COURSE CODE PHDCW101	COURSE NAME Research Methodology	L	T	P	C
		1	1	0	2
Total Credits: 2	Total Hours in semester: 15+15	Total Marks: 50			

1	**Course Pre-requisites:**
2	**Course Category: Ability Enhancement Compulsory Course**
3	**Course Revision/ Approval date:**
4	**Course Objectives**
	4.1 To learn types and methods of research.
	4.2 To understand data collection and Analysis.
	4.3 To understand Field work and Field Methods.
	4.4 To develop article and thesis writing skills.
	4.5 To understand elements of Thesis writing.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1 Types and Methods of Research: Different Patterns of Research: Inductive & Deductive, Comparison &Contrast, Spatial, Chronological, Cause & Effect etc. Quantitative and Qualitative approach Collection of Information and evaluation	25%	4	Lecture, Discussion, Powerpoint Presentation, Sample Practice, Revision
Unit 2 Material Collection and Analysis: Objectives and Classification Primary and Secondary sources Different Resources: Library, Field and Other sources Collection of data from the Library sources	20%	3	Power Presentation, Lecture, Discussion, Software Based Learning / Language Lab, Sample Practice
Unit 3 Field work : Field work and Field Methods Designing an Interview Note Taking	15%	2	Power Presentation, Lecture, Discussion, Software Based, Learning / Language

			Lab, Sample Practice, Role Play
Unit 4 Writing Stage: Report Writing the First Draft Revisions Language and Style Use of Quotations Method of Transcription Special Elements: title page, table of contents, headings and sub-headings, footnotes, tables and figures, appendix, bibliography etc.	20%	3	Discussion, Powerpoint Presentation, Sample Practice, Notes
Unit 5: Post writing Stage: Elements of Thesis, The Preliminaries, Title Page, Table of Contents, Approval. Sheet, Typing Instructions, Proof Reading	20%	3	Notes and PPT

Learning Resources	
1.	Textbook: 1. Becker, H. S. Writing for Social Scientists: How to Start and finish Your Thesis, Chicago; University of Chicago Press, 1986. 2. Flyvbjerg, Bent. Making Social Science Matter: Why Social Inquiry Fails and How it can Succeed Again, UK: Cambridge University Press, 2001 3. Gilbert, Nigel. Researching Social life, New Delhi: Sage Publication, 1993 4. Goodde and Hatte. Methods in Social Research, New York: McGraw – Hill, 1952 5. Gopal, M. H. An Introduction to Research Procedures in Social Sciences, Bombay: Asia Publishing House, 1970
2.	Reference books: 1. Becker, H. S. Writing for Social Scientists: How to Start and finish Your Thesis, Chicago; University of Chicago Press, 1986. 2. Flyvbjerg, Bent. Making Social Science Matter: Why Social Inquiry Fails and How it can Succeed Again, UK: Cambridge University Press,

	2001 3. Gilbert, Nigel. Researching Social life, New Delhi: Sage Publication, 1993 4. Goodde and Hatte. Methods in Social Research, New York: McGraw – Hill, 1952 5. Gopal, M. H. An Introduction to Research Procedures in Social Sciences, Bombay: Asia Publishing House, 1970 6. Henn, Matt; Mark Weinstein and Nick Foard, A Short Introduction to Social Research, New Delhi: Vistaar Publications, 2006 7. Hunt, Morton, Profiles of Social Research: The Scientific Study of Human Interactlions, Bombay: Popular Prakashan, 1989 8. Krishnaswami, O. R. Research Methodology in Social Sciences, Delhi: Himalaya Publications, 2000 9. Kumar, Renjith. Research Methodology: A Step by Step Guide for Research, Delhi: Pearson Education, 2009.
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme	**Total Marks**
End semester Marks	50

Course Outcomes	After Completion of the course student will be: 1. Understand and comprehend the basics in research methodology and applying them in research/ project work.
	2. Able to select an appropriate research design.
	3. Enable to collect the data, edit it properly and analyze it accordingly.
	4. Able to identify elements of thesis.
	5. Developed skills to write Research article and thesis.
Additional Information to enhance learning	

