Veer Bahadur Singh Purvanchal University, Jaunpur U.P.

Syllabus of Pre-Ph.D. course work In

MATHEMATICS

As per NEP-2020 guidelines

With effective from **academic session 2022-23**

Subject prerequisites: Prerequisite for research work in mathematics is knowledge of basic mathematical analysis, Linear algebra and Differential equation.

Programme outcomes

PO1: Through Ph.D. course work researcher will be able to understand research process.

PO 2; Provide students with knowledge, general competence in research techniques, mathematical typing

and analytical skills in Research Methodology as well as understanding the

ethical aspects in Research & Publication.

PO 3: Build their foundation for research in Mathematics.

PO4 :Provide basic information about various resources to get available mathematical literature online/ offline. Emphasize on developing problem solving skills

Programme specific outcomes (PSOs)

PSO1: Provide knowledge and understanding of basic concepts of pure and applied

mathematics, developing various tools to handle

    Research problems at higher level. To aware student with current research trends and

som open problems in mathematics.

PSO2: After completion of this course students will be able to find appropriate research

problems to take carry further research work in

    Related field.

List of all papers of Pre-Ph.D. course work or Post graduate diploma in Research (PGDR)

Year	Sem	Course Code	Course Title	Theory/ Research	Credit	Max. Marks
6	XI	B031101T	BasicAlgebra and Linear algeebra	Theory	6	100 [25(CIE)+75(UE)]
		B031102T	Mathematical Analysis and	Theory	6	100

		Differential equations			[25(CIE)+75(UE)]
		B031103T	Research Methodology, Research Publication Ethics and Computer Applications	Theory	4	100 [25(CIE)+75(UE)]
		B031104R	Research Project	**Research**	-	100 [25(CIE)+75(UE)]

Credit system:

- A four (4) credit theory course/paper will have four Lectures/periods (of one hour) in a week. In one full semester the course will be covered in 60 Lectures.
- Similarly, a six (6) credit theory course/paper will have six Lectures/periods (of one hour) in a week. In one full semester the course will be covered in 90 Lectures.

Continuous Internal Evaluation (CIE) of 25 marks:

- Continuous internal evaluation will be performed by the teacher/ course coordinator concerned.
- CIE shall be 25% of total assessment in a Theory paper and research project.
- 25 marks shall be distributed as 5 marks for attendance, 5 marks for presentation and assignment and remaining 15 marks for class test.

Marking system:

- All papers will have a total maximum mark of 100, including both CIE and University Examination (UE).Maximum marks of 25 will be allotted to CIE and 75 to UE in a theory paper/ research project.
- The CIE of the research project shall be evaluated by the research supervisor and co-supervisor (if any).
- 75 marks of **research project** shall be distributed as 50 marks (project work and presentation) and a viva voce of 25 marks.
- The evaluation (Max Marks 75 UE) of the research project shall be done by internal examiner/s (Supervisor and Co-supervisor (if any)) and one external examiner appointed by the University.

Research Project Submission:

- The evaluated research project report in two sets of hard copy (spiral binding) must be prepared. One copy of it shall be submitted to the university if it demands. A second copy of the evaluated research project report must be in the records of the college/research centre.

- The format of university Ph.D. thesis writing guidelines can be used as format of Research project writing guidelines.

Programme: Post graduate diploma in Research (PGDR)	Year: six (6)	Semester: XI
Subject: Mathematics		
Course Code: **B03**1101T	**Course Title: BasicAlgebra and Linear algebra**	
Course Outcomes (COs) CO 1. Understand Group theory covering a wide area of research in abstract algebra. CO 2. Understand Sylows theorems, group homomorphism, isomorphism etc are used to define the structure of groups as well as it is applicable in physical and chemical sciences and abstract concept of division in ring. CO 3. Understanding of Linear algebra is necessary to understand different branches of mathematics and essential tool for solving different research problems.		
Credits: 6	**Core Compulsory**	
Max. Marks: 25 (CIE) + 75(UE)	**Min. Passing marks: 55**	
Total number of lectures: Lectures-Tutorials- Practicals (6 hours in a week) L-T-P: 6-0-0 **(90 hr#)**		

