



DEPARTMENT OF MATHEMATICS
PROF. RAJENDRA SINGH (RAJU BHAIYA) INSTITUTE OF PHYSICAL SCIENCES FOR STUDY AND RESEARCH
Veer Bahadur Singh Purvanchal University, Jaunpur U.P.

Syllabus of Pre-Ph.D. course work

As per NEP-2020 guidelines

With effective from **academic session 2024-2025**

Programme outcomes (POs):

PO1: The analytical thinking in recognizing and analysing the mathematical problems with sufficient knowledge, theoretical skills, questioning and plausible explanations.

PO2: To prepare sound base for interpreting, synthesis, and evaluation of research techniques and to identify the current unsolved research problems in a specific area.

PO3: Effectively communicating research to the mathematical community through publications in journals and presentations in conferences. Integrating the knowledge and skills that they have acquired throughout to become pro-active professionals in research and personal life.

PO4: To develop the innovative ideas and strategies for addressing a research problem and undertaking the original research on a particular concurrent and relevant topic in the field of mathematics.

PO5: The skill to identify and apply scientific research in new emerging areas of mathematics for resolution of economic environmental and societal problems.

PO6: Evolving as excellent professionals in the educational institutions/research laboratories and contribute towards the general and scientific growth of the country.

Programme specific outcomes (PSOs):

PSO1: Acquiring deep knowledge and expertise in chosen area of research in pure or applied mathematics.

PSO2: Facilitating interaction and exchange with national and international researchers and developing collaborations.

PSO3: Imbibing highest standard of ethics in research publications. Skill in publishing quality research papers in reputed mathematical journals.

PSO4: Developing pedagogical and research skills. Capability in communicating the basic and advanced mathematical topics to undergraduate and graduate students.

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Page 1 of 11

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	Differential Equations and Fluid Mechanics	Theory	6	100 [25(CIE)+75(UE)]
		B031102T	Special Functions and Linear Programming	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).
- 75 marks of **research project** shall be distributed as 50 marks (project work and presentation) and a viva voce of 25 marks.

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- 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: B031101T	Course Title: Differential Equations and Fluid Mechanics	
Course Outcomes (COs)		
<p>CO1: To apply the existence and uniqueness conditions for first order initial value problems, sufficient conditions for singular solutions of differential equations.</p> <p>CO2: Learn about Wronskian and general solution of linear non-homogeneous differential equations.</p> <p>CO3: To solve the differential equations using matrix methods on the basis of eigen systems.</p> <p>CO4: To understand the concept of fluid and types of fluid flows and certain approaches to study the fluid motion and equation of continuity.</p> <p>CO5: To study the orthogonal curvilinear coordinates in various coordinates systems and to know about the physical similarity, Geometrical similarity, Dynamical similarity and certain dimensionless numbers.</p> <p>CO6: To investigate the compressible flows and supersonic flows, normal and oblique shock waves.</p>		

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Page 3 of 11

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 Hrs)		
Unit	Topics	No. of Lecture Hrs.
I	Existence and uniqueness theorem for first order initial value problem (statements only), p -discriminant of a differential equation and c -discriminant of family of solutions, respectively, Envelopes of one parameter family of curves, Uniqueness of solutions with a given slope, Singular solutions as envelopes of families of solution curves, Sufficient conditions for existence and non-existence of singular solutions.	15
II	Conditions for transformability of a system of I order equations into an equation of higher order, Linear dependence, and linear independence, Wronskians, General solutions covering all solutions for homogeneous and non-homogeneous linear systems, Abel's formula, Method of variation of parameters for particular solutions, Linear systems with constant coefficients.	15
III	Matrix methods, Different cases involving diagonalizable and non-diagonalizable coefficient matrices, Real solutions of systems with complex eigenvalues, Ordinary and singular points.	15
IV	Concept of fluid, Types of fluids, certain types of fluid flow, Review of basic concepts in fluid mechanics, Lagrangian and Eulerian approaches, Equation of continuity in both approaches and their equivalences, Concept of stresses, Rate of deformation tensors, Two-dimensional stress invariants.	18
V	Orthogonal curvilinear coordinates, Scale factors and unit vectors, Concept of physical similarity, Geometrical similarity, Dynamical similarity, Dimensionless numbers,	15
VI	Introduction to compressible flows, Velocity of sound and Mach number, Isentropic flow, Flow with friction and heat transfer,	12

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	Analysis of flows with normal and oblique shock waves. Supersonic flows. Unsteady flows.	
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Suggested Readings:

1. Happel, J., and Brenner, H., "Low Reynolds Number Hydrodynamics", *Martinus Nijhoff Publishers*, 1983.
2. Nield, D.A. and Bejan, A., "Convection in Porous Media", *Springer*, 2006.
3. Warsi, Z.U.A., *Fluid Dynamics*, *CRC Press*, 2006.
4. Murphy, G.M., "Ordinary Differential Equations and Their Solutions", *D. Van Nostrand Company*, 1969.
5. Lukaszewicz, G., "Micropolar Fluids: Theory and Applications", *Springer*, 1999.
6. Bachelor, G.K.: "An Introduction to Fluid Dynamics", *Cambridge University Press*, 2012.
7. Charlton, F., "Text Book of Fluid Dynamics", *C.B.S. Publishers*, 1967.
8. Simmons, G.F., "Differential Equations", *Chapman and Hall*, 2016.

