Rungta International Skills University (RISU), Bhilai

Ph.D. Course Work Scheme and Syllabus

Session: 2025-26

Prepared by: Board of Studies, School of Research

Rungta International Skills University, Bhilai

Approved by: Academic Council

Ph.D. Course Work Examination Scheme & Detailed

Syllabus

As per Ordinance–16 (Ph.D. Regulations) of RISU, aligned with UGC Regulation 2022 & NEP 2020.

Course Work Structure

The Ph.D. Course Work at RISU consists of three papers with a total of 12 credits. Two papers are common and compulsory for all disciplines, and one paper is subject-specific. The candidate must choose one subject-specific paper related to his or her area of research or discipline. Each paper carries 4 credits (100 marks).

Paper	Credits	Nature
Research Methodology and Computer Applications	4	Paper I Common to all disciplines
Research & Publication Ethics (RPE)	4	Paper II Common to all disciplines
Subject Specific Paper	4	Paper III As per discipline (Prepared separately by Concern BoS)

To qualify in the Ph.D. coursework, a scholar must secure a minimum of 55% marks or its equivalent grade in each paper as per the UGC 10-point grading system. Only upon successful completion of all the coursework papers shall the scholar be eligible to continue in the Ph.D. program.

Ph.D. Course Work Syllabus

(Common to all disciplines)

Paper I: Research Methodology and Computer Applications (RU-700-18-00001)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To introduce the fundamental principles, processes, and types of research.
- To develop skills in identifying research problems, designing studies, and applying suitable methodologies.
- To enable students to use data collection tools and conduct statistical analysis with modern software.
- To train scholars in academic writing, report preparation, and effective presentation of research outcomes.

Course Outcomes (COs):

- **CO1:** Understand fundamental principles of research and apply research designs.
- **CO2:** Demonstrate skills in data collection, statistical analysis, and interpretation.
- **CO3:** Formulate hypotheses and develop suitable research tools.
- **CO4:** Apply modern software and ICT tools in research.
- **CO5:** Prepare structured reports, dissertations, and scientific documents.

Course Content (Syllabus):

Unit I: Research Fundamentals

- Concept of Research: Definition, objectives, characteristics.
- Types of Research: Pure, applied, action, qualitative, quantitative, mixed.
- Identification and Formulation of Research Problems
- Research Questions, Objectives, and Hypotheses
- Review of Literature: Sources (Scopus, Web of Science, PubMed, IEEE, UGC-CARE, ScienceDirect).

Unit II: Research Design and Data Collection

- Research Design: Exploratory, descriptive, experimental, longitudinal, cross-sectional.
- Population and Sample: Probability and non-probability sampling, sample size determination.

- Data Collection Methods: Questionnaire, interview, case study, observation, experiments.
- Tools for Data Collection: Surveys, digital platforms (Google Forms, REDCap, SurveyMonkey).
- Reliability, Validity, and Bias in Research

Unit III: Statistical Methods and Data Analysis

- Descriptive Statistics: Mean, median, mode, variance, standard deviation.
- Inferential Statistics: Hypothesis testing, t-test, chi-square, ANOVA, regression, correlation.
- Non-Parametric Tests: Mann-Whitney U, Kruskal-Wallis, Wilcoxon test.
- Software Applications: SPSS, R, Python, MATLAB, MS Excel.
- Data Interpretation and Presentation

Unit IV: Computer Applications in Research

- ICT Tools in Research: MS Office, LaTeX, Overleaf.
- Reference Management: EndNote, Zotero, Mendeley.
- Plagiarism Detection: Turnitin, iThenticate, URKUND.
- Accessing E-Resources: Open access platforms, ResearchGate, Academia.edu.
- Digital Data Visualization Tools: Tableau, Power BI, Origin, GraphPad.

Unit V: Research Communication and Dissemination

- Academic Writing: Structure of thesis, dissertation, technical reports.
- Preparation of Research Articