UTTARANCHALUNIVERSITY

ArcadiaGrant,P.O.Chandanwari, Premnagar,Dehradun, Uttarakhand-

248007,INDIA

Detailed Course Structure & Syllabus
of
Pre Ph.D. (Mathematics)
Course Work
(As per CBCS system)
W.E.F Session 2022-23

Course Structure of the Pre-Ph.D (Mathematics) Course Work:
Applicable for Batch: 2022-23

SCHEME OF EXAMINATION

Ph.D(Mathematics)
(Effective from Academic Year 2022-23)

Under Choice Based Credit System (CBCS)

Course Structure of the Pre-Ph.D (Mathematics) Course Work:
Applicable for Batch: 2022-23

Scheme of Pre-Ph.D. Course Work

S.No	Course Code	Subject	Credits	Period			Sessional			Examination	
				L	T	P	CT-I	CT-II	Total	ESE	Sub. Total
Courses											
1.	RM-101	Research Methodology	4	4	0	0	20	20	40	60	100
2.	RM-102	Computer & Stats Application in Research	2	2	0	0	20	20	40	60	100
3.	RPE-103	Research & Publication Ethics	2	2	0	0	20	20	40	60	100
4.	DSE-104	Discipline Specific Electives	3	3	0	0	20	20	40	60	100
5.	RS-105	Seminar Presentation	2	0	0	4	20	20	40	60	100
		Total	13	11	0	4	100	100	200	300	500

List of Electives

S. No.	Course Code	Course Name
1	MTH 104 (1)	Advanced Applied Mathematic
2	MTH 104 (2)	Advanced Pure Mathematics

UTTARANCHAL UNIVERSITY

SYLLABUS

of

Ph.D(Mathematics)

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Programme Name	**Pre-Ph.D. Course Work**	Programme Code	23-
Course Code	RM-101	Credit	4
Year/Sem	1/1	L-T-P	4-0-0
Course Name	Research Methodology		

Objectives of the Course:
1. To Equip the Students with the Concept and Methodology of Research.
2. To provide knowledge about type of research, preparation of reports and thesis, designing of Research using Scientific Methods.

UNIT I (Total Topics- 7 and Hrs-12)

Introduction to Research: Definition, Nature and significance, Role and Objectives; Types of Research: exploratory, descriptive, experimental and diagnostic research, social and legal research and traditional, analytical, empirical & fundamental research, Doctrinal and non-doctrinal research methods; Various Research Designs; Scientific Research Process: Overview, Problem identification and formulation of research statement.

UNIT II (Total Topics- 7 and Hrs- 12)

Data Collection: sources, primary and secondary methods, significance of Primary and Secondary Data, questionnaire Vs. schedules; Data Processing: Editing, Coding Organization and Presentation; Attitude Measurement and scaling: Measurement Scales, Sources of Errors in Measurement, Techniques of Developing Measurement Tools, Classification and Testing (Reliability, Verification and Validity) Scales, Designing Questionnaires and Interviews.

UNIT- III (Total Topics- 5 and Hrs- 10)

Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions: Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors, Concept of Permutation, Combination & Probability for research analysis.

UNIT-IV (Total Topics- 5 and Hrs- 10)

Interpretations and Report Writing: Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report Writing, Steps in Report Writing, Layout of Report and Precautions in Writing Research Reports. Limitations of RM: Ethics in Research, Philosophical Issues in Research.

CO1. Acquire in-depth knowledge of various fundamentals, theories and principles related to the research and apply the acquired knowledge in carrying out research studies in the area of interest.

CO2. Identify, formulate and critically investigate research problems by applying research-oriented knowledge and analyze relevant data to reach certain conclusions in the form of alternative solutions to these problems.

CO3. Apply the acquired knowledge and skills to develop minds to think out of the box while carrying out research operations to conclude something.

CO4. Apply parametric and non-parametric statistical tests to verify the developed hypothesis to suggest innovative solutions to the problem being investigated.