COURSE CODE PHDCW102	COURSE NAME Research and Publication Ethics	L	T	P	C
		2	0	0	2
Total Credits: 3	Total Hours in semester: 30	Total Marks: 100			
1	Course Pre-requisites:				
2	Course Category: Ability Enhancement Compulsory Course				
3	Course Revision/ Approval date:				
4	Course Objectives				
	4.1 To learn philosophy and ethics of research.				
	4.2 To understand Scientific conduct.				
	4.3 To identify Publication Misconduct.				
	4.4 To know Open Access Publishing.				
	4.5 To learn types of Databases and Research Metrics.				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: **PHILOSOPHY AND ETHICS :** Introduction to philosophy: definition, nature and scope, concept, branches Ethics: definition, moral philosophy, nature of moral judgements and reactions	10%	3	Notes and Discussion
Unit 2 **SCIENTIFIC CONDUCT** Ethics with respect to science and research Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing Selective reporting and misrepresentation of data	15%	5	Lecture, Discussion, Sample Practice
Unit 3 PUBLICATION ETHICS Publication ethics: definition, introduction and importance Best practices / standards setting initiatives and guidelines: COPE,	25%	7	Notes and Discussion

WAME, etc. Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types Violation of publication ethics, authorship and contributor ship Identification of publication misconduct, complaints and appeals Predatory publishers and journals			
Unit 4 **OPEN ACCESS PUBLISHING:** Open access publications and initiatives SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies Software tool to identify predatory publications developed by SPPU Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. **PUBLICATION MISCONDUCT:** Subject specific ethical issues, FEP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Use of plagiarism software like Turnitin, Urkund and other open source software tools	25%	8	Discussion, Sample Practice, Software Based, Learning
Unit 5: 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, i10 index.	25%	7	Notes and PPT

Learning Resources

1.	Textbook: 1. Bird, A., Philosophy of Science. Routledge, 2006. 2. MacIntyre, Alasdair, A Short History of Ethics. London, 1967. 3. P. Chaddah, Ethics in Competitive Research: Do not get scooped; do not get plagiarized, 2018.
2.	Reference books: 1. C. Paramasivan, Research And publication Ethics, Charulatha Publications, 2021 2. David B. Resnik Oxford University Press, 2003 3. Ethics in Science Education, Research and Governance Edited by Kambadur Muralidhar, Amit Ghosh Ashok Kumar Singhvi. Indian National Science Academy, 2019. 4. Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of Research Integrity. 2007.
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme	**Total Marks**
End Semester Marks	50

Course Outcomes	After Completion of the course student will be: 1. Understand Research ethics and Plagiarism.
	2. Able to select an appropriate journal for Publication.
	3. Able to use plagiarism software.
	4. Able to identify research misconduct and predatory publications.
	5. Understand indexing and citation databases
Additional Information to enhance learning	

COURSE CODE PHDCW103	COURSE NAME Data Analysis(Statistics)	L	T	P	C
		1	1	0	2
Total Credits: 2	Total Hours in semester: 15+15	Total Marks: 50			
1	**Course Pre-requisites:** Basic knowledge of statistics and Mathematics				
2	**Course Category: Ability Enhancement Compulsory Course**				
3	**Course Revision/ Approval date:**				
4	**Course Objectives**				
	4.1 To give brief idea about Statistical methodology				
	4.2 To equip them different types of data collection techniques and classification.				
	4.3 To make aware about the importance of descriptive statistics.				
	4.4 To emphasize the development of quantitative research.				
	4.5 To understand the importance of Hypothesis testing.				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1 Introduction to Quantitative Research: Essence of Quantitative Data, Collection and Analysis Techniques Summarizing and describing a collection of data and classification, Univariate, and bivariate analysis	20%	3	Discussion, Power point Presentation,
Unit 2 Descriptive Statistics: Mean, mode and standard deviation, Percentages and Ratios, Measurement of skewness and Kurtosis	20%	3	MS Excel, Quiz and Discussion
Unit 3 Corelation and Regression Analysis Types of Corelation, Method of studying corelation, Rank Corelation, Uses of regression Analysis and Regression equations	20%	3	Discussion, Software Based Learning,
Unit 4 Introduction to Applied	20%	3	Discussion

