PhD Mathematics

Course Structure and Syllabus

(Based on Choice Based Credit System)

2016 onwards

IK Gujral Punjab Technical University

VISION

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the future leaders of technology and techno- innovation responsible for the techno-economic, social, cultural and environmental prosperity of the people of the State of Punjab, the Nation and the World

MISSION

- To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to promote research, discovery and entrepreneurship.
- To prepare its students to be responsible citizens of the world and the leaders of technology and techno-innovation of the 11st Century by developing in them the desirable knowledge, skills, and attitudes base for the world of work and by instilling in them a culture for seamlessness in all facets of life.

OBJECTIVES

- To offer globally relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate and research levels in various areas of engineering & technology and applied sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global technological needs, is motivated to give its best and is committed to the growth of the Nation.
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization.
- To participate in the planning and solving of engineering and managerial problems of relevance to global industry and to society at large by conducting basic and applied research in the areas of technologies.
- To develop and conduct continuing education programs for practicing engineers and managers with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core competence of the University.

- To develop strong collaborative and cooperative links with private and public sector industries and government user departments through various avenues such as undertaking of consultancy projects, conducting of collaborative applied research projects, manpower development programs in cutting-edge areas of technology etc.
- To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit.
- To provide leadership in laboratory planning and in the development of instructional resource material in the conventional as well as in the audio-visual, the video and computer-based modes.
- To develop programs for faculty growth and development both for its own faculty as well as for the faculty of other engineering and technology institutions.
- To anticipate the global technological needs and to plan and prepare to cater to them.
- To interact and participate with the community/society at large with a view to inculcate in them a feel for scientific and technological thought and endeavor and
- To actively participate in the technological development of the State of Punjab through the undertaking of community development programs including training and education programs catering to the needs of the unorganized sector as well as that of the economically and socially weaker sections of society.

ACADEMIC PHILOSOPHY

The philosophy of the education to be imparted at the University is to awaken the **"deepest potential"** of its students as holistic human beings by nurturing qualities of self-confidence, courage, integrity, maturity, versatility of mind as well as a capacity to face the challenges of tomorrow to enable them to serve humanity and its highest values in the best possible way.

DEPARTMENT OF MATHEMATICAL SCIENCES

VISION

To be a knowledge nerve centre in Mathematical Sciences, Pure and Applied Research and industry requirements for creating sustainable infrastructure and enhancing quality of life

MISSION

1. To offer globally-relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate and research levels in various areas of Mathematical sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global scientific and technological needs, is motivated to give its best and is committed to the growth of the Nation;
2. To develop and conduct continuing education programs for Science graduates with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core specialization of the University;
3. To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit.

PhD (Mathematics) Program

The main objective of this program is to cultivate a mathematical aptitude and nurture the interests of the students towards problem solving aptitude. Further, it aims at motivating the young minds for research in mathematical sciences and to train computational scientists who can work on real life challenging problems. It further aims at motivating the students to pursue research and teaching as profession.

Duration: PhD Mathematics is an advance research level program of the Department of Mathematics which is 8-years (maximum) program. It is consisting of a Pre-PhD course work of one semester duration and six-monthly progress reports evaluated by RAC (Research Advisory Committee).

Program Code: MPHM (Doctor of Philosophy in Mathematics)

Eligibility: M.A./M.Sc. or equivalent from a recognized university with Mathematics as one of the major subjects with at least 55% marks in aggregate or its equivalent grade B in UGC 7-point scale. A relaxation of 5% or an equivalent relaxation of grade shall be allowed to SC/ST/OBC (non-creamy layer) or other categories decided by commission from time to time. The candidate must qualify PhD Entrance Exam and Interview conducted by the University. The NET/GATE qualified candidates are exempted from PhD Entrance Test.

