Department of Physics

Prof. Rajendra Singh (Rajju Bhaiya) Institute of Physical Sciences for Study and Research

V. B. S. Purvanchal University, Jaunpur U.P.

Syllabus of Pre-Ph.D. Course Work

Post Graduate Diploma in Research

As per NEP-2020 guidelines

With effective from **Academic Session 2022-23**

Subject prerequisites: Post-Graduate in Science Subjects

Programme outcomes (POs): Upon successful completion of the Post Graduate Diploma in Research in Physics, graduates will demonstrate the following program outcomes:

PO1: Advanced Knowledge: Acquire in-depth knowledge and understanding of advanced concepts and theories in the field of physics, particularly focusing on the physics of materials, experimental techniques, and research methodology.

PO2: Research Skills: Develop proficiency in conducting independent research, including the ability to design experiments, analyse data, and draw meaningful conclusions in the context of physics.

PO3: Critical Thinking: Cultivate critical thinking and problem-solving abilities to address complex and multidisciplinary research challenges in physics.

PO4: Effective Communication: Demonstrate effective communication skills in presenting research findings, both in written reports and oral presentations, to a diverse audience.

PO5: Ethical Conduct: Understand and adhere to the ethical principles and guidelines governing research and publication in physics, demonstrating integrity and honesty in all research endeavours.

PO6: Interdisciplinary Collaboration: Collaborate effectively with peers, mentors, and researchers from diverse backgrounds, fostering an interdisciplinary approach to research in physics.

PO7: Computer Proficiency: Develop proficiency in using computer applications, computational tools, and software relevant to physics research, enhancing data analysis and modelling capabilities.

Programme specific outcomes (PSOs):

PSO1: Graduates will be proficient in using advanced microscopy and spectroscopy techniques for the structural and chemical characterization of materials.

PSO2: Graduates will have mastered various experimental techniques, including sample preparation, data collection, and instrument operation, ensuring their competency in conducting independent research.

PSO3: Graduates will be skilled in designing research experiments, formulating hypotheses, and applying appropriate research methodologies for scientific investigations.

PSO4: Graduates will possess strong data analysis skills, enabling them to interpret research results accurately and draw meaningful conclusions.

PSO5: Graduates will understand and adhere to ethical principles in research, including authorship, citation, and responsible research publication practices.

PSO6: Graduates will be proficient in using computational tools and software for data analysis, modelling, and simulations, enhancing their research capabilities in the digital age.

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					20.09.2023

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	B011101T	Physics of Materials	Theory	6	100 [25(CIE)+75(UE)]
		B011102T	Experimental Techniques	Theory	6	100 [25(CIE)+75(UE)]
		B011103T	Research Methodology, Research Publication Ethics and Computer Applications	Theory	4	100 [25(CIE)+75(UE)]
		B011104R	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) months**	**Semester: XI**
Subject: Physics		
Course Code: B011101T	**Course Title: Physics of Materials**	

Course Outcomes (COs)

CO1: Understand the various types of materials, including metals, alloys, ceramics, composites, intermetallic, liquid crystals, and nano-materials.

CO2: Master the fundamentals of semiconductor physics, including band structures of metals, insulators, and semiconductors.

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CO3: Apply this knowledge to design and characterize solar cells, thermoelectric devices, LEDs, and photo detectors.
CO4: Explore ultrasonic velocity-related parameters, attenuation, and measurement techniques in different materials.
CO5: Examine classical, Einstein, and Debye theories of specific heat and their relevance to material properties.
CO6: Understand the principles of DFT, including functionals, functional derivatives, and many-body problems.

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 to Material Science**: Types of Materials – Metals and alloy, ceramics, Composites, Intermetallics, Liquid Crystals and Nano-materials, Emergence of Nanotechnology, Historic Background, System classification confined to one two or three dimensions and their effect on properties,	15
II	**Review of semiconductor physics:** Band Structure of metals, insulators and semiconductors, E-K diagram, Density of States, Fermi Level Intrinsic and extrinsic semiconductors. Design and characterization of Solar Cells, Thermoelectric devices, Light Emitting Diodes (LEDs), Photo Detectors (PDs).	15
III	**Ultrasonic Properties of the Materials:** Characteristics and detection of ultrasonic wave, Classification of ultrasonic application and testing, Ultrasonic NDT as a material characterization, Ultrasonic velocity related parameters and its theoretical evaluation, measurement techniques of ultrasonic velocity, Source of ultrasonic attenuation; Measurement techniques of ultrasonic attenuation, Ultrasonic attenuation and velocity in different materials.	15
IV	**Thermal Properties of Materials**: Classical, Einstein and Debye theory of specific heat, Vibrations of Crystal lattices, Thermal Conductivity, Thermal Expansion, Specific heat capacity, thermal diffusivity, and Thermal stability.	18
V	**Thermoelectric properties of the materials**: Thermoelectric Effect, Seebeck coefficient, Peltier Effect, Thomson Effect, electric conductivity, Methods of tuning the thermoelectric parameters and their optimization. Thermoelectric Properties in Bulk and Low-Dimensional Structures. Applications of thermoelectric materials.	15
VI	**Density Functional Theory**: Functionals and the Functional Derivative, Many-body problems, The Hohenburg-Kohn Theorems, Local Density Approximation (LDA), Generalised Gradient Approximation (GGA), Hybrid Exchange Functionals. Structural optimization using DFT.	12

