GUIDELINES, COURSE STRUCTURE AND SYLLABUS

FOR

Pre-Ph.D. COURSE WORK

With effective from academic session 2022-2023 onwards

Department of Mathematics

Faculty of Engineering & Technology

Veer Bahadur Singh Purvanchal University, Jaunpur, U.P., INDIA

22/9/23		
(Prof. Mukesh Kumar)	(Dr. Vineet Kumar Singh)	(Dr. Raj Kumar)
External Expert	External Expert	BOS Convener

Veer Bahadur Singh Purvanchal University, Jaunpur U.P.

Guidelines and Syllabus of Pre-Ph. D. Course Work

(in partial fulfilment for the award of the degree of Ph. D.)

1. This syllabus is subject to any amendments or updates in the Ph.D. ordinance of the V.B.S. Purvanchal University.
2. The guidelines and syllabus of the pre-Ph.D. coursework may be framed and modified by the Board of Studies (BOS) of the Department of Mathematics from time to time as per requirements and direction by the University.
3. Every student admitted to the Department for Ph.D. programme shall be required to pass the 'Pre-Ph.D. Course Work' which is equivalent to **Postgraduate Diploma in Research in Mathematics**.
4. As per the university ordinance, the research scholars who are provisionally registered for the Ph.D. programme will undergo a Pre-Ph.D. Course work which is mandatory for all.
5. After successfully earning 16 (6+6+4) credits in pre-Ph.D. course work, and non-credit research project, the student will be awarded a **Postgraduate Diploma in Research in Mathematics**.
6. A student with a Postgraduate in mathematics, physics, applied physics, applied mathematics, industrial mathematics, statistics, computer applications, computer science, computer engineering, mechanical engineering, operational research, and information science can take admission into the **interdisciplinary Ph.D. program in mathematics**.
7. Reservations shall be applicable as UP state government rules are updated from time to time.
8. The end semester presentation will be conducted by an examination board comprising the concerned research supervisor, head of department, and head or dean of the institute or faculty. The research scholar is required to give an end semester presentation in the presence of other students and faculty members.
9. The core papers will be evaluated by the respective course instructor (Research Supervisor and co supervisor, if any).
10. A candidate will be eligible to appear in the University examination, if he/she fulfils the minimum attendance requirement as per the existing university rules, submits all fees (dues), and submits the examination form within the stipulated time.
11. The thesis of the research scholar will be forwarded from the department after clearing minimum IPR standards and norms from the IPR cell of the V.B.S. Purvanchal University, Jaunpur. All the published papers must follow minimum research ethics as per guidelines of UGC/State Government orders issued from time to time.

22/9/23		
(Prof. Mukesh Kumar)	(Dr. Vineet Kumar Singh)	(Dr. Raj Kumar)
External Expert	External Expert	BOS Convener

Syllabus of Pre-Ph.D. course work

As per NEP-2020 guidelines

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

Aim of the Course work: The Pre-Ph.D. coursework is meticulously intended to prepare students for in-depth investigation into a specific subject/area or the utilization of certain methodologies. A comprehensive examination of the previous findings to develop innovative concerns, frameworks, and insights. Upon completion of the course, students could acquire fundamental research skills, including investigative, evaluative, comprehensive, reasoning, analytical, and writing abilities. The course goals aim to foster a comprehensive comprehension of the subject matter within the realm of their research.

Subject prerequisites: To study the subject exposure to post graduate level in mathematics, physics, applied physics, applied mathematics, industrial mathematics, statistics, computer applications, computer science, computer engineering, mechanical engineering, operations research, and information science.

Programme outcomes (POs): The students should be able

PO1: To develop a basic, in-depth understanding of mathematics and attain specialization in one sub-area.

PO2: To understand the research methodology in their specific area and the development of the area in a specific direction.

PO3: To develop a strong foundation in the fundamentals and applications of several advanced topics in mathematics.

PO4: To explore the concept of research, research tools, research ethics, and different types of research methodology.

PO5: To learn analytical and writing abilities for a research project.

Programme specific outcomes (PSOs): At the end of the programme, the student should be able:

PSO1: To acquire a comprehensive understanding of various research types, research tools, and methodologies.

PSO2: To get a comprehensive understanding of fundamental mathematical principles and their practical applications in solving real-world issues.

PSO3: To provide a comprehensive understanding of the fundamental principles and practical applications of various analytical and numerical approaches.

PSO4: To cultivate proficiency in advanced techniques pertinent to state-of-the-art research in mathematics or interdisciplinary mathematics by means of advanced coursework.

PSO5: Utilizing computational software and methodologies for conducting research in the field of mathematical sciences.