Statistics: Identifying the dependent and independent variables, Confidence levels, Math that manipulates data			and Notes
Unit 5 Inferential Statistics: Drawing inference from data, modelling assumptions, Identifying Patterns, T-test, Analysis of Variance, Chi-square test.	20%	3	Excel and, PPT, Notes

Learning Resources	
1.	Textbook 1. Mood, Graybill and Boes, Introduction to the theory of Statistics, 3rd Edition, McGraw Hill, 1974
2.	Reference books 1. Probability and Statistics By T K V Iyengar, S chand, 3rd Edition, 2011. 2. Fundamentals of Mathematical Statistics by S C Gupta & V K Kapoor, Sultan Chand & Sons, New Delhi 2009
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme	**Total Marks**
End Semester Marks	50

Course Outcomes	After Completion of the course student will be able to: 1. Organize & present quantitative data and think critically with respect to quantitative information characterized by the centre, spread, and skewness of data
	2. Develop the concept of a sampling distribution and infer some characteristics of a population by examining a portion of the population and to make informed decision in a probabilistic environment
	3. 3. Express quantitatively the degree and direction of association between two linearly related variables and fit a regression model to the data as well as investigating the

	explained portion
Additional Information to enhance learning	Use Microsoft excel spreadsheets for Data Analyses.

Ph.D. Coursework

SCHOOL OF SCIENCE

COURSE CODE PHDCW104	COURSE NAME Seminar and Report	L	T	P	C
		0	1	1	2
Total Credits: 2	Total Hours in Semester: 15+30	Total Marks: 50			
1	Course Pre-requisites : Basic knowledge of Computer				
2	Course Category: Professional Elective/Core Professional/Generic Elective/Courses Offered by other departments/Open Electives				
3	Course Revision/ Approval date				
4	Course Objectives				
	4.1 To get skills for seminar and Report.				
	4.2 To develop presentation skills.				
	4.3 To learn tools for preparing seminar and Report.				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1 : Open Seminar on Recent Advancement of Concerned Research Topic.	20%	3	Discussion
Unit 2 : Research work presentation.	20%	3	Power Point Presentation
Unit 3: Use of modern digital media for better understanding of research output.	20%	3	Discussion, Software Based Learning
Unit 4: Development of presentation skills.	20%	3	Discussion, Software Based Learning
Unit 5: Open seminar.	20%	3	Power Point Presentation

Learning Resources	
1.	Textbook
2.	Reference books Few topic and recent publication will be given by the concerned faculty.
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Ph.D. Coursework

SCHOOL OF SCIENCE

Evaluation Scheme	Total Marks
End Semester Marks	50

Course Outcomes	1. Student get skills for seminar and report.
	2. Student learn different tools and techniques for presentation.
Additional Information to enhance learning	

COURSE CODE: PHDCM101	Spectroscopy	L	T	P	C
		2	0	0	2
Total Credits:2	Total Hours in Semester: 30	Total Marks: 50			
1	Course Pre-requisites : Basic Knowledge of Spectroscopy.				
2	Course Category: Core Professional				
3	Course Revision/ Approval date				
4	Course Objectives				
	4.1 To get deep knowledge of Infrared Spectroscopy				
	4.2 To get deep knowledge of Raman Spectroscopy				
	4.3 To get deep knowledge of Electronic Spectroscopy				
	4.4 To get deep knowledge of Luminescence Spectroscopy				
	4.5 To get deep knowledge of NMR Spectroscopy				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Infrared Spectroscopy: General principles, factors influencing vibrational frequencies, selection rules, Analysis of Infra-red technique, Fourier- transform IR– Spectroscopies.	20%	6	PPT, Discussion and Notes
Unit 2: Raman Spectroscopy: Principles, normal, resonance and laser Raman Spectroscopies. Structure determination by symmetry selection rules (normal coordinate analysis). Nuclear magnetic resonance Spectroscopy.	20%	6	PPT, Video, Software based learning
Unit 3: Electronic spectroscopy: General principles, Electronic absorption spectra of organic and inorganic molecules, Selection rules and their implications	20%	6	PPT, Video, Software based learning
Unit 4: Luminescence Spectroscopy: Introduction, characteristics of	20%	6	PPT, Video, Software based learning