Suggested Readings:

1. Chung YW, Kapoor M, "Introduction to Materials Science and Engineering" TAYLOR & FRANCIS, Boca Raton, 2022. 2nd Edition
2. Sze SM, Kwok K Ng, "Physics of Semiconductor Devices", Wiley & Sons, 2006
3. Jiles, DC, "Sound Waves: Acoustic and Ultrasonic Properties of Materials", Introduction to the Principles of Materials Evaluation, CRC Press, Boca Raton, 2013.
4. Grimvall G, "Thermophysical Properties of Materials", Elsevier, Holland, 1999.
5. Park CR, "Advanced Thermoelectric Materials", Wiley, USA, 2019

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6. Sholl, DS, Steckel, JA, "Density Functional Theory: A Practical Introduction" John Wiley & Sons, Inc., Hoboken, New Jersey, 2009

Suggested Online Platforms:

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Programme: Post graduate Diploma in Research (PGDR)	**Year: six (6) months**	**Semester:** XI
Subject: Physics		
Course Code: B011102T	**Course Title: Experimental Techniques**	

Course Outcomes (COs)

CO1: The students will be able to demonstrate proficiency in both top-down and bottom-up nanomaterial synthesis methods.
CO2: The students will be able to utilize X-ray Diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and scanning electron microscopy (SEM) for in-depth structural characterization.
CO3: The students will gain proficiently in operating and interpreting results from transmission electron microscopy (TEM) and atomic force microscopy (AFM) for nanoscale imaging and analysis.
CO4: The students will be able to apply Thermo gravimetry analysis (TGA), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC) for precise thermal characterization.
CO5: The students will be able to utilize Raman spectroscopy, UV/Vis/NIR, and FTIR spectroscopy to analyse the composition and properties of nanomaterials.
CO6: The students will be able to integrate multiple characterization techniques to holistically investigate and present findings on nanomaterials.

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	**Nanomaterial Synthesis Techniques**: Top-down and bottom-up synthesis approaches, Physical and chemical techniques for nanomaterial synthesis	15
II	**Advanced Nanomaterial Synthesis**: Preparation of nanomaterials, Sol-gel, CVD, PVD, and M.B.E etc, Nanowires synthesis, Carbon nanotubes synthesis, Graphene synthesis	15
III	**Structural Characterization Techniques:** X-ray Diffraction (XRD), X-ray photoelectron spectroscopy (XPS), Scanning electron microscopy (SEM)	15
IV	**Microscopy and Imaging Techniques**: Transmission electron microscopy (TEM), Atomic force microscopy (AFM)	15
V	**Thermal Analysis Techniques:** Thermo gravimetry analysis (TGA), Differential thermal analysis (DTA), Differential scanning calorimetry (DSC)	12
VI	**Spectroscopic and Advanced Measurement Techniques:** Raman spectroscopy, UV/Vis/NIR spectroscopy, UV-visible spectrophotometry, Thermal Conductivity Measurement Techniques, Ultrasonic Spectroscopy	18

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Suggested Readings:

1. "Introduction to Nanomaterials and Nanotechnology" by Charles P. Poole Jr. and Frank J. Owens
2. "Scanning Electron Microscopy and X-Ray Microanalysis" by Joseph I. Goldstein, Dale E. Newbury, David C. Joy, Charles E. Lyman, Patrick Echlin, Eric Lifshin, Linda Sawyer, Joseph R. Michael, and Henry Fiori (Springer)
3. "Principles of Thermal Analysis and Calorimetry" by Simon Gaisford and Peter Warren (Royal Society of Chemistry)
4. "Introduction to Heat Transfer" by Frank P. Incropera and David P. DeWitt
5. "Ultrasonic Spectroscopy: Applications in Condensed Matter Physics and Materials Science" by D. S. Tse and K. K. Shung.

Suggested Online Platforms:

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsde.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Programme: Post graduate Diploma in Research (PGDR)	**Year: six (6) months**	**Semester:** XI
Subject: Physics		
Course Code: B011103T	**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.

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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 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** 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

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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) months**	**Semester:** XI
Subject: Physics		
Course Code: B011104R	**Course Title: Research Project**	
Course Outcomes (COs): After the completion of the course, the students will be able to CO1: 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 project topic. CO3: Identify, analyse, 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 which is suitable to communicate/present in workshops and conferences.		
Credits: Non -Credit	**Core Compulsory**	
Max. Marks: 25 (CIE) + 75(UE)	**Min. Passing marks: 55**	

Suggested Readings: As per the field of the project.

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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.

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

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$CGPA = \frac{\sum Cj.Sj}{\sum Cj}$	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

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