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Reference Books

1. William G. Zikmund, "Business Research Methods", Orlando: Dryden Press.
2. C. William Emory and Cooper R. Donald, "Business Research Methods", Boston, Irwin.
3. Fred N Kerlinger, "Foundations of Behavioural Research", New Delhi: Surjeet Publications.
4. Naresh Malhotra, Marketing Research : An Applied Orientation, Pearson publication David Nachmias and ChavaNachmias, "Research Methods in the Social Sciences", New York: St.Marlia's Press.
5. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books.

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Programme Name	**Pre-Ph.D. Course Work**	Programme Code	23-
Course Code	RM-102	Credit	2
Year/Sem	1/1	L-T-P	2-0-0
Course Name	Computer & Stats Application in Research		

Objectives of the Course:

1. To appraise computational skills for research application.
2. To assess statistical method for research analysis.

UNIT I

Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system, single user, multi-user, multi-tasking single tasking, application of computer for business and research, MS-windows, Linux .Application of Internet in research : INFLIBNET, Use of Internet, sights (DOAJ), Use of E Journals, Use of E library, use of EBSCO HOST online database of Academic Libraries. Subject/field specific tools on www.freeware.com

UNIT II

Computer Application in Research,. Basic concept of Computer, Use of Internet for Research Purpose: E-mail, WWW, Web browsing, technical skills, drawing inferences from data, Research publishing tools-MS Word, Adobe acrobat, Graphics tool-MS Excel, Presentation tool-MS Power, Data Analysis Software and Analysis Techniques point. Creating presentation and adding effects, Introduction to Data analysis software-SPSS: Definition, objectives and features, data analysis using SPSS.

UNIT- III

Statistical methods for research application in analysis of data,Measurement in Research , data interpretation, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), std deviation, Measures of Relationship, Simple Regression Analysis, Correlation and Regression, Partial Correlation.

UNIT-IV

Statistical Tools-Hypothesis and Hypothesis Testing: Parametric & Non-Parametric Tests, Important Parametric Tests ,Hypothesis Testing of Correlation Coefficients ,U Test, Chi Square Test, ,T-Test.Analysis of Variance (ANOVA) , The Basic Principle of ANOVA ,ANOVA Technique, Setting up Analysis of Variance Table, Short-cut Method for One-way ANOVA, Coding Method, Two-way ANOVA .

Course Outcomes:

CO1. Acquire knowledge of concept of computer with application in Research.

CO2. Apply acquired knowledge of computer for presentation skills.

CO3. Acquire knowledge of statistical methods for Research.

CO4. Apply acquired knowledge to describe the inductive nature of quantitative data analysis.

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Reference Books
1. C. R. Kothari, "Research Methodology: Methods and techniques", New Delhi: Vishwa Prakashan.
2. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
3.Jain, Satish: "Introduction to Computer Science and basic Programming." BPB Publications, New Delhi, 1990. • Rajaraman, V., "Fundamental of Computers", Prentice Hall of India, New Delhi, 1996.

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Programme Name	**Pre-Ph.D. Course Work**	Programme Code	23-
Course Code	RPE-103	Credit	2
Year/Sem	1/1	L-T-P	2-0-0
Course Name	Research& Publication Ethics		

Objectives of the Course:
Its objectives to provide knowledge about ethics and code of research publication with concept of plagiarism.

UNIT I (Total Topics- 2 and Hrs-8)

1. Introduction to philosophy: definition, nature and scope, concept, branches

2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

UNIT II(Total Topics- 5 and Hrs- 5)

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

UNIT- III (Total Topics-7 and Hrs-7)

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

UNIT- IV (Total Topics-4and Hrs-4)

Practice

Open Access Publishing

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 tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

CO1. Recognize the basics of philosophy of science & ethics, research integrity, publication ethics and theories of research ethics.

CO2. Familiarize with important issues in research ethics, research integrity, scientific misconduct and misinterpretation of data.

CO3. Analyze the best practices for publications, publication ethics and identify the predatory publishers & journals.

CO4. Demonstrate &use plagiarism software tools, open-source software tools, citation databases and

research metrics.

CO5. Publish credible & scholarly publications in reputed peer-reviewed journals.

References-

Research and Publication Ethics, Dr Sumanta Dutta, Bharti Publications,2021

Research and Publication Ethics, Dr Santosh kumar Yadav, Anne Publications,2020

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Programme Name	**Pre-Ph.D. Course Work**	Programme Code	23-
Course Code	RS- 105	Credit	2
Year/Sem	1/1	L-T-P	0-0-4
Course Name	Seminar Presentation		

Objectives of the Course:

Main objective of this course is to develop presentation skills in the scholars and knowledge about review of literature so that they can review properly for utilisation in their research work.

Seminar Presentation-Candidate/Research Scholar has to go through the review of literature in the concerned field of research. Review of literature guidelines will be given by the concerned faculty/Dean of Department/School/College. Research Scholar has to prepare presentation on review of literature in the concerned field/ topic assigned by the department (DRC) periodically during course work. There will be minimum 3 presentations of review of literature during pre-Ph.D. course work.

- First presentation will be required in DRC/FRC for review of literature with concerned Department focus on area of research. It will be evaluated and assessment sheet will be sent from Department to Dean Research & Studies office.
- Similarly second presentation will be required by research scholar with extension of first presentation and more number of references would be added.

Internal & end term examination marks will be as per scheme. Each presentation is to be assessed by the department as per instructions from Dean-Research & Studies.

Final presentation would be required at the time of end term/sem. examination on proposed synopsis. General guidelines would be issued by Dean-Research for seminar presentation.

Course outcomes

CO1. Research Scholar would be able to develop & explore the review of literature in concerned area.
CO2. Analyze review of literature critically for finding the research gap.
CO3. Apply acquired knowledge in making systematic seminar presentations.
CO4. Apply acquired knowledge for improving development of all-round research.

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Programme Name	**Pre-Ph.D. Course Work**	Programme Code	23
Course Code	MTH 104 (1)	Credit	3
Year/Sem	1/1	L-T-P	3-0-0
Course Name	**Advanced Applied Mathematic**		

Objectives of the Course:

1. To identify the various aspects of Inventory control theory, Queuing theory, Replacement Problems its application and impact on multidisciplinary environment.
2. To provide the knowledge of differential equations (ODE and PDE) with its application.
3. To assess the detailed knowledge of numerical methods and learn Finite difference method for solution of hyperbolic, elliptic and parabolic with applications.
4. To provide the detailed knowledge of graphs, graph matrix, coloring and its properties.
5. To understand and illustrate the applications of fuzzy sets theory, Fuzzy numbers, fuzzy logic, and fuzzy relations.

UNIT-I (Total Topics -7 and Hrs-7)

Operations Research:

Linear programming problems, simplex methods, duality, Elementary queuing and inventory models, and Steady-state solutions of Markovian queuing models (M/M/1): (N/∞), (M/M/C): (∞/∞). Replacement theory, Job and sequence.

UNIT-II (Total Topics -7 and Hrs-8)

Differential Equations: First order ordinary differential equations, singular solutions, initial value problem of first order ODE, General theory of homogeneous and non-homogeneous linear ODE, Elementary PDE, equation solvable by direct integration, non-linear equations of first order, Charpit's method.

UNIT- III (Total Topics -6 and Hrs-7)

Numerical Methods: Finite difference method for elliptic, parabolic and hyperbolic problems. Stability, Consistency and convergence of finite difference scheme, Solution of system of linear equations, finite element methods for boundary value problems of ordinary and partial differential equation.

UNIT-IV (Total Topics -22 and Hrs-10)

Graph Theory: Introduction of Graph, Types of graphs, Operations on graphs, Hamiltonian paths and circuits, Directed graphs, Types of digraphs, Digraphs and binary relations, Directed paths and Connectedness, Euler Digraphs, Tree, Incidence matrix, Submatrix of A(G), Circuit matrix, Fundamental circuit matrix and rank of B, Cut-sets matrix, Path matrix and Adjacency matrix. Chromatic number, Chromatic partitioning, Chromatic polynomial, Matching's, Coverings, Four-color problem, Five-color theorem.