PROGRAM OBJECTIVES: The Program Objectives are the knowledge skills and attributes which the students have at the time of post-graduation. At the end of the program, the student will be able to:

PO1	Apply the scientific knowledge of Mathematics specialization for deeper understanding of the real world phenomena.
PO2	Identify, formulate, research literature, and analyze advanced scientific problems reaching substantiated conclusions using first principles of mathematics.
PO3	Design solutions for advanced scientific problems and design system components for multi-disciplinary field processes.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of results, and synthesis of the information to provide valid conclusions.
PO5	Create, select, and apply appropriate techniques, resources, and modern scientific and IT tools including prediction and modelling to complex scientific activities with an understanding of the limitations.
PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional scientific practices.
PO7	Communicate effectively on complex scientific activities with the Scientific/engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change.

PROGRAM SPECIFIC OUTCOMES: At the end of the program, the student will be able to:

PSO1	Apply principles of advance mathematical concepts in understanding, applying and analysis of mathematical problems.
PSO2	To develop human resource with specialization in theoretical and experimental techniques required for career in academia, research and industry.
PSO3	To introduce advanced ideas and techniques required in emerging areas of Mathematics.
PSO4	Engage in lifelong learning and adapt to changing professional and societal needs.

Scheme of the Pre PhD Course Work

Contact Hours: 17 Hrs.

Course Code	Course Title	Course Type	Load Allocation			Marks Distribution			Credits
			L	T	P	Internal	External	Total	
MPHM-101	Research Methodology	Compulsory	4	0	0	40	60	100	4
MPHM-102	Methods in Applied Mathematics	Elective	4	0	0	40	60	100	4
MPHM-103	Continuum Mechanics		4	0	0	40	60	100	4
MPHM-104	Advanced Analysis		4	0	0	40	60	100	4
UC-MSM-504-18	Advanced Number Theory		4	0	0	40	60	100	4
UC-MSM-510-18	Advanced Numerical Analysis		4	0	0	40	60	100	4
MPHM-105	Presentation/Seminar	Compulsory	3	0	0	75	0	75	3
MPHM-106	Interdisciplinary	Compulsory	4	0	0	40	60	100	4
	Research and Publication Ethics (RPE)	Compulsory	2	0	0	20	30	50	2
Total			17	0	0	215	210	425	17

MPHM-101	Research Methodology	L-4, T-0, P-0	4 Credits

Pre-requisite: Students must have the knowledge of basic statistics and excel, word, LATEX software and online search engines.

Course Objectives: The objective of the course on **Research Methodology** is to equip the PhD scholars with the practical aspects of LATEX, Mathematica and MATLAB software and theoretical aspect of multivariate analysis. Their applications in paper writing, data analysis and modelling of research problems. Furthermore, students will be introduced to Online resources for research literature.

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

CO1	Understand the basic concepts of LATEX packages and data statistics.
CO2	Able to use research methods in research literature flow charts.
CO3	Sketch graphs, draw flow charts, survey research related problems and infer data using multiple discriminant analysis.
CO4	Apply the knowledge of Multivariate analysis and computational techniques in research problem analysis.
CO5	Understand the fundamental relation between motivation of research and Methods in research.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					√		√	
CO2	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√

RESEARCH METHODOLOGY

MPHM-101

1. **Introduction to Research**Objectives of research, motivation in research, types of research, significance of research, research methods vs methodology, research process in flow chart, criteria of good research, problems encountered by researchers in India.
2. Difference between TEX and LATEX, basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and installing LATEX packages.
3. Introduction to MATHEMATICA and MATLAB
4. Introduction to origin, basics of importing and exporting data, working with Microsoft excel, graphing, statistics in origin, hypothesis testing, power and sample size, basic linear regression and curve fitting.
5. Error Analysis and Basic Statistics Measuring errors, uncertainties, parent and sample distributions, mean and standard deviation of distribution, types of probability distribution, instrumental and statistical uncertainties, propagation of errors, specific error formulas, method of least square fitting.
6. **Multivariate analysis**: Multiple regression. multiple discriminant analysis. multiple
analysis of variance. canonical correlation analysis. Factor analysis cluster analysis. path analysis. Computational techniques.
7. **Survey of literature**: The students will be required to review literature in their respective disciplines and submit an assignment for evaluation.

