments on prisoners in concentration camps. After the war, these doctors were tried for their crimes at the trials conducted at Nuremberg, Germany, in 1947 which led to the establishment of the Nuremberg Code of medical ethics

### VI. What is Salami Slicing?

Salami Slicing is the process of deriving several partial publications from a single source of study. Each publication would be substantially similar to an article published previously by the same author/s without full cross reference.

### VII. What is the purpose of Contributor Roles Taxonomy (CRediT) statement in a publication? Enumerate at least five CRediT roles.

CRediT taxonomy statement is the best currently available method for embedding authors' contributions in journal metadata. Most journals use this statement to indicate the contributions of various authors in a particular publication. These are: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

### VIII. What is the role of institutional ethics committees?

Role of an institutional ethics committee is to ensure the protection of the rights, safety and well-being of human subjects involved in a clinical trial and it shall be responsible for reviewing and approving the protocol, the suitability of the

investigators, facilities, methods and adequacy of information to be used for obtaining and documenting informed consent of the study subjects and adequacy of confidentiality safeguards. In the case of any serious adverse event occurring to the clinical trial subjects during the clinical trial, the Ethics Committee shall analyze and forward its opinion as per procedure specified.

IX. What are Predatory journals and how do they harm scientific community?

Predatory journals and publishers are entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial and publication practices, a lack of transparency, and/or the use of aggressive and indiscriminate solicitation practices.

X. What is the purpose of UGC-CARE?

UGC strongly emphasizes on promoting high quality research and knowledge contents by faculty members, researchers and students. To meet these goals and to ensure prevention of academic misconduct, UGC has set up “Consortium for Academic and Research Ethics (CARE). Through CARE, publications in dubious/predatory/sub-standard journals are sought to be prevented by maintaining a reference UGC CARE List of quality journals.

**Q.8 . Answer any five**

**[5X6=30]**

- I. Self-driving cars (autonomous vehicles) are the vehicles of future in which the driver is replaced with an artificial intelligence (AI) driven robotic system. The AI codes are, of course, made by human technologists. The scenario is that such a car is cruising along a road with some passengers. Suddenly, a pedestrian starts crossing the road illegally and comes directly in the path of the car. The situation is that if the car applies brakes, it will definitely harm the passengers and if it doesn't, the pedestrian would be hit. How would you program the car's AI to react to this situation and give moral reasons for the same?

Just like human drivers, self-driving vehicles can become involved in traffic situations where an accident cannot be avoided, and a fast reaction is needed in order to reduce its consequences as far as possible. A considerable number of ethics papers have been devoted to cases in which this reaction has to deal with an ethical dilemma, for instance between driving either into a pedestrian or swerving. Furthermore, there have to be two reasonably controlled options to choose between. In almost all situations when a crash is imminent, the most important reaction is to decrease the car's speed as much as possible in order to reduce its momentum. The choice is therefore between braking maximally without swerving and braking maximally and at the same time swerving. The latter option has severe disadvantages: swerving reduces the efficiency of braking, so that the collision will take place with a larger momentum. Swerving leads to loss of control, so that the car's trajectory becomes unpredictable. This can lead to skidding, spinning, and a sideways collision that is not alleviated by the crumple zones at the car's front. The chances for pedestrians and others to move out of harm's way are also

smaller if the car is spinning and skidding. In summary, the self-driving car “does not face a decision between hitting an object in front of it and hitting an object off to one side. Instead, the decision is better described as being between a controlled manoeuvre—one which can be proven with generality to result in the lowest impact speed of any available option—and a wildly uncontrolled one.” Due to the physics of braking and crashing, the situation is very much the same for self-driving systems as it is for human drivers. Consequently, the need for including deliberations on this type of dilemmas does not seem to be larger in the programming of automatized vehicles than in driver’s education. Discussions of such dilemmatic situations seem to have been driven by theoretical considerations, rather than by attempts to identify the ethical problems arising in automated road traffic. The ethical problems of crash avoidance, in particular the speed–safety trade-offs and the other trade-offs described above, will in all probability be much more important and should therefore be at the centre of the ethical discussion. The bottom line would be that people would not buy an automated vehicle which would endanger their own lives.