UNIT-V (Total Topics -26 and Hrs-11)

Fuzzy Mathematics: Crisp sets, Fuzzy sets, representation of Fuzzy sets, Basic operations on fuzzy sets, Fuzzy convex sets, α cuts, additional properties of α cuts, Decomposition theorems, Extensions principal for fuzzy sets and related theorems. Fuzzy Complements, Equilibrium of a fuzzy complement, Theorems on Fuzzy complement, characteristic Theorem for fuzzy complement, fuzzy intersection, Drastic intersection, fuzzy unions, Drastic union, theorems on t conforms, combination

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

of operations and related theorems . Fuzzy numbers, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations. Crips and fuzzy relations, Binary fuzzy relations on single set, fuzzy relations.

Course Outcomes:

CO1: Acquire a strong foundation in operation research and its application in multidisciplinary fields.

CO2: Gain a broad understanding of the different method of solving differential equations.

CO3: Acquire a suitable breadth of knowledge to provide a foundation for undertaking high level research based numerical problems.

CO4: Deep Understanding of concepts in graph theory and fuzzy set theory to create analyze mathematical models.

CO5: Demonstrate depth knowledge in chosen area of research specialization and ability to conduct independent mathematical research at professional level.

Reference Books
1. Sharma, S. D., An Introduction to Operations Research, Kedar Nath, 2020th edition.
2. Swarup, K., Gupta, P.K. and Manmohan, Operations Research, Sulthanchand, 2010.
3. Sharma, J. K., Operations Research, Theory and Applications, MACIN; 5th Edition, 2012.
4. Taha, H. A., Operations Research:An Introduction Hardcover, Pearson, 9th edition, 2010.
5. Simmons, G.F., Ordinary Differential Equation with applications and Historical notes, McGraw –Hill, 1991.
6. Ross, S.L., Differential equations, John Wiley and Sons, India, 2004., 3rd Ed.
7. Myint-U, T. and Debnath, L., Linear Partial Differential Equations for Scientists and Engineers, Springer, Indian reprint, 2006, 4th edition.
8. Abell, M. L. and Braselton J. P., Differential equations with MATHEMATICA, Elsevier Academic Press, 2004, 3rd Ed.
9. Sneddon, I., Elements of partial differential equation , McGraw –Hill, 1986.
10. Gupta S. and Dey S., Numerical Method, McGraw-Hill Eduction, 2015, 2nd reprint.
11. Sastry S. S., Introductory Methods of Numerical Analysis, 2012, 5th edition.
12. Iyengar S. R. K., Jain R. K., Numerical Methods, New age International, 2009.
13. Grewal B. S., Numerical Methods in Engineering and Science, Mercury Learning & Information, 2018.
14. Deo, N. S., Graph Theory, Prentice Hall India Learning Private Limited; New edition, 1979
15. Harary, F., Graph Theory, Addison-Wesley Publishing Company.
16. Zimmerman H. J., Fuzzy Set Theory and its Applications, SPRINGER (SIE), 2006
17. J. K. George and Yuan B., Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson; 1st edition, 1995.
18. Kaufmann, A and Gupta M. M., Fuzzy Mathematical Models in Engineering and Management Science, Elsevier Science Ltd, 1988.
19. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall of India Pvt, 2006.

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

Programme Name	**Pre-Ph.D. Course Work**	Programme Code	23
Course Code	MTH 104 (2)	Credit	3
Year/Sem	1/1	L-T-P	3-0-0
Course Name	ADVANCED PURE MATHEMATICS		

Objectives of the Course:

1. To develop critical thinking by identifying, analyzing sequence of function, Riemann Integration and their applications.
2. To understand and illustrate the theory and applications of the complex analysis.
3. To improve the concept of class equation, conjugacy, normal series and composition series, quotient ring, field of quotient and factorization of polynomial ring.
4. To learn the advance knowledge of Metric spaces, topological spaces and its applications.
5. To develop the concept of measure function, Lebesgue measure sets. Riemann integration, L^p spaces and its applications.

UNIT-I (Total Topics -15 and Hrs-9)

Real Analysis: Existence of Riemann-Stieltjes integral, Conditions for R-S integrability, Properties of the R-S integral, R-S integrability of functions of a function, Integration of vector-valued functions, Rectifiable curves, Sequences and series of functions, pointwise and uniform convergence, Cauchy's criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Power series.