REFERENCES:

1. Research methodology (http://www.newagepublishers.com/samplechapter/000896.pdf)

2. The not so short introduction to LATEX by TobianOetiker, Hubert Partl, HreneHyna

and Elisabeth Schlegl, Version 4.16, May 08, 2005 (http://tobi.oetiker.ch/lshort/lshort.pdf)

3. T.Veerarajan and T. Ramachandran "Numerical methods" Tata McGraw Hill. New Delhi. 2008

4. Data reduction and error analysis for physical sciences by Philip R. Bevington and D.

Keith Robinson

(http://www.physast.uga.edu/files/phys3330_fertig/BasicErrorAnalysis.pdf)

MPHM-102	Methods in Applied Mathematics	L-4, T-0, P-0	4 Credits

Pre-requisite: Students must have the basic knowledge of Integral and Differential equations.

Course Objectives: The objective of the course on **Methods in Applied Mathematics** is to equip the PhD scholars with the theoretical aspects of classical Fredholm theory, Gibbs phenomena, Complex Fourier Transformation and Wavelet transforms. Their applications in multiresolution analysis. Furthermore, students will be introduced to Hankel and Mellin transforms and their applications.

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

CO1	explain the different types of Differential and Integral Equations.
CO2	visualize wavelets and general construction of wavelets using computational techniques.
CO3	apply the knowledge of Gibbs Phenomena and Stormberg wavelet.
CO4	explain the between wavelet transform and Fourier transform.
CO5	study further the periodic wavelets, classical Fredholm theory and Complex Fourier integral.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	√	√	√	√	√		√	
CO2	√	√	√	√	√		√	
CO3	√	√	√	√	√		√	
CO4	√	√	√	√	√		√	
CO5	√	√	√	√	√		√	

MPHM-102 Methods in Applied Mathematics

UNIT-I

Integral Equations: Their origin and classification. Relation between differential and Integral equations. IVP AND BVP reducible to Integral equations. Integral equation with separable kernals. Method of successive approximations. Classical Fredolm theory.

UNIT-II

Fourier series and its convergence. Gibbs phenomenon. Integration and Differentiation of Fourier Series. the phase angle form of Fourier series. Complex Fourier series and frequency spectrum. Fourier Integrals. Fourier Cosine and sine Integrals. Complex Fourier Integrals.

UNIT-III

Fourier transforms Properties of Fourier Transform and its Applications. Convolution. Fourier cosine and Sine transforms. Discrete Fourier Transforms. Fast Fourier Transform. Solution of equations. Hankel and Mellin transforms and their Applications.

UNIT-IV

Wavelets: History of wavelets. The Haar wavelets. The Stromberg Wavelet. Wavelet expansion. Multiresolution analysis with Haar wavelets. Periodic wavelets. General Construction of wavelets. Wavelet transform versus Fourier transform.

Suggested Readings/ Books:

1. Ram P. Kanwal: Linear Integral Equations. Academic Press (1971)
2. Abdul J. Jerri: Introduction to Integral Equations with Applications. Monographs and Text Books in Pure and Applied Mathematics. Marcel Dekker. INC (1985)
3. F. B Hildebrand: Methods of Applied Mathematics. Dover Publication (1965)
4. Lokenath Debnath and Dambaru Bhatta: Integral Transforms and Their Applications. Second Edition Chapman and Hall/ CRC (2006)
5. Brian Davies: Integral Transforms and Their Applications. Text Book in Applied Mathematics. Vol 41. 3rd Edition. Springer (2002)
6. P. Wojtaszczyk. A Mathematical Introduction to wavelets. London Mathematical Society Students Text. 73. (1999)
7. Veronique Delouille: An Introduction to Wavelet Analysis. Connexions. (2009)
8. Willard Miller. Introduction to the Mathematics of Wavelets, University of Minnesota. (2006)
9. Peter V. O'Neil. Advanced Engineering Mathematics. Thomson.

MPHM-103	Continuum Mechanics	L-4, T-0, P-0	4 Credits

Pre-requisite: Students must have the basic knowledge of Mass, density, laws of motion and elasticity.