## II. Discuss the role of an ethical framework in science and research.

Ethical frameworks are required because they could give consistent solutions on what is right or wrong conduct in research. Ethical theories built on solid moral principles help in this direction. But, can we really have such universal theories? Unfortunately, no, because ethics is tough. One way out is to use our reason to figure out ethical guidelines for our conduct and consciously follow those rules. Present day research environment is quite prone to problems and needs constant course corrections. For many young scientists, research has become a mine-field of ethical issues. Therefore, the need of the hour is make ourselves aware of the serious ethical issues that we would have to confront at some point of time in our careers. A proper ethical framework will facilitate innovative research by encouraging the research community to share their guidance, experience and solutions to ethical dilemmas. The framework must ensure that research should be designed, reviewed and undertaken to ensure integrity, quality and transparency. In medical research, the confidentiality of information supplied by research participants and the anonymity of respondents must be respected. Research participants must take part voluntarily, free from any coercion and harm to them must be avoided in all instances. The independence of research must be clear, and any conflicts of interest or partiality must be explicit.

## III. Some scientists who start out with a clean slate early in their careers but commit scientific misconduct later. Describe the possible reasons behind this transformation. Describe some serious scientific misconducts.

There are several reasons for which some individuals in the field of scientific research commit scientific misconduct. The current scenario disproves the belief that misconduct in science is only due to certain “bad apples” or rogue scientists. There are factors in modern research environment that contribute to scientific misconduct. Some possible reasons that induce deviation in scientific conduct are: (1) career and funding pressures, (2) institutional failures of oversight, (3) commercial conflicts of interest, (4) inadequate

training, (5) erosion of standards of mentoring, (6) personal ambitions like fame, fortune or position, (7) cultural differences, (8) publish or perish culture and (9) part of a larger pattern of social deviance. Under such conditions, the overworked, underfunded and under-published researchers are stressed enough to abandon their personal value systems. Scientific misconducts range from unintentional like wrong observations or analysis to very intentional outright fraud like fabrication and falsification of data and plagiarism. The transition goes through some seemingly unintentional misconducts like undeclared conflicts of interest, publication bias, etc. Serious ones are: 1) fabrication of data, where there is reporting results of experiments never done and cooking up of data. Fabricated results are not based on actual authentic data. 2) Falsification of data, where experiments are performed but the outcome of the experimentation is manipulated. It is manipulation of research materials, equipment, processes, and modifying or omitting of data results in such a way that the research is not accurately represented in the research records. 3) Plagiarism, where there is appropriation of another person's ideas, processes, results or words without giving appropriate credit where it is due. It is presentation of someone else's research plan, manuscript, article or text or parts thereof as one's own.

- IV. Plagiarism in research has become a scourge nowadays. Why do scientists indulge in plagiarism? What are the steps that you should adopt in order that you do not plagiarize and also, that your work should not get plagiarized or scooped?

One of the most common reasons that scientists indulge in plagiarism is lack of confidence in their scientific skills. This invariably leads to copying from others whom they idolize or see as more talented. Lack of proper writing skills also contributes in this regard. Another common reason is lack of efficient time management. Present day scientific research is extremely time-bound with very tight schedules for different tasks in a particular project or program. Scientists who manage their time schedules poorly often face immense pressure to complete the tasks and writing of a manuscript which usually happens at the end of a complex sequence of tasks, becomes a horrendous task. Sometimes younger scientists get overloaded with tasks by the senior scientists. There is a huge temptation at this stage to plagiarize from other works. Another reason is lack of seriousness in research work which could lead to such people plagiarizing other works. Another class of scientists feel that they are dare-devils and no one can catch them. They just simply plagiarize for the sake of it, smug in the belief that they will never be caught. Hence, the reasons for which scientists plagiarize are a complex mixture of competitive pressures, personal circumstances, individual psychology, poor supervision and inadequate training.

One of the first steps to be taken to prevent plagiarism would be to reach out and boost the confidence of the affected scientists. They may be provided with the necessary skills, especially in writing manuscripts, and made to believe that they can succeed. Those who are very poor at time management skills may also be given guidance on the same and care may be taken not to overload such people or push them beyond what they are capable of. For those who think that they would never get caught plagiarizing, plagiarism software comes in very handy. The number of such people is very much less now. Proper mentoring on what is incorrect and correct and improving writing and paraphrasing skills would go a long way in preventing plagiarism.