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

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	B031103T	Research Methodology, Research Publication Ethics and Computer Applications	Theory	4	100 [25(CIE)+75(UE)]
		B031104T **(Core 1)**	Analytical and Numerical Techniques in Mathematics	Theory	6	100 [25(CIE)+75(UE)]
		B031105T **(Core 2)**	Differential Equations and Tensors	Theory	6	100 [25(CIE)+75(UE)]
		B031106R	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.

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

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.
- The research project report draft should follow the minimum IPR standards and norms of plagiarism. Complete draft of project will follow research ethics.

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**	
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**	**12**

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

	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.	
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 Software** 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

22/9/23		
(Prof. Mukesh Kumar)	(Dr. Vineet Kumar Singh)	(Dr. Raj Kumar)
External Expert	External Expert	BOS Convener

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: **B031104T**	**Course Title:** **Analytical and Numerical Techniques in Mathematics**	

Course Outcomes (COs): After completing the course, students will be able to

CO1: Solve linear and nonlinear PDEs and their applications to solve some physical problems.
CO2: To classify linear integral equations, and to learn the conversion of ODEs into integral equations, their solutions by approximation methods.
CO3: To apply Laplace and Inverse Laplace transforms, and their applications to solve many integrals and ODEs, PDEs and Integral equations.
CO4: To apply Fourier Transforms and their applications to solve some physical problems
CO5: To learn the concept of finite difference operators and their applications to solve some physical problems.
CO6: To familiar about numerical solution of first order ODEs using Taylor's series, Picard's successive approximations, Euler's, Modified Euler's, Runge-Kutta and Milne's Predictor-Corrector methods.

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	Linear and Nonlinear PDEs of First Order, Lagrange's Equations, Charpit's Method, Cauchy's Method of Characteristics, Solution of linear PDEs of higher order with constant coefficients, equations reducible to linear PDEs with constant coefficients. Their applications to solve some physical problems.	**15**
II	Definition and classification of linear integral equations, Conversion of ordinary differential equations into integral equations, Linear integral equations of the first and second kind of Fredholm and Volterra types, Solution by successive substitutions and successive approximations.	**12**
III	A review on Laplace and Inverse Laplace transforms, and their applications to solve various integrals and ODEs, PDEs and Integral equations.	**16**
IV	Fourier Transforms and their applications to solve some physical problems	**14**
V	Review on finite difference operators, and Interpolation. Applications of finite difference operators, and Interpolation to solve some physical problems.	**15**

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

VI	Numerical solution of ODEs using Taylor's series, Picard's successive approximations, Euler's, Modified Euler's, Runge-Kutta and Milne's Predictor-Corrector methods.	**18**

Suggested Readings:

1. M.D. Raisinghania, Advanced Differential equation 19th edition, S. Chand. 2018.
2. A. S. Gupta, Calculus of Variations with Application. PHI Learning Pvt Ltd,1996.
3. Kendall E. Atkinson, Introduction to Numerical Analysis (2nd-edition) Wiley India Private Limited 2008
4. F. John, Partial differential equations, Springer-Verlag, 1982.
5. Y. Pinchover and J. Rubinstein, An introduction to partial differential equations, Cambridge, 2005.
6. I.N. Snedon, Fourier Transforms, Dover Publications, 2010

Suggested equivalent online courses:

https://nptel.ac.in/courses/111106101
https://nptel.ac.in/courses/111106111
https://archive.nptel.ac.in/courses/111/101/111101153/

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

Programme: Post graduate diploma in Research (PGDR)	**Year: Six (**6)	**Semester:** XI
Subject: Mathematics		
Course Code: B031105T	**Course Title: Differential Equations and Tensors**	

Course Outcomes (COs): After completing this course, students can learn

CO1: About PDEs and their solutions by method of characteristics
CO2: Reduction of a PDE of second order into Canonical forms, Solution of wave equations up to three space dimensions on bounded domains, and by method of separation of variables.
CO3: To familiar about Parallelogram identity, Domain of dependence, and influence, Causality principle, Finite speed of propagation, Conservation of energy, Huygens principle, Propagation of confined disturbances.

CO4: To get solutions of BVPs (Boundary value problems), Construction of Greens function for Dirichlet's problem posed on special domains.

CO5: Concept of Tensors, Fibre Bundles, tensor curvatures and their types, Lie group and Algebra, Conformal transformations and their applications.