Course Objectives: The objective of the course on **Continuum Mechanics** is to equip the PhD scholars with the theoretical aspects of continuum mechanics, stress, strain, equilibrium equations and balance of energy. Their applications in initial and boundary value problems of viscous fluids flows. Furthermore, students will be introduced to Entropy inequality and Navier-Stokes equation.

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

CO1	explain the basic concepts of mass, density, motion, spatial coordinates, stress, tensor, elasticity, shear velocity, bulk velocity etc.
CO2	apply the knowledge of stress analysis to homogenous isotropic bodies.
CO3	use programming in plotting and visualization of graphs of action of surface forces on fluids.
CO4	obtain governing equations for a viscous fluid flow.
CO5	study further the balance of energy, entropy inequality and Euler's equation of motion.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	√	√	√	√	√		√	
CO2	√	√	√	√	√		√	
CO3	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√		√	
CO5	√	√	√	√	√		√	

MPHM 102 Continuum Mechanics

Unit-I

Continuum Hypothesis: Notion of Continuum. Configuration of a Continuum. Mass and Density. Description of motion. Material and Spatial Coordinates

Analysis of Strain: Affine Transformation. Infinitesimal Affine Deformation. Geometrical Interpretation of the Components of Strain. Strain Quadric of Cauchy. Principal Strains. Invariants. General Infinitesimal Deformation. Examples of strain. Notation. Equations of Compatibility. Finite Deformation

Unit-II

Analysis of Stress: Body and Surface Forces. Stress Tensor. Note on Notation and Units. Equations of Equilibrium. Transformation of Coordinates. Stress Quadric of Cauchy. Maximal Normal and Shear Stresses. Examples of Stresses

Stress Strain Relations: Hookes law. Generalized Hookes law. Homogeneous isotropic bodies. Elastioc moduli of isotropic bodies. Equilibrium Equations for an isotropic elastic solid. Dynamical equations of an isotropic elastic solid.

Unit-III

The strain energy function and its connection with Hooke's law. Uniqueness of solution of the

Boundary-value problems of Elasticity. Saint-Venant's
Principle.

Fundamental laws of continuum mechanics: Conservation of mass. Balance of linear momentum. Balance of angular momentum. General solutions of the Equation of Equilibrium. Balance of energy. Entropy inequality. Constitutive Equations

Unit-IV

Equations of fluid mechanics: Viscous and non-Viscous fluids. Stress tensor for a non-viscous fluid. Governing Equations for a non-viscous fluid flow. Initial and boundary conditions. Euler's equation of motion. Equation of motion of an elastic fluid. Stress tensor for a viscous fluid. Shear viscosity and bulk viscosity. Governing equation for a viscous fluid flow. Initial and boundary conditions. Navier- Stokes equation.

Suggested Readings/ Books:

1. Sokolnikoff, I.S., *Mathematical Theory of Elasticity*, Krieger Publishing Company (1983).

2. Chandrasekharaiah and Debnath, *Continuum Mechanics*, Academic Press (1994).

3. Jog, C. S., *Foundations and Applications of Mechanics: Volume I: Continuum Mechanics*, Norosa Publications, (2006).

MPHM-104	Advanced Analysis	L-4, T-0, P-0	4 Credits

Pre-requisite: Students must have the basic knowledge of Fourier Transformation, compact space and variational problems.

Course Objectives: The objective of the course on **Advanced Analysis** is to equip the PhD scholars with the theoretical aspects of test functions and their distributions, trace theory. Elliptic boundary value problems and eigen value problems. Their applications in weak solutions of elliptic boundary value problems. Furthermore, students will be introduced to Galerkin method and finite element methods.