It is important that if one is doing path-breaking research work, special care must be taken to disseminate or publish the scientific knowledge so generated. Recourse may also be taken to putting up the work in the repositories or archives of the respective fields of research. This would ensure that the credit remains with the author.

- V. What are conflicts of interest and in scientific research and publishing, who are the various people or entities having conflicts of interest? Elaborate by giving some examples.

There must be clear definitions of conflicts of interest and processes for handling conflicts of interest of authors, reviewers, editors, journals and publishers, whether identified before or after publication. Conflicts of interest are situations that have the potential to influence people's judgments. Such situations may affect, or may be perceived to affect, every stage of research, from planning to applying for or allocating funding, conducting a study, interpreting data and reporting research. In publishing, conflicts of interest could influence peer review, editorial decisions and publication management and hence, it is required to minimize the effect of conflicts of interest and thereby help maximize the objectivity and integrity of the research and scholarly literature. A conflict of interest (COI) is a situation in which a person or organization is involved in multiple interests, financial interest, or otherwise, one of which could possibly corrupt the motivation of the individual or organization. The presence of a conflict of interest is independent of the occurrence of impropriety. A competing interest is anything that interferes with, or could reasonably be perceived as interfering with, the full and objective presentation, peer review, editorial decision-making, or publication of research or non-research articles submitted to a journal. Competing interests can be financial or nonfinancial, professional, or personal. Competing interests can arise in relationship to an organization or another person. Competing interests may arise in the conduct of research itself, and in the context of publishing are thus not restricted to the presentation, peer review, decision making, or publication of articles in journals. Authors, journal editors, reviewers, and funding agencies can have conflicts of interest in various aspects. For example, on the editorial board of all academic journals, editors should carry a COI statement that reflects their past history, as well as actual relationships and positions that they have, as these may influence their editorial functions. Editors form extensive networks, either with other professionals, industry, academic bodies, journals, or publishers. Such networks and relationships may influence their decisions or even their subjectivity towards a set of submitting authors, paper, or institute, ultimately influencing the peer review process

- VI. What are Hybrid and Open Access journals? Discuss the advantages and disadvantages of both.

Some subscription based journals have started a new system of publishing called the Hybrid mode. In this, some articles in the journal could be made Open Access on payment of specific charge, usually termed as Article Publication (Processing) Charge (APC). The funds required for APC are again recovered from the authors or their institutions and the reader would be able to download the articles for free. This is

basically a “purchase of extra visibility at a price” and presently, a number of large publishing houses offer this system for their author groups. If an author publishes an Open Access article through his institution which already subscribes to the journal, then the article is paid for twice, and this is called Double-dipping. Hence, there should be a decrease in the subscription cost to the library based on the number of Open Access articles from that institute. Hybrid mode is sometimes discriminatory against Third World and low-income countries and institutions which do not have large library budgets and scholars. APCs are too high and waivers are too few. APCs are not sensitive to the market but closely connected to the perceived value of the publication. There is a lack of discoverability makes this option not really the best value for money. More money goes into hybrid which could be otherwise spent on more innovative and more sustainable publishing models.

Open Access (OA) journals were established mostly by non-profit societies like PLoS, Public Library of Science in the US and BMJ. APCs are the central means of financing professional publishing. From year 2000 onwards, importance of APC as a business model for OA publishing has really grown several folds. Many large subscription journals have started full open access journals funded by APCs. OA journals using this model charge anywhere between USD 1000 – 3000 as APC, which is a substantial barrier for many, especially in the Third World. While an author transfers the copyright on his published paper to a subscription journal, it is retained in the case of OA journal authors. If anyone wishes to use any part of a published paper in a subscription journal, they will have to obtain permission while OA journals often use Creative Commons licenses (CC licenses). With these licenses, users can share, use, and build upon the original work. Many OA journals have reasonably good impact factors, making them attractive to publish. OA journals, at least those established by well-known societies and publishing houses, follow the same standards of scientific peer review, production and publishing as those followed by the subscription based journals. But there is reason to believe that these standards could go for a toss in view of the profits involved.

VII. What are authorship disputes and how can they be resolved? How are these different from authorship misconduct? Elaborate on different types of authorship misconduct.