fluorescence and phosphorescence emission, effects of solvents on fluorescence spectra.			
Unit 5: NMR Spectroscopy: Nuclear magnetic resonance Spectroscopy: General principles, sensitivity of the method, CW and FT-NMR, instrumentation. Application in chemical analysis (with special reference to 1H – NMR): Chemical shift, spin-spin splitting, area of peak, shift reagents, off-resonance decoupling.	20%	6	Notes and Discussion.

Learning Resources	
1.	**Textbook** 1. C.N. Banwell, Fundamentals of Molecular Spectroscopy (4th edition), Tata McGraw Hill, New Delhi, 1994. 2. R.M. Silverstein, G.C. Bassler, C. Morril, Spectrometric Identification of Organic Compounds (5th edition), John Wiley & Sons, 1991
2.	**Reference books** 1. J. R. Lakowicz, Principles of Fluorescence Spectroscopy (3 rd edition), 2006. 2. M. Rose, and R.A.W. Johnston, Mass Spectrometry for Chemists and Biochemists (2nd edition), Cambridge University Press, 1996. 3. D.L. Pavia, G.M. Lampman, G.S. Kriz, Introduction to Spectroscopy (3 rd edition), Thomson Brooks/Cole, 2000. 4. Fritz Helmet, Mössbauer Spectroscopy 5. J.A. Weil, and J.R. Bolton, Electron Paramagnetic Resonance: Elementary Theory and Practical Applications.
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme	Total Marks
End Semester Marks	50

Course Outcomes	1. Able to know the processes of data handling.
	2. Knowledge on different spectroscopy.
	3. Knowlede on HPLC
	4. Knowledge of UV and IR spectroscopy.
	5. Knowledge of NMR spectroscopy
Additional Information to enhance learning	

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COURSE CODE PHDBT101	COURSE NAME Emerging Techniques in Biotechnology	L	T	P	C
		2	0	0	2
Total Credits:2	**Total Hours in Semester: 30**	**Total Marks: 50**			
1	**Course Pre-requisites:** Basic knowledge of Biotechnology and Microbiology				
2	**Course Category:** Core Professional				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 To learn emerging techniques in Optical microscopy.				
	4.2 To learn emerging techniques in Mass Spectroscopy.				
	4.3 To learn emerging techniques in Structural biology.				
	4.4 To learn emerging techniques in Nanobodies.				
	4.5 To learn emerging techniques in Bioinformatics.				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1 Optical microscopy: Principles and applications of Dark field; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy, Confocal microscopy	20%	3	Lecture, Discussion, Powerpoint Presentation,
Unit 2 Mass Spectroscopy: Ionization techniques; mass analysers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry	20%	3	Lecture, Discussion,
Unit 3 Structural biology: X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small- angle X-ray scattering, Atomic force microscopy	20%	3	Lecture, Discussion, Software Based, Learning / , Sample Practice,
Unit 4 Nanobodies:	20%	3	Discussion,

Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies			
Unit 5 Systems biology: High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modelling and designing testable predictions	20%	3	Excel and Geogebra software, PPT

Learning Resources	
1.	Textbook: 1. Campbell, I.D. (2012).Biophysical Techniques. Oxford: Oxford University Press. 2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press. 3. Phillips, R., Kondev,J.,& Theriot, J.(2009). Physical Biology of the Cell. New York: Garland Science 4. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016.doi:10.1146/annurev. biochem.77.061906.092014.
2.	Reference books: 1. Campbell, I.D. (2012). Biophysical Techniques. Oxford: Oxford University Press. 2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press. 3. Phillips, R., Kondev,J.,& Theriot, J.(2009). Physical Biology of the Cell. New York: Garland Science

	4. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016.doi:10.1146/annurev. biochem.77.061906.092014. 5. Mohanraju, P.,Makarova, K. S., Zetsche, B., Zhang, F.,Koonin, E. V.,& Oost, J. V. (2016).Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). 6. Lander,E.(2016).The Heroes of CRISPR. Cell, 164(1-2), 18-28. 7. Ledford,H.(2016).The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a 8. Chakravarty, R., Goel, S., & Cai, W.(2014). Nanobody: The "Magic Bullet" for Molecular Imaging? Theranostics, 4(4),386-398.doi:10.7150/thno.8006.
3.	Journal 1. Journal of Microscopy 2. EMBO J 3. Nature 4. Science
4.	Periodicals 1. Biotech Magazine 2. Biotech Express Magazine
5.	Other Electronic resources 1. Nature Biotechnology 2. Journal of Applied Biology & Biotechnology

Evaluation Scheme	**Total Marks**
End Semester Marks	50

Course Outcomes	1. Students should understand latest technologies in the area of biotechnology and Microbiology.
	2. Students should also be able to learn about various applications of these technologies.
	3. Students should know applications in depth and able to apply it in their research projects.
	4. Students should be able to debate/discuss new technologies
	5. Students should be able to design experiments based on such technologies.
Additional Information to enhance learning	

Ph.D. Coursework

SCHOOL OF SCIENCE – Ph.D. MATHEMATICS

COURSE CODE PHDMA101	Mathematical Analysis	L	T	P	C
		2	0	0	2
Total Credits:2	Total Hours in Semester: 30	Total Marks: 50			
1	Course Pre-requisites: Basics of Real Analysis, Linear Algebra, Topology				
s2	Course Category: Core Professional				
3	Course Revision/ Approval date				
4	Course Objectives				
	4.1 To obtain depth knowledge of Real Analysis				
	4.2 To be able to solve critical problems in Topology.				
	4.3 To be able to understand concepts of Dynamical Systems				
	4.4 To obtain depth knowledge in Linear Algebra				
	4.5 To be familiar with recent advances in Mathematical Analysis				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Theory: real number system as a complete ordered Field, Supremum, Infimum, Sequences and Series, Convergence, Continuity, Uniform Continuity, Differentiability, Mean Value theorem	20%	6	Chalk-board, PPT and notes
Unit 2: Theory: Functions of Several variables, Partial derivatives, Derivative as linear transformation Riemaann Integral and Improper Integral, Uniform Convergence of Sequence and Series of functions	20%	6	Chalk-board, PPT and notes
Unit 3: Theory: Metric space, connectedness, compactness, normal linear space, Matrices and Vector space, Linear Transformation, Matrix representation of a linear	20%	6	Chalk-board, Notes and Discussion

transformation, Inner product spaces			
Unit 4: Theory: Discrete Dynamical Systems, Pseudo orbit Tracing Property, Expansivity, Chaos, Stability	20%	6	Chalk-board, Notes and Discussion
Unit 5: Theory: Topology, Product topology, separation Axioms, Connectedness compactness	20%	6	Chalk-board, notes and Online tools

Learning Resources	
1.	Textbook 1. Walter Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw-Hill 2. H.L. Royden and P.M. Fitzpatrick, Real Analysis, 4th Edition, Pearson Education.
2.	Reference books 1. Discrete Dynamical Systems with an Introduction to Discrete Optimization Problems, Arild Wikan, 1st Edition Bookboon 2. J. Munkres, Topoloty, 2nd Edition Person
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme	**Total Marks**
End Semester Marks	50

Course Outcomes	1. Apply Mathematical Analysis to solve Real life problems
	2. Develop critical thinking ability to solve Advanced Mathematical Problems

	3. Learn deep knowledge in Pure and Applied Mathematics
	4. Familiar with recent advances in Mathematical Analysis
	5. Demonstrate skills in constructing rigorous mathematical arguments.
Additional Information to enhance learning	

