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Syllabus of Pre-Ph.D. coursework 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. coursework 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.

PO3: 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 some 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.



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

Year	Sem	Course Code	Course Title	Theory/ Research	Credit	Max.Marks
6		B031101T	Algebra & Differential Equation	Theory	6	100 [25(CIE)+75(UE)]
		B031102T	Mathematical Analysis & Mechanics	Theory	6	100 [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:

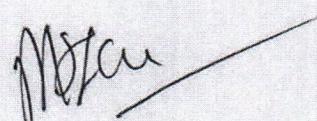
- A four (4) credit theory course/paper will have four Lectures/periods (of one hour) in a week. In one full semester the course will be covered in 60 Lectures.
- Similarly, a six (6) credit theory course/paper will have six Lectures/periods (of one hour) in a week. In one full semester the course will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

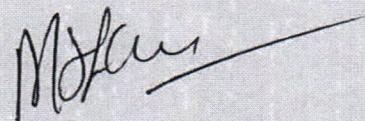


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- 75 marks of **research project** shall be distributed as 50 marks (project work and presentation) and a viva voce of 25 marks.
- The evaluation (Max Marks 75 UE) of the research project shall be done by internal examiner/s (Supervisor and Co-supervisor (if any)) and one external examiner appointed by the University.

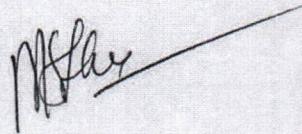
Research Project Submission:

- 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.

A handwritten signature in black ink, appearing to read "M. S. K. S. S.", is written over a diagonal line.

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

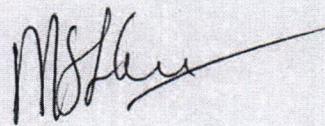
Programme: Postgraduate Diploma in Research(PGDR)	Year: six(6)	Semester: I		
Subject: Mathematics				
Course Code: B031101T	Course Title: Algebra & Differential Equation			
Course Outcomes(COs)				
<p>CO1.Understand Group theory covering a wide area of research in abstract algebra.</p> <p>CO2.Understand Sylow's 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.</p> <p>CO3.Understanding of Linear algebra is necessary to understand different branches of mathematics and essential tool for solving different research problems.</p>				
Credits:6	Core Compulsory			
Max.Marks:25(CIE)+75(UE)	Min.Passingmarks:55			
Total number of lectures: Lectures-Tutorials-Practicals(6 hours in a week) L-T-P:6-0-0 (90hr#)				
Unit	Topics	No. of Lecture Hrs.		
I	Groups, subgroups, normal subgroups, homeomorphisms, 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, field 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 Nullity theorem, Dual spaces, Transposes of linear transformations. Trace and determinant, Eigen values and eigenvectors, Invariant subspaces, Bilinear and Quadratic forms. Inner Product Space, The Gram-Schmidt Orthogonalization process. And Orthogonal complements.	20		



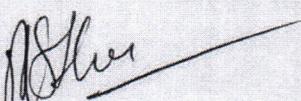
IV	<p>Linear differential equations, Self adjoint differential equations, Lagrange identity, The existence and uniqueness theorem. Green's Function for ordinary differential initial and boundary value problem. Series solution of differential equations- Power series method, Bessel, Legendry and Hyper geometric equations. Bessel, Legendre and Hyper geometric functions and their properties. Convergence, recurrence and generating relations. Orthogonality of functions. Sturm-Liouville problem. Eigenfunctions and Eigen values. Orthogonality of Bessel functions and Legendre polynomial</p> <p>Partial differential equations of the first order. Lagrange's solutions. Char pit's general method of solution. Partial differential equations of second and higher orders.</p>	25
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Suggested Readings:

1. N.Herstein, Topics in Algebra, Wiley Eastern, 1975.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nag pal, 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. H.Helson, Linear Algebra, Hindustan Book Agency, New Delhi, 1994.
9. N.Jacobson, Basic Algebra, Vol.1, Hindustan Publishing Co., New Delhi, 1984.



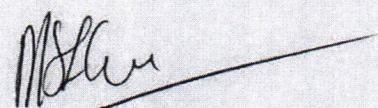
Programme: Postgraduate Diploma in Research(PGDR)		Year:	Semester:			
Subject: Mathematics						
Course Code: B031102T	Course Title: Mathematical Analysis and Mechanics					
Course Outcomes(COs)						
<p>CO 1. Demonstrate an intuitive and computational understanding of functions of bounded variation, Riemann-Stieltjes integrals, point-wise convergence, uniform convergence and power series.</p> <p>CO2. Enter into wide area of research in analysis and Function of Several Variable.</p> <p>CO3.. Understand the use of this course in different field of mathematical Analysis. CO 4. Think and develop new ideas in complex analysis</p>						
Credits:6	Core Compulsory					
Max.Marks:25(CIE)+75(UE)	Min.Passingmarks:55					
Total number of lectures: Lectures-Tutorial-Practical(6 hours in a week) L-T-P:6-0-0			(90hr#)			
Unit	Topics	No. of Lecture Hrs.				
I	Metric spaces, Open and closed sets, Compactness and connectedness. Completeness, Continuous functions of several variables, uniform convergence, Differentiation, inverse and implicit function theorems. Riemann integrations, Definition and existence of Riemann-Stieltjes integral, Conditions for R-S integrability. Properties of the R-S integral, R-S integrability of functions.	20				
II	Complex Integration. Cauchy-Goursat Theorem. Cauchy's integral formula. Higher order derivatives. Morera's theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra. Maximum modulus Principle, Laurent's Series. Isolated singularities. Meromorphic functions. The argument principle. Rouche's theorem. Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to $\arg Z$, $\log Z$, and Z^a . Analytic continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve.. Spaces. Inner product spaces, Hilbert spaces. Orthonormal sets. Bessel's inequality. Complete orthonormal sets and Parseval's identity. Structure of Hilbert spaces. Projection theorem. Riesz representation theorem. Riesz Fischer theorem, Adjoint of an operator on a Hilbert space.	20				
III	Normed linear space. Banach space Bounded Linear transformations. Open mapping and closed graph theorems. Uniform boundedness Principle and its consequences. Hahn Banach theorem for real linear spaces, Application of Hahn-Banach theorem. Dual spaces with examples. Separability. Reflexive Spaces. Inner product spaces, Hilbert spaces. Orthonormal sets. Bessel's inequality. Complete orthonormal sets and Parseval's identity. Structure of Hilbert spaces. Projection theorem. Riesz representation theorem. Riesz Fischer theorem, Adjoint of an operator on a Hilbert space	25				



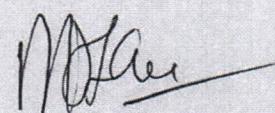
IV	<p>Analytical Dynamics: Kinetic energy and angular momentum of rigid body rotating about its fixed point. Euler dynamical and geometrical equations of motion. Generalized coordinates, momentum and force components. Lagrange equations of motion under finite forces, cyclic coordinates and conservation of energy. Hamiltonian canonical equation. Hamilton principle and principle of least action. Phase space, Poisson Bracket. canonical transformations,</p> <p>Fluid Mechanics: Equations of continuity. Boundary surfaces. Stream lines. Velocity potential. Irrational and rotational motions. Lagrange's and Euler's equations of motion. Bernoulli's theorem. Irrational motion in two-dimensions. Stream function Complex velocity potential. Sources, sinks, doublets and their images.</p>	25
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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:	Semester:		
Subject: Mathematics				
Course Code: B031103T	Course Title: Research Methodology, Research Publication Ethics and Computer Applications			
Course Outcomes(COs)				
<p>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.</p> <p>CO2: The student will be able to understand the research process and acquire the skill of writing research articles.</p> <p>CO3: The course will enable you to execute the best practices, morals, and ethical values in scientific conduct and avoid publication misconduct.</p> <p>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.</p> <p>CO5: After this course, the students will be able to learn how to use computers and different application software for manuscript writing.</p> <p>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.</p>				
Credits:4	Core Compulsory			
Max.Marks:25 (CIE)+75(UE)	Min.Passingmarks:55			
Total number of lectures: Lectures-Tutorial-Practical(4hours in a week) L-T-P:4-0-0 (60hr)				
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.			



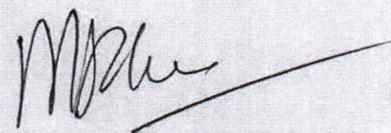
III	Philosophy, Ethics, Scientific Conducts and misconduct Moral Philosophy, Nature of Moral Judgments and Reactions, Publication Ethics, Best Practices/Standards Setting Initiatives and Guidelines: Committee on Publication Ethics (COPE), World Association of Medical Editors(WAME) etc., Intellectual 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-10Index, and Altimetric.	08
V	Fundamentals of Computers and application Software Types Of Computers, Computer Peripherals and internal component, Types of Operating Systems, Web Browser, Web Search Engine, Spread sheet Processing, Presentation (MS Power Points Preparation or Beamer or Libre Office (Optional), Project/Thesis/Report writing, Using MS-Word or LaTeX or Libre Office documentation Style Labeling, References Style, Foot notes etc.	12
VI	Scientific Software Use of Reference Management Software Like Mendeley, Zotero, Reference Manager, Endnote, Author a Etc. Anti-Plagiarism Software Like Turn tin Authenticate, Urkund, EBooks and Virtual Library, UGC-Info net, 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/>



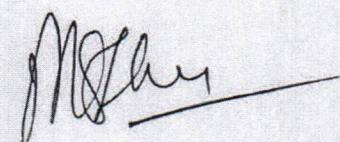
Programme: Postgraduate Diploma in Research(PGDR)	Year:	Semester:
Subject: Mathematics		
Course Code: B031104R	Course Title: Research Project	
Course Outcomes(COs)		
CO1: This course enables student's critical thinking on various topics in mathematics. . CO2: On completion of this course, students will have the knowledge, skill and understanding of particular area in mathematical perspective through research. CO3: The outcome of the research project will be helpful in planning and problem Formulation and solving various problems of concerned area		
Credits: Non-Credit	Core Compulsory	
Max.Marks:25(CIE)+75(UE)	Min.Passingmarks: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

Types of Question	Total No of Questions	Questions to be Attempted	Maximum Marks = 75 (UE) (Questions marks)
Very Short Answer Type Questions(50words)	10	10	$10 \times 2 = 20$
Short Answer Type(200words)	8	5	$5 \times 7 = 35$
Longs Answer Type(500words)	4	2	$2 \times 10 = 20$
			=75(Maximum Marks)



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

As per the UP GOs 1567/संर-3-2021-16 (26)/2011 TC dated 13 July 2021, 401/संर-3-2022, dated 09 Feb. 2022, and 1032/संर-03-2022-08(35)/2020, dated 20 April 2022 regarding 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 SGPA and CGPA shall be followed as given in table 2:

Table 2

For j^{th} Sem. $\text{SGPA}(S_j) = \frac{\sum C_i G_i}{\sum C_i}$	Here: C_i = number of credits of the i^{th} course in the j^{th} semester G_i = grade point scored by the student in the i^{th} course in j^{th} semester
$\text{CGPA} = \frac{\sum C_j S_j}{\sum C_j}$	Here: S_j = SGPA of the j^{th} semester C_j = total number of credits in the j^{th} semester

Allocation of CGPA Into Division:

The allocation of CGPA into division in pre-Ph.D. coursework 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	Greaterthanorequalto5.5andlessthan6.5
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