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

CO1	understand and describe the different concepts of Schwartz space, tempered distributions, and finite element methods.
CO2	obtain the weak solutions of elliptic boundary value problems.
CO3	analyze operations with distributions and trace theory.
CO4	understand Galerkin method and maximum principles in eigen value problems.
CO5	have a solid foundation in fundamentals required to solve elliptic boundary value problems.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	√	√	√	√		√	√	√
CO2	√	√	√	√		√	√	√
CO3	√	√	√	√		√	√	√
CO4	√	√	√	√		√	√	√
CO5	√	√	√	√		√	√	√

Advanced Analysis

Unit-I

Distributions: Test functions & Distributions, Some Operations with Distributions, Supports and Singular Supports of Distributions, Convolution of functions, Convolution of Distributions, Fundamental solutions, The Fourier Transform, The Schwartz Space, The Fourier Inversion formula, Tempered Distributions.

Unit-II

Sobolev spaces: Definition and basic properties, Approximation by smooth functions, Extension theorems, Imbedding theorems, compactness theorem, Dual spaces, fractional order spaces, trace spaces, trace theory

Unit-III

Weak solutions of elliptic boundary value problems: Some abstract variational problems, examples of elliptic boundary value problems, Regularity of weak solutions, Examples of Galerkin method, Maximum Principles, eigen value problems, Introduction to Finite element methods.

Reference Book:

S Kesavan: Topic in Functional Analysis and Applications, New Age Publishers (P) Limited; 2003.

Chapter-1, 2 and 3.

UC-MSM-504-18	Advanced Number Theory	L-4, T-0, P-0	4 Credits

Pre-requisite: Elementary Number Theory

Course Objectives: This Course helps the students to understand the concept of Partitions and Compositions. In this course we introduce the concepts of various identities like Jacobi's triple product identity, Gollnitz-Gordon identities, Rogers-Ramanujan type identities for n-color partitions, and their applications. Also, the weak and strong versions of various important theorems.

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

CO1	understand the different types of partitions & compositions.
CO2	students will have a working knowledge of the various types of identities
CO3	work with congruence's, solve congruence equations and systems of equations with one and more variables.
CO4	be literate in the language and notation of number theory.
CO5	understand the concept of for n-color partitions

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	√	√	√	√		√	√	√
CO2	√	√	√	√		√	√	√
CO3	√	√	√	√		√	√	√
CO4	√	√	√	√	√	√	√	√
CO5	√	√	√	√		√	√	√

Course Title: Advanced Number Theory

Course Code: UC-MSM-504-18

UNIT-I

Partitions, Compositions, Ferrers graphs, Jacobi's triple product identity, Congruence properties of $p(n)$, Rogers-Ramanujan identities, Basic hypergeometric series, q-binomial theorem, Sylvester's theorem (Statement only), Heine's transformation (Statement only).

UNIT-II

Restricted partitions, q-Gauss theorem, Gaussian polynomials, Bailey's lemma (weak version) (Statement only), Rogers lemma, q-Saalschutz's theorem (Statement only), Finite version of q-Saalschutz's theorem.

UNIT-III

Schur's theorem, Gollnitz-Gordon identities, Generalization and various analogues of Rogers-Ramanujan identities, Bailey's lemma (strong version) (Statement only), Watson's q-analogue of Whipple's theorem (Statement only) and its applications in deriving Rogers-Ramanujan identities and Gollnitz-Gordon identities.

UNIT-IV

Rank & Crank of a partition, n-colour partitions, Conjugate and self-conjugate n-colour partitions, Restricted n-colour partitions, Rogers-Ramanujan type identities for n-colour partitions.

RECOMMENDED BOOKS:

1. Agarwal, A.K., Padmavathamma and Subbarao, M.V., *Partition Theory*, Atma Ram & Sons, Chandigarh, 2005.
2. Andrews, G.E., *The Theory of Partitions, Encyclopedia of Mathematics and its Applications* (Addison-Wesley), 1976, Re-issued: Cambridge University Press, Cambridge, 1988.
3. Gasper, G. and Rahman, M., *Basic Hypergeometric Series, Encyclopedia of Mathematics and its Applications,* Vol. 35, Cambridge University Press, Cambridge, 1990.
4. Agarwal, R.P., *Resonance of Ramanujan Mathematics,* Vol. 1 (New Age International), 1996.
5. Gupta, H., *Selected Topics in Number Theory*, ABACUS Press, 1980.
6. N.J. Fine, *Basic Hypergeometric Series and Applications*, Mathematical Surveys and Monographs, No. 27, American Mathematical Society, 1988.