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PhD COURSE WORK

SCHOOL OF SCIENCE | Ph.D. PHYSICS

COURSE CODE PHDPY101	PHYSICS OF MATERIALS	L	T	P	C
		2	0	0	2
Total Credits: 2	**Total Hours in Semester: 30**	**Total Marks:50**			
1	**Course Pre-requisites:** Student must have basic knowledge of material science				
2	**Course Category: Core Professional**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 To understand the classification of the materials.				
	4.2 To understand the mechanical properties of the materials.				
	4.3 To gain knowledge related to materials behavior under modified conditions.				
	4.4 To learn different preparation methods for materials synthesis.				
	4.5 To understand the different characterization techniques.				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Structure of Materials Classification of material, ferrous & non-ferrous materials, Structure of Metals and Alloys, Crystal Structure, Phase Diagram, Solid Solution, Grain boundaries, Iron-Carbon Phase Diagram	20%	6	Presentation, Video, discussion
Unit 2: Mechanical Properties Mechanical Behavior of Metals & Alloys, Mechanical Properties, stress-strain diagram,, tensile properties, hardness, fatigue, creep.	20%	6	Demonstration , Video and Presentation
Unit 3: Material Degradation & Failure Analysis Fundamental of Corrosion, Types of corrosion, electrochemical corrosion, Corrosion Control & Monitoring	20%	6	Demonstration , Case study, Presentation
Unit 4: Preparation of Materials Ball-Milling, Solution & Melt method for crystal growth, epitaxial	20%	6	Demonstration , Video, Presentation

growth method, Sol gel technique, Deposition techniques, sputtering, Polymerization techniques for polymer synthesis			
Unit 5: Characterization of Materials Crystal structure analysis using XRD, Raman Spectroscopy, Photoluminescence, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), X-Ray Photoelectron Spectroscopy (XPS), Atomic FOrce Microscopy (AFM), Energy Dispersive X-Ray Analysis (EDAX), scanning tunneling microscope (STM)	20%	6	Demonstration, Case study, Presentation, Video

Learning Resources	
1.	Textbook 1. Principles of corrosion Engineering and corrosion control, Zaki Ahmad, Elsevier Science & Technology Books ISBN: 0750659246 2. Corrosion Engineering by Mars G. Fontana, McGraw-Hill, (1986) 3. William D. Callister, Material science and Engineering and Introduction, Wiley, 2006
2.	Reference books 1. Solid State Physics by Ashcroft and Mermin, CENGAGE Learning Asia, 2016 2. Fundamentals of surface and thin film analysis by L.C. Feldman and J.W. Mayer (North-Holland, Amsterdam, 1986) 3. An Introduction of X-ray Crystallography by Michael M. Woolfson, M. M.. Woolfson, Cambridge University Press, 1997 4. Essentials of Crystallography, M. A. Wahab, Narosa, New Delhi 5. Amorphous Semiconductors , Richard and Zallen 6. Handbook of Conducting Polymers, T.A Skotheim and J.R. Reynolds 7. Nanomaterials: Synthesis; properties and applications, A.S. Edelstein and R.C. Commarata 8. Modern Techniques of Surface Science, D. P. Woodruff, T. A. Delchar, Cambridge University Press, 03-Mar-1994

	9. Woodruff and Delchar : Experimental Techniques of Surface Science
3.	Journal
4.	Periodicals
5.	Other Electronic resources: https://ocw.mit.edu/courses/3-012-fundamentals-of-materials-science-fall-2005/ https://www.feynmanlectures.caltech.edu/

Evaluation Scheme	**Total Marks**
End Semester Marks	50

Course Outcomes	1. The students will understand the classification of the materials.
	2. The students will get an understanding related to different properties of materials.
	3. The students will gain knowledge related to materials behavior under modified conditions.
	4. The students will learn different preparation methods for materials synthesis.
	5. The students will understand and gain knowledge related to different characterization techniques for materials.
Additional Information to enhance learning	https://nptel.ac.in/courses/113108051 https://archive.nptel.ac.in/courses/113/102/113102080/ https://ocw.mit.edu/courses/3-012-fundamentals-of-materials-science-fall-2005/