Unit	Topics	No. of Lecture Hrs.
I	Groups, subgroups, normal subgroups, homomorphisms, quotient groups, automorphisms,.Sylow theorems and applications, finitely generated abelian groups. permutation groups, cyclic groups, dihedral groups, matrix groups.	20
II	Basic properties of rings, units, ideals, homomorphisms,quotient rings, prime and maximal ideals, fields of fractions, Euclidean domains, principal ideal domains and unique factorization domains, polynomial rings .Elementary properties of finite field extensions and roots of polynomial.	25
III	Vector spaces, Bases and dimensions, Change of bases and change of coordinates, Sums and direct sums, Quotient spaces. Linear transformations, Representation of linear transformations by matrices, The rank and	25

		nullity theorem, Dual spaces, Transposes of linear transformations. Traceand determinant, Eigenvalues and eigenvectors, Invariant subspaces,	
IV		Inner Product Spacee, The Gram-Schmidt Orthoganilation process. and Orthogonal complements,The adjoint of a linear operator, Normal, Self-Adjoint and Unitary Operator and their matrics, Orthogonal projection and the spectral theorem, Singular value decomposition theorem and their Pseudo-inverse, Bilinear and Quadratic forms.	**20**

Suggested Readings:

1. 1. I. N. Herstein, Topics in Algebra, Wiley Eastern, 1975.

2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition 1977.

3. Ramji Lal, Algebra 1 and Algebra 2, Infosys Science foundation Series in Mathematical Sciences, Springer, Singapore, 2017.

4. D. S. Dummit and R.M. Foote, Abstract Algebra, John Wiley, N.Y., 2003.

5. T. W. Hungerford, Algebra, Springer (India) Pvt. Ltd., New Delhi, 2004.

6. J. B. Fraleigh, A first course in Abstract Algebra, Pearson Education, inc. 2002.

7. K. Hofmann and R. Kunze, Linear Algebra. Prentice Hall of India, New Delhi, 1972.

8. D. S. Dummit and R. M. Foote, Abstract Algebra, John Wiley & Sons, N.Y., 2003.

9. H. Helson, Linear Algebra, Hindustan Book Agency, New Delhi, 1994.

10. N. Jacobson, Basic Algebra, Vol. 1, Hindustan Publishing Co., New Delhi, 1984.

Programme:Post graduate diploma in Research (PGDR)	Year: six (6)	Semester: XI
Subject: Mathematics		
Course Code: **B03** 1102T	Course Title: Mathematical Analysis and Differential equations	

Course Outcomes (COs)

CO 1. Demonstrate an intuitive and computational understanding of functions of bounded variation, Riemann-Stieltjes integrals, point-wise convergence, uniform convergence and power series.
 CO 2. Enter into wide area of research in analysis and Function of Several Variable.
CO 3.. Understand the use of this course in different field of mathematical Analysis.
 CO 4. Think and develop new ideas in complex analysis

Credits: 6	Core Compulsory
Max. Marks: 25 (CIE) + 75(UE)	Min. Passing marks: 55

Total number of lectures: Lectures-Tutorial-Practical (6 hours in a week) L-T-P: 6-0-0   **(90 hr#)**

Unit	Topics	No. of Lecture Hrs.
I	Metric spaces,Open and closed sets, Compactness and connectedness.Completeness, Continuousfunctions of several variables, uniform convergence, Differentiation, inverse and implicitfunction theorems .Riemann integrations, Lebesgue integrations.	25
II	Elementary properties of analytic functions and complex integration, Meromorphic functions, Poisson integral,singularities, Hadamard'stheorems,conformal mappings, Riemann mapping theorem,	20
III	First Order ODE First and Second Order Linear differential equations.Fundamental system of solutions and general solution of homogeneous equation. Use of Known solution to find another, Existence and uniqueness of solution of IVP, Wronskian and general solution of non-homogeneous equations. Euler-Cauchy Equation, extensions of the results to higher order linear equations, Power Series Method application to Legendre Eqn., Legendre Polynomials, Frobenious Method, Bessel equation,Properties of Bessel functions, Sturm-	25

		Liouville BVPs, Orthogonal functions, Fourier Series, Fourier transform and Laplace Transform. Solving Differential Equations using transform method.	
IV		Introduction to PDE, basic concepts, Linear and quasilinear first order PDE, Cauchy-Kowalewski theorem, second order PDE and classification of second order semilinear PDE (Canonical form), D' Alemberts formula and Duhamel's principle for one dimensional wave equation, Laplace's and Poisson's equations, Maximum principle with application, Fourier Method for IBV problem for wave and heat equation, rectangular region, Fourier method for Laplace equation in three dimensions.	**20**

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Suggested Readings:

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

2. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill 1976.