UC-MSM-510-18	Advanced Numerical Methods	L-4, T-0, P-0	4 Credits

Pre-requisite: Basic Calculus and analysis. Basic numerical analysis

Course Objectives: This course is designed to provide a theoretical introduction and application of advanced numerical methods for solving different types of problems viz. linear systems, eigenvalues problems, ordinary and partial differential equations arising in various field of applications, for example in science, engineering, and economics etc. The major focus will be on development, analysis and implementation of numerical methods keeping in mind advantages & limitations of these methods.

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

CO1	Apply the knowledge of advanced numerical methods to solve different types of problems viz. linear systems, eigenvalues problems, ordinary and partial differential equation arising in various field of applications for example in science, engineering and economics etc.
CO2	Understand advantages and limitations of advanced numerical methods.
CO3	Select and implement an appropriate numerical method for solving a given problem keeping in mind nature of the problem.
CO4	Use theoretical basis of these methods in order to study their counterparts existing in the scientific literature.
CO5	Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically) and find their appropriate solutions accurately and efficiently.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√

Course Title: Advanced Numerical Methods
Course Code: UC-MSM-510-18

Unit-I

Iterative Methods for Linear Systems & Eigenvalue problem: The classical iterative methods: Jacobi, Gauss-Seidel and Successive Over Relaxation (SOR) methods. Conjugate gradient method. Eigenvalues & eigenvectors: Rayleigh power method & Givens method.

Unit-II

Finite Difference Methods: Explicit and implicit schemes, consistency, stability and convergence, Lax equivalence theorem, numerical solutions to elliptic, parabolic and hyperbolic partial differential equations.

Unit-III

Approximate methods of solution: Rayleigh-Ritz, collocation and Galerkin methods, properties of Galerkin approximations, Petrov-Galerkin method, Generalized Galerkin method.

Unit-IV

Finite Element Method (FEM): FEM for second order problems, One- and two-dimensional problems, The finite elements (elements with a triangular mesh and a rectangular mesh and three-dimensional finite elements), Fourth-order problems, Hermite families of elements, iso-parametric elements, numerical integration.

BOOKS RECOMMENDED:

1. Jain, M.K, Iyengar, S.R.K. and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation*, 5th Edition, New Age international, 2008.
2. Hoffman Joe D., *Numerical methods for Engineers and Scientists*, McGrow-Hill, 1993.
3. Atkinson, K.E, *An Introduction to Numerical Analysis,* 2nd Edition, *John Wiley*, 2004.
4. Gupta R.S., *Elements of Numerical Analysis*, McMillan India, 2009
5. Seshu P., *Textbook of Finite Element Analysis*, Prentice Hall India, 2003.

	Research and Publication Ethics (RPE)	L-4, T-0, P-0	4 Credits

Pre-requisite: Ethical and moral responsibilities towards research community.

Course Objectives: This course is designed to insight the research scholars towards their responsibility towards the research community. They will learn about the pulication misconduct, plagiarism, predatory publishers and journals.

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

CO1	familiarize with moral philosophy of Research Ethics.
CO2	acquire knowledge on definition, concept and problems that lead to unethical behavior in research.
CO3	understand predatory publishers and journals.
CO4	search relevant journals and research papers using online resources.
CO5	identify the challenging problems in research integrity and intellectual honesty.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	√	√	√	√		√	√	√
CO2	√	√	√	√		√	√	√
CO3	√	√	√	√		√	√	√
CO4	√	√	√	√	√	√	√	√
CO5	√	√	√	√		√	√	√

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Estd. Under Punjab Technical University Act, 1996
(Punjab Act No. 1 of 1997)

Ref. No. : IKGPTU/Reg/NF/ 169 *Dated :* 23.06.2021

NOTIFICATION

Sub: Introduction of two credit course "Research and Publication Ethics (RPE).

