# Revised Syllabus for Ph. D. Course Work in Mathematics

## (From the Academic Year 2020-21)

a) The Course Pattern and Scheme of Examination:

| Papers | Particulars | Hours of Instruction per week | Duration of Examination (Hrs) | IA | Theory | Total | Credits |
|---|---|---|---|---|---|---|---|
| | | | | Marks | | | |
| Paper 1 | Research Methodology | 4 | 3 | 30 | 70 | 100 | 4 |
| Paper 2 | Research and Publication Ethics | 2 | 2 | 10 | 40 | 50 | 2 |
| Paper 3 | Review of Literature | | | | | | |
| | Review Report | 16 | - | - | - | 150 | 6 |
| | Viva | - | - | - | - | 50 | |
| | | | | | | Total: | 12 |

b) The research candidate has to undergo course work for a minimum period of one semester.

c) Internal Assessment (IA) marks for Paper 1 and Paper 2 shall be based on at least one written test and one seminar/assignment.

## Pattern of Semester Examination Question Papers for Paper 1 and Paper 2

**Paper 1.** The question paper shall contain Part A and Part B. Part A shall contain 10 short answer questions of 2 marks each out of which 7 questions are to be answered. Part B shall contain 8 questions of 14 marks each out of which 4 questions are to be answered.

**Paper 2.** The question paper shall contain Part A and Part B. Part A shall contain 6 short answer questions of 2 marks each out of which 5 questions are to be answered. Part B shall contain 4 questions of 10 marks each out of which 3 questions are to be answered.

## Programme Outcomes

- **Domain knowledge:** Demonstrate knowledge of post graduate concepts, principles and applications of the specific science discipline.
- **Resource Utilization.** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.
- **Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
- **Critical thinking and Problem solving:** Identify and critically analyse relevant problems in the respective discipline with the aid of tools and techniques so as to approach to arrive at viable conclusions/solutions.
- **Project Management:** Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organizational skills and the ability to manage time and resources.
- **Individual and team work:** Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Effective Communication:** Communicate effectively in spoken and written form as well as through electronic media with scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
- **Environment and Society:** Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
- **Ethics:** Commitment to professional ethics and responsibilities.
- **Life-long learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline.

## Programme Specific Outcomes

At the end of the programme, the student will be able to

- Improve the research problems solving skills.
- Collaborate with the other related areas.
- Improve the theoretical knowledge of Mathematical concepts.
- Creatively apply the knowledge of Mathematics in selected real life situations.
- Adopt the professional/research ethics.

## Paper 1: Research Methodology

(Common to all candidates) **(50 Hours; 4 Credits)**

**Unit 1: Review and update of theory and problem solving skill in Algebra:**

Examples of Groups and General Theory, $S_n$, $A_n$, $D_n$. Direct products, Free Groups, Products, Generators and Relations, Finite Groups. Rings and Ideals, Polynomials, Fields and their Extensions, Elementary Number theory.

Vector Spaces, Rank and Determinants, Systems of Equations, Linear Transformations, Eigen values and Eigen vectors, Canonical forms, Similarity, Bilinear, Quadratic forms and Inner product spaces, General theory of matrices.                                    **(20 hours)**

**Unit 2: Review and update of theory and problem solving skill in Real and Complex Analysis:**

Limits and Continuity, Sequences, Series and Products, Differential Calculus, Integral Calculus, Sequences of functions, Fourier Series, Convex Functions.

Conformal mappings, Integral representation of analytic functions, Functions on the unit disc, Analytic and Meromorphic functions. Zeros and singularities, Harmonic functions and Residue theory.    **(20 hours)**

**Unit 3: Review and update of theory and problem solving skill in Topology:**

Topology of $R^n$, General theory, Fixed point theorem.                       **(10 hours)**

**References:**

[1] Paulo Ney de Souza, Jorge-Nuno Silva, *Berkeley Problems in Mathematics,* Springer- Verlag, 2004.

[2] Michael Artin, *Algebra,* Prentice-Hall of India, 1996.

[3] Walter Rudin, *Principles of Mathematical Analysis,* McGraw Hill, 3rd edition, 1976.

[4] Walter Rudin, *Real and Complex Analysis,* McGraw Hill International Edition, New Delhi, 1987.

[5] J. R. Munkres, *Topology,* Prentice-Hall of India, 2nd edition, 2000.

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## Paper 2: RESEATCH AND PUBLICATION ETHICS (RPE)
### (Common to all candidates) **(30 Hours ; 2 credits)**

### UNIT 1: Philosophy and Ethics:
Introduction to philosophy: definition, nature and scope, concept, branches.
Ethics: definition, moral philosophy, nature of moral judgments and reactions. **(4 hours)**

### UNIT 2: Scientific Conduct:
Ethics with respect to science and research. Intellectual honest and research integrity. Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. **(4 hours)**

### UNIT 3: Publication Ethics:
Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines, Conflicts of interest.
Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals. **(7 hours)**

### UNIT 4: Open Access Publishing:
Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. **(4 hours)**

### UNIT 5: Publication Misconduct:
**Group Discussions:** Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad.
**Software tools:** Use of plagiarism software by Turnitin, Urkund and other open-source software tools. **(4 hours)**

### UNIT 6: Databases and Research Metrics:
**Databases:** Indexing databases. Citation databases: Web of Science, Scopus, UGC-CARE; Mathematics subject classification, Mathematical Reviews, zbMATH, MathSciNet, ORCID, etc.
**Research Metrics:** Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score.
Metrics: $h$-index, $g$-index, $i10$-index, altmetrics. **(7 hours)**

### References:

[1] Alexander Bird, *Philosophy of Science*, Routledge, 2006.

[2] Alasdair Mac Intyre, *A Short History of Ethics*, Touchstone, London, 1967.

[3] David B. Resnik, *What is ethics in research & why is it important*, National Institute of Environmental Health Sciences, 2011, 1-10.
https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

[4] Jeffrey Beall, *Predatory publishers are corrupting open access*, Nature, 489(7415), 2012, 179-179.
https://doi.org/10.1038/489179a

[5] Praveen Chaddah, *Ethics in Competitive Research: Do not get scooped; do not get plagiarized*, 2018.

[6] Radhakrishna L., *Write Mathematics Right: Principles of professional presentation*, Exemplified with Humor and Thrills, Narosa, 2013.

[7] *On Being a Scientist: A Guide to Responsible Conduct in Research*, Edited by Committee on Science, Engineering and Public Policy, National Academy of Science, National Academy of Engineering, and Institute of Medicine of the National Academies, Washington, DC, 3rd edition, 2009.

[8] *Ethics in Science Education, Research and Governance*, Edited by K. Muralidhar, Amit Ghosh, A.K. Singhvi, Indian National Science Academy (INSA), New Delhi, 2019.
https://www.insaindia.res.in/pdf/Ethics_Book.pdf

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