ICMJE has laid down four criteria for authors: (1) Substantial contributions to the research work, (2) Drafting and critical revision for important intellectual content, (3) Final approval of the version to be published, (4) Agreement to be accountable for all aspects of the work.

Authorship issues are not uncommon and these can also threaten the scientific integrity. Authorship disagreements which do not contravene ICMJE guidelines can be classified as ‘authorship disputes’. Various levels of expectations on the part of contributors regarding authorship/ acknowledgment exist and can vary between disciplines, countries, cultures, etc. It is always better to discuss authorship issues at the start of the project. Such discussions can clarify roles and responsibilities. They can also minimize heartburn and increase motivation. Some major questions that could be thrashed out could be:

1. Before submission or presentation, who will be authors and who will be acknowledged as contributors.



2. Who will be the first (and/or corresponding) author and what will be the order of authorship.
3. Responsibilities and expectations of each contributor.
4. Intellectual property and confidentiality issues involved that may affect the publication.
5. Who gets to decide where and when the manuscript will be submitted.

Roles and contributions to a research activity could keep changing during the course of the work and it would be difficult to appropriately evaluate each person's contribution until the manuscript is written or even just before the final version. Hence, there is a need to re-assess authorship roles whenever significant changes occur. Care should be taken to protect research students who, due their disadvantaged power position, could become vulnerable to exploitation.

Authorship disagreements that violate the ICMJ guidelines can be classified as 'authorship misconduct'. Some typical examples of authorship misconduct are:

- (a) Ghost authorship where authors who contributed to the work but are not listed generally to hide a conflict of interest from editors, reviewers and readers,
- (b) Guest authorship where individuals are given authorship credit even though they have not contributed in any substantive way to the research but are added due to their stature,
- (c) Orphan authorship, where authors who have contributed materially to the work but are omitted from author list unfairly by the head of the laboratory, and
- (d) Forged authorship where unwitting authors who had no part in the work but whose names are appended to the paper without their knowledge to increase the likelihood of publication.

VIII. How different is plagiarism from other types of gross scientific misconduct? What is role of plagiarism detection software and are they effective as they are purported to be? If not, give reasons?

Plagiarism is appropriation of another person's ideas, processes, results or words without giving appropriate credit where it is due. It is presentation of someone else's research plan, manuscript, article or text or parts thereof as one's own. Therefore, while data fabrication and falsification have a clearly identifiable perpetrator, plagiarism will have a clearly identifiable victim in addition, whose credit has been stolen. This makes plagiarism quite unique when compared to other forms of gross scientific misconduct. In order to fight this grave misconduct, there are a number of aids available today in the form of plagiarism detection software. They have helped in a number of cases of plagiarism by detection of repeated text strings in manuscripts. But there have been a number of occasions where such software has failed to detect cleverly masked plagiarized text. Also, such software cannot detect when scientific ideas are plagiarized without giving due credit. Hence, software cannot determine plagiarism but can only point to cases of matching text. Such software can be useful for flagging up cases but not for discriminating between originality and plagiarism. This would require human intervention with careful reading of the manuscripts.

**The above answer key is only a guide to the examiner. One may expect some interesting arguments, especially for the ethics questions, and the examiner is requested to exercise his/her discretion and judgment while awarding marks.**

## Research Methodology, Module C at HRI

Course Structures: This course will be offered at HRI. The timing will be mentioned in due time.

**Experimental Methods:** Verifying/formulating conjectures through examples or to check possibilities etc. Examples.

**Computational Methods:** Introducing Sage and similar softwares usually used in Mathematics research, and practicals with these.

**Literature Survey:** Familiarise students with Mathscent, zbMath, ArXiv and other survey portals.

**Participation in Scientific Activities:** Importance of participation in internal seminars, workshops and conferences, and how to get best out of these activities.

**Mathematical Writings:** Mathematical writing style, precision and organisation of articles etc.

**Typesetting with Latex Software:** Familiarising students with typesetting with Latex, mostly practical.

**Technical Presentation:** An introduction to Beamer and practical session for preparing Beamer slides for Technical presentation in Latex.

**Publications of Findings:** Awareness on journal standard/quality, relevance (and irrelevance) of impact factors and other quotients. How to choose a journal for publication of the result.

**Plagiarism Check:** Plagiarism Check using computer softwares, including a demonstration.

**Reports:** The process of writing academic reports including annual progress report.

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