I.K. Gujral Pujnab Technical University, Jalandhar has introduced a mandatory two credit course on "Research and Publication Ethics (RPE) for all Ph.D students in their pre-registration course work from January 2021 onwards. The course content/ structure as per UGC guidelines (letter No.D.O.No.F.1-1/2018 (Journal/CARE) dated December 2019) has been included in Ph.D. course work. The details are as follows:

Research and Publication Ethics (RPE)
(2 Credits)

1. Course structure

- The course comprises of six modules listed in table below. Each module has 4-5 units.

Modules	Unit title	Teaching hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE 05	Publication Misconduct	4
RPE 06	Database and Research Metrics	7
	Total	**30**

Syllabus (as suggested by UGC)

THEORY

- **RPE 01: PHILOSOPHY AND ETHICS (3hrs.)**

1. Introduction to Philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral Philosophy, nature of moral judgements and reactions

- **RPE 02: SCIENTIFIC CONDUCT (5hrs.)**

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing.
5. Selective reporting and misrepresentation of data

- **RPE 03: PUBLICATION ETHICS (7hrs.)**

1. Publication Ethics: definition, introduction, and importance
2. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types.
5. Violation of publication ethics, authorship, and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

- **RPE 04: OPEN ACCESS PUBLISHING (4hrs.)**

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies.
3. Software tool to identify predatory publications developed by SPPU.
4. Journal finder/journal suggestion tool viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

- **RPE 05: PUBLICATION MISCONDUCT (4hrs.)**

A. Group Discussion (2hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

B. Software tools (2hrs.)

Use of plagiarism software like Turnitin, Urkund, and other open-source software tools.

- **RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)**

A. Databases (4hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3hrs.)

1. Impact Factor of journal as per Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g-index, i10 index, altmetrics

2. Course Work Structure – 17 Credits

All candidates admitted to Ph.D programme shall be required to complete the Ph.D course work, proposed by the Supervisor keeping in view the candidate's areas of research in the University Teaching Department. Pre Ph.D course work will be **17 credits and shall be offered on regular** basis at IKGTU campus.

Structure of course work is as under:

Sr. No.	Nature of Course	Name of Course	Credits	Remarks
1	Core	1. Research Methodology	4	The syllabus of RM should be formulated faculty wise such as Engineering, Sciences, Management/ Humanities and Life Sciences
		2. Subject Related theory paper	4	Discipline specific related to Advancements in theoretical methods for research.
		3. Presentation	3	Discipline specific
2.	Interdisciplinary	4. Elective	4	From list of Subjects from allied fields
3.	Research and Publication Ethics (RPE)	5. Research and Publication Ethics (RPE)	2	As Per UGC
	Total Minimum credits		**17**	

a. The candidate will have to clear Courses within the first two semesters as per the programme of the Department.

b. Direct fellowship awardees or candidates registered for Ph.D. during the middle of the semester will take up course work in the following semester

c. The syllabus for the Pre-Ph.D. course work, not covered in the ongoing PG curriculum, will be drawn by the Board of Studies or RAC subject to the approval by BoS and highest academic body of the University.

d. An Attendance less than the mandatory 75% (including 10% attendance benefit on medical grounds) in the course work shall attract cut in the scholarship /fellowship.

3. Applicability:

It is decided that the 17 credit course work will be applicable to all students which are enrolled from January 2021 onwards.

(Sandeep Kumar Kazal)
Registrar

Endst. No. IKGPTU/Reg/NF/170-174 **Dated:**23**.06.2021**

A copy is forwarded to the following officers for information please.

1. Vice Chancellor Secretariat: For information of Vice Chancellor
2. Dean (R&D)
3. Director (Main Campus): To inform all Deputy Dean (Faculty), HoDs (Teaching) and In-charge, Constituent Campuses
4. Director/Principal, Autonomous College
5. Incharge (ITS): For upload of notice in the Notice Board of University website and Ph.D admissions link also.

(Sandeep Kumar Kazal)
Registrar