UNIT-II (Total Topics -12 and Hrs-8)

Complex Analysis: Complex Integration, Expansion of a complex function as power series, Taylor's and Laurent's series, Singularities and their Classifications, Residue, Cauchy Residue Theorem, Application of Residue Theorem in evaluation of proper and improper real Integrals and evaluation of sums, Conformal Mapping properties, Mobius Transformation, Elementary examples, Maximum Modulus Theorem, Mittag-Leffer Theorem.

UNIT- III (Total Topics -14 and Hrs-8)

Algebra: Class equation and conjugacy classes, Cauchy's theorem for finite abelian and non-abelian groups, Sylow's Ist ,IInd and IIIrd theorems, The normal series and composition series, External and internal direct products, Ideals, Principal ideals, Quotient rings, fundamental theorem on homomorphism and isomorphism, Prime and maximal ideals, Ring of polynomials, Factorization of polynomials over a field, Factorization theorem in integral domain, Euclidean domain.

UNIT-IV (Total Topics -22 and Hrs-9)

Topology: Metric space, open sets, closed sets, convergence, completeness, continuity in metric space, elementary concept, basis for a topology, open and closed sets, interior and closure of sets, neighborhood of a point, limit points, boundary of a set, Topological space, subspace topology, Continuous functions, continuity theorem for open and closed sets, Connectedness, local connectedness, compactness, finite intersection property, uniform continuity, Bolzano-Weierastrass property, local compactness

UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)
(Uttarakhand Act No. 11 of 2013)
Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

UNIT-V (Total Topics -11 and Hrs-10)

Measure Theory: Functions of bounded variation, Lebesgue differentiation theorem, differentiation and integration, absolute continuity of functions, Measures and Outer measures, measure spaces, The L^p spaces Holder and Murkowski inequalities, completeness of L^p spaces, convergence in measure, almost uniform convergence, Egorov's theorem.

Course Outcomes:

CO1: Develop the advanced knowledge of R-S integral, convergence of sequence series of functions and uniform convergence.

CO2: Acquire the deep knowledge of complex number theory and application of complex integration.

CO3: Enhance understanding of advanced group theory and ring theory.

CO4: Demonstrate the conceptual knowledge of topological spaces and measure integration theory in pure mathematics.

CO5: Demonstrate depth knowledge in chosen area of research specialization and ability to conduct independent mathematical research at professional level.

Reference Books

1. Rudin, W., Principles of Mathematical Analysis, McGraw Hill Education, 2017, 3rd edition.
2. Knopp,, K., Theory and Application of Infinite Series, Dover Publications Inc., 1990, Illustrated edition.
3. Apostol, T. M., Mathematical Analysis, narosa publishing house, 2002, 2nd edition.
4. Rudin,Real and Complex Analysis, McGraw Hill Education; 3rd edition, 2017, 3rd edition.
5. Conway, J. B., Functions of One Complex Variable I, Springer-Verlag New York, 1978.
6. Somasundaram D and Chaudhry, B., Complex Analysis, narosa publishing house, 1996.
7. Fraleigh, J. B., A first course in Abstract Algebra, narosa publishing house, 2003.
8. Herstein, I. N., Topics in Algebra, Wiley, 2006, 2nd edition.
9. Gallian, A. J., Contemporary Abstract Algebra, Narosa, 1998, 4th edition.
10. Munkres J., General Topology, Pearson, 2000, 2nd edition.
11. Kelley J. L., General Topology, Dover Publications, 2017, Reprint edition.
12. Pervin J. W., Foundation of General Topology, Academic Press, 2014.
13. Joshi K. D., Introduction to General Topology, Wiley Eastern Ltd., 1985.
14. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw-Hill, 1983.
15. Barra G. D., Measure theory and integration, Halsted Press, 1981.
16. Hewitt E. and Stromberg K., Real and Abstract Analysis, Springer, 1975.
17. Royden H. L., Real Analysis, Mac Millan CollDiv, 1988, 2nd edition.