3. E. Hewitt and K. Stromberg, Real and Abstract Analysis, Berlin, Springer, 1969.

4. H. L. Royden: Real Analysis, Macmillan Pub. Co. Inc. New York, 4th Edition, 1993.

5.E.C. Titchmarsh: Theory of Functions, Oxford University Press, London. 1976.

6. R.V. Churchill & J.W. Brown. Complex Variables and Applications, 5th Edition McGraw-Hill, New York, 1990.

7.. S. Ponnusamy, Foundation of Complex Analysis, Narosa Publication, 2011.

8. B. Rai, D. P. Choudhury and H. I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.

9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 1968.

10. I.N. Sneddon: Elements of Partial Differential Equations, McGraw-Hill Pub.,1957.

11. T. Amaranath: An Elementary Course in Partial Differential Equations, Narosa Pub. 2005.

12. G.F.Simmons: Differential Equations with Applications and Historical Notes, Mcgraw-Hill Education,2017.

Programme: Post graduate diploma in Research (PGDR)	Year: six (6)	Semester: XI
Subject: Mathematics		
Course Code: **B03**1103T	Course Title: Research Methodology, Research Publication Ethics and Computer Applications	

Course Outcomes (COs)

CO1: With the help of this course, students will be able to decide the research field, topic, design, and pros and cons of research, sampling, and data collection techniques.

CO2: The student will be able to understand the research process and acquire the skill of writing research articles.

CO3: The course will enable you to execute the best practices, morals, and ethical values in scientific conduct and avoid publication misconduct.

CO4: With the help of this course, students will be able to learn about the standards of journals for good-quality publications of their research work.

CO5: After this course, the students will be able to learn how to use computers and different application software for manuscript writing.

CO6: This course will enable the students to learn about reference management and the maintenance of academic integrity using scientific tools. They will be familiar with the protection of the machines from computer hazards.

Credits: 4	Core Compulsory
Max. Marks: 25 (CIE) + 75(UE)	Min. Passing marks: 55

Total number of lectures: Lectures-Tutorial-Practical (4 hours in a week) L-T-P: 4-0-0 **(60 hr)**

Unit	Topics	No. of Lecture Hrs.
I	**Research Methodology** Definition, and Objectives, Motivation and Significance of Research, Types of Research, Truth and Facts of Research, Similarity and Contrast in Literary Research and Scientific Research, Research and Criticism, Research Problem and Research Design, Sampling Design and Methods of Data Collection.	12
II	**Research standards:** Layout of the Research Report, Research Process: subject Selection, Outline of the Research, Review of Literature, Material Collection; Testing and Classification, Analysis, Discussion and Conclusions, Precautions in Writing Synopsis/Research Paper/Thesis/Research	12

		Report.	
III		**Philosophy, Ethics, Scientific Conducts and misconduct** Moral Philosophy, Nature of Moral Judgments and Reactions, Publication Ethics, Best Practices/Standards Setting Initiatives and Guidelines: Committee on Publication Ethics (COPE), World Association of Medical Editors (WAME) etc., Intellectual Honesty and Research Integrity: Falsification, Fabrication and Plagiarism (FFP), Open Access Publishing, and Publication Misconduct.	08
IV		**Databases and Research Metrics** Databases: Indexing Databases, Citation Databases: Web of Science, Scopus etc., Research Metrics: Impact Factor of Journal as Per Journal Citation Report, SNIP, SJR, IPP, Cite Score; Metrics: h-Index, g-Index, i-10 Index, and Altimetric.	08
V		**Fundamentals of Computers and application Softwares** Types Of Computers, Computer Peripherals andinternalcomponent, Types of Operating Systems, Web Browser, Web Search Engine, Spreadsheet Processing, Presentation (MS PowerPoints Preparation or Beamer or Libre Office (Optional), Project/Thesis/Report writing, Using MS-Word or LaTeX or LibreOffice documentation style Labelling, References Style, Footnotes etc.	12
VI		**Scientific Softwares** Use of Reference Management Software Like Mendeley, Zotero, Reference Manager, Endnote, Authorea Etc. Anti-Plagiarism Software Like Turnitin, iAuthenticate, Urkund, Ebooks and Virtual Library, UGC-Infonet, Computer Hazards and Security	08

Suggested Readings:

1. C.R. Kothari, *Research methodology Methods and Techniques*, 4th Edition, New Age International (P) Ltd. Publisher, 2014.