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	Introduction, First order partial differential equations, Method of characteristics, Cauchy problem for Quasilinear first order partial differential equations, Cauchy problem for fully nonlinear first order partial differential equations	15
II	Canonical forms of second order PDEs, Wave equation: d'Alembert's formula, Solution of wave equation on bounded domains, Solution by method of separation of variables, Wave equation in two and three space dimensions	**18**
III	Wave equation: Parallelogram identity, Domain of dependence, Domain of influence, Causality principle, Finite speed of propagation, Conservation of energy, Huygens principle, and Propagation of confined disturbances	**12**
IV	Laplace equation: Boundary value problems, Fundamental solution, Construction of Greens function for Dirichlet's problem posed on special domains	**15**

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

V	Review on tensors, Curvature and Ricci Tensor, Scalar and Sectional Curvature, Schur's Theorem, Einstein's manifold, Relation between Sectional and Ricci Curvatures, Conformal Curvature Tensor, Conharmonic Curvature Tensor, Concircular Curvature Tensor, Conformal Transformations and their applications.	**15**
VI	Different forms of the tensor, Exterior derivative, Trace of a Tensor Field, Covariant derivative, General covariant derivative, Divergence of a Tensor Field, Lie group and Algebra, and their application, Principle Fibre Bundle, Linear frame Bundle, and Vertical Lift.	**15**

Suggested Readings:

1. I.N. Sneddon: Elements of Partial Differential Equations, Mc-Graw Hill, 1988.
2. T. Amarnath: An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi, 2005.
3. U. Tyn Myint: Partial Differential Equations of Mathematical Physics, 2nd Edison, Elsevier Publications, 1980
4. F. W. Warner: Foundations of Differential Manifolds and Lie Groups, Springer, Springer-Verlag, 1983.
5. R. S. Mishra, A course in Tensors with Applications to Riemannian Geometry, Pothishala, Pvt. Ltd., Allahabad, 1965.
6. A. A. Shaikh, U.C. De , J. Sengupta, Tensor Calculus, Narosa, 2008
7. Zafar Ahsan, Tensors: Mathematics of Differential Geometry and Relativity, PHI Learning, 2015

Suggestive digital platforms web links: https://archive.nptel.ac.in/courses/111/101/111101153/

https://nptel.ac.in/courses/103102024

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

Programme: Post graduate diploma in Research (PGDR)	**Year: Six (**6)	**Semester:** XI
Subject: Mathematics		
Course Code: B031106R	**Course Title:** **Research Project in Mathematics**	
Course Outcomes (COs): After the completion of the course, the students will be able to: **CO1:** Review of literature and apply fundamental and disciplinary concepts and methods in ways appropriate to their principal area of study. **CO2:** Demonstrate skill and sound technical and conceptual knowledge of their selected topic of the research project. **CO3:** Identify, analyze, and solve problems creatively through critical investigation. **CO4:** Demonstrate an awareness and application of appropriate personal, societal, and professional ethical standards. **CO5:** Develop oral and written communication skills. **CO6**: Able to work on research-level projects that are suitable to communicate in workshops and conferences		
Credits: Non credit	**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	Review of Literature	**30**
II		
III	Applications of symbolic computation software like MATLAB/	**40**
IV	Maple/Mathematica or some others appropriate to the field	
V	Simulation, and summarize them to get results (if any)/solutions by using related methodology that are physically meaningful.	**20**
VI	Dedicated to disseminating study and reporting project progress.	

Suggested Readings:

As per the related subfield of the student.

1. Amos Gilat: MATLAB: An Introduction with applications, John Wiley & Sons, INC (2004).
2. I. K. Shingareva,C. Lizárraga-Celaya: Maple and Mathematica: A Problem Solving Approach for Mathematics, Springer; 2nd ed. 2009
3. D. Somasundaram: Differential Geometry, A First Course, Narosa Publishing House, New Delhi, 2005.
4. U. C. De, A. A. Sheikh: Differential Geometry of Manifolds, Narosa Publishing House, 2007.
5. P.J. Olver, Applications of Lie Groups to Differential Equations. Springer-Verlag, New York (1993).
6. G.W. Bluman, J.D. Cole, Similarity Methods for Differential Equations, Applied Mathematical Sciences, Springer-Verlag, New York (1974).

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

Suggestive digital platforms web links:

https://archive.nptel.ac.in/courses/115/106/115106121/
https://nptel.ac.in/courses/103106118
https://shorturl.at/mDGS6

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)

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.

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener

Computation of CGPA:

Calculations for SGPA and CGPA shall be followed as given table 2:

Table 2

For j^{th} Sem. SGPA (S_j) $= \frac{\sum Ci.Gi}{\sum Ci}$	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 $= \frac{\sum Cj.Sj}{\sum Cj}$	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

22/9/23

(Prof. Mukesh Kumar)
External Expert

(Dr. Vineet Kumar Singh)
External Expert

(Dr. Raj Kumar)
BOS Convener