Programme: Post Graduate Diploma in Research (PGDR)	Year: Six (6)	Semester: XI
Subject: Mathematics		
Course Code: B031102T	Course Title: Special Functions and Linear Programming	
Course Outcomes (COs)		
<p>CO1: Solve, expand, and interpret solutions of many types of important differential equations by making use of special functions and orthogonal polynomials.</p> <p>CO2: Understand the basic knowledge of basic hypergeometric series.</p> <p>CO3: Derive the formulas and results of certain classical special functions and orthogonal polynomials by different methods.</p> <p>CO4: To understand the linear programming problems, convex sets, and related phenomenon.</p> <p>CO5: Find the optimal solutions of LPP(s) using analytical techniques</p> <p>CO6: Applications of LPPs in business like transportation and recruitments/assignments of objects.</p>		
Credits: 6	Core Compulsory	
Max. Marks: 25	Min. Passing marks: 55	

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(CIE) + 75(UE)		
Total number of lectures: Lectures-Tutorial-Practical (6 hours in a week) L-T-P: 6-0-0 (90 Hrs)		
Unit	Topics	No. of Lecture Hrs.
I	Basic Hypergeometric Series: Hypergeometric and basic hypergeometric series; The q-binomial theorem; Heine's transformation formulas; Heine's q-analogue of Gauss' summation formula; The q-gamma and q-beta functions; The q-integral.	15
II	Gamma Function, Hypergeometric Functions: Definition and special cases, convergence, integral representation, differentiation, contiguous function relations, transformations and summation theorems, The confluent Hypergeometric function: Basic properties of ${}_1F_1$, Kummer's first formula. Kummer's second formula	15
III	Bessel Functions: Definition, connection with hypergeometric function, differential and pure recurrence relations, generating function, Integral representation; Hermite and Laguerre polynomials; Ordinary and singular points of differential equations, Regular and irregular singular points of hypergeometric, Bessel, Legendre, Hermite and Laguerre differential equations; Examples on above topics.	15
IV	Linear Programming and examples, Convex Sets, Hyperplane, Open and Closed half-spaces, Feasible, Basic Feasible and Optimal Solutions, Determination of Optimal solutions, Unbounded solution in Primal.	18
V	Extreme Point & graphical methods, Simplex method, Charnes-M method, Two phase method, Unrestricted variables, Duality theory, Dual linear Programming Problems, fundamental properties of dual Problems.	15
VI	Transportation Problems, Balanced and unbalanced Transportation problems, U-V method, Paradox in Transportation problem, Assignment problems.	12

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Suggested Readings:

1. Rainville, E.D., Special Functions, *Chelsea Publishing Co.*, 1971.
2. Miller, W. J., Lie Theory and Special Functions, *Academic Press*, 1968.
3. McBride, E. B., Obtaining Generating Functions, *Springer*, 1971.
4. Gasper, G. and Rahman, M., Basic Hypergeometric Series, *Cambridge University Press*, 2004.
5. Hadley, G.: Linear Programming, *Narosa Publishing House*, 6th edition. 1995.
6. Sinha, S. M.: Mathematical Programming, Theory and Methods, 1st Edition, *Elsevier*, 2006.

Programme: Post Graduate Diploma in Research (PGDR)	Year: Six (6)	Semester: XI
Subject: Mathematics		
Course Code: B031103T	Course Title: Research Methodology, Research Publication Ethics and Computer Applications	
<p>Course Outcomes (COs)</p> <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. Passing marks: 55	
Total number of lectures: Lectures-Tutorial-Practical (4 hours in a week) L-T-P: 4-0-0 (60 Hrs)		
Unit	Topics	No. of

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Page 7 of 11

		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 Report.	12
III	Philosophy, Ethics, Scientific Conducts and misconducts 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 and internal component, 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	08

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Page 8 of 11

	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	
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Suggested Readings:

1. Kothari, C.R.: Research methodology Methods and Techniques, 4th Edition, *New Age International (P) Ltd. Publisher*, 2014.
2. Creswell, W.: Research Design, Qualitative, Quantitative and mixed method approaches, 3rd Edition, *Sage Publications*, Inc.
3. Resnik, D.B.: 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>, 2011.
4. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance, ISBN:978-81-939482-1-7. https://www.insaindia.res.in/pdf/Ethics_Book.pdf, 2019.
5. Thareja, R.: Fundamentals of Computers (2nd Edition), Oxford University Press, 2019.
6. Microsoft Office 365 : A complete Guide to Master Word, Excel, and PowerPoint 365 for Beginners, Matt Vic
7. Lamport, L.: 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/>

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Programme: Post Graduate Diploma in Research (PGDR)	Year: Six (6)	Semester: XI
Subject: Mathematics		
Course Code: B031104R	Course Title: Research Project	
Course Outcomes (COs)		
<p>CO1: Identify an area of interest and to select a topic therefrom realizing ethical issues related to one's work and unbiased truthful actions in all aspects of work and to develop research aptitude.</p> <p>CO2: Have deep knowledge and level of understanding of a particular topic in core or applied areas of Mathematics, imbibe research orientation.</p> <p>CO3: Understand mathematical texts from books/journals/e-contents, to communicate through write up/report and oral presentation.</p> <p>CO4: Demonstrate knowledge, capacity of comprehension and precision, capability to work independently.</p>		
Credits: Non -Credit	Core Compulsory	
Max. Marks: 25 (CIE) + 75(UE)	Min. Passing marks: 55	

Suggested Readings:

The books required for the research project for the students will be recommended by the concerned supervisor.

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 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)

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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 TC dated 13 July 2021, 401/सत्तर-3-2022, dated 09 Feb. 2022, and 1032/सत्तर-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 table 2:

Table 2

For j^{th} Sem. SGPA (S_j) $= \frac{\sum C_i \cdot G_i}{\sum C_i}$	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
CGPA $= \frac{\sum C_j \cdot S_j}{\sum C_j}$	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. 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