2. W. Creswell, *Research Design, Qualitative, Quantitative and mixed method approaches*, 3rd Edition, Sage Publications, Inc.

3. D.B. Resnik, (2011) What is ethics in research & Why is it important. National institute of Environmental Health Science, 1-10 Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

4. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. https://www.insaindia.res.in/pdf/Ethics_Book.pdf

5. Reema Thareja (2019) Fundamentals Of Computers (2nd Edition), Oxford University Press

6. Microsoft Office 365 : A complete Guide to Master Word, Excel, and PowerPoint 365 for Beginners, Matt Vic

7. Leslie Lamport, LaTeX, A Document Preparation System, 2nd Edition, Addison-Wesley Professional Publisher, July, 1994.

8. Latex tutorials   https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

9. Libre Office tutorial: www.documentation.libreoffice.org/en/english-documentation

Suggested equivalent online courses: https://epgp.inflibnet.ac.in/

Programme: Post graduate diploma in Research (PGDR)	Year: six (6)		Semester: XI
Subject:**Mathematics**			
Course Code: **B031104R**	**Course Title: Research Project**		
Course Outcomes (COs) **CO1: This course enable students critical thinking on various topics in mathematics. .** **CO2: On completion of this course, students will have the knowledge, skill and understanding of particular area in mathematical perspective through research.** **CO:3 The outcome of the research project will be helpful in planning and probleem formulation and solving various problems of concerned area**			
Credits: Non -Credit	**Core Compulsory**		
Max. Marks: 25 (CIE) + 75(UE)	**Min. Passing marks: 55**		

Suggested Readings: Decided by concerned Supervisor/ Co-Supervisor (if any)

The format of the question paper and evaluation will be as follows –

The duration of each question paper is 3 hours
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Types of Question	Total No of Questions	Questions to be Attempted	Maximum Marks = 75 (UE) (Questions x marks)
Very Short Answer Type Questions (50 words)	10	10	10 x 2 = 20
Short Answer Type (200 words)	8	5	5 x 7 = 35
Longs Answer Type (500 words)	4	2	2 x 10 = 20
			= 75 (Maximum Marks)

10-point grading system for evaluation of the Pre-Ph.D. course work

As per the UP GOs 1567/सत्तर-3-2021-16 (26)/2011 TCdated13 July 2021, 401/सत्तर-3-2022, dated09 Feb. 2022, and 1032/सत्तर-03-2022-08(35)/2020, dated 20April2022regarding NEP-2020,the grading system for the Pre-Ph.D. course work shall be followed as given in table -1

Table-1

Letter Grade	Details	Limit of Marks	Grade Point
O	Outstanding	91-100	10
A+	Excellent	81-90	9
A	Very Good	71-80	8
B+	Good	61-70	7
B	Above Average	55-60	6
F	Fail	<55	0
AB	Absent	Absent	0
Q	Qualified		
NQ	Not Qualified		

In pre-Ph.D. course work, there is a mandatory research project that is qualifying in nature. This research project shall be a**non-credit course**. The letter grade for the research project will be Q or NQ. The grade of research project will not be included in the computations of the CGPA.

Computation of CGPA:

Calculations for SGPAand CGPAshall be followed as given table 2:

Table 2

For j^{th}Sem. $$SGPA\ (S_j) = \frac{\Sigma Ci.Gi}{\Sigma Ci}$$	Here: C_i = number of credits of the ith course in the jth semester G_i = grade point scored by the student in the ith course in j^{th} semester
$$CGPA = \frac{\Sigma Cj.Sj}{\Sigma Cj}$$	Here: S_j = SGPA of the jth semester C_j = total number of credits in the jth semester

Allocation of CGPA Into Division:

The allocation of CGPA into division in pre-Ph.D. course work follows as given in Table 3:

Table 3

Division	CGPA
First	Greater than or equal to 6.5 and less than or equal to 10

Second	Greater than or equal to 5.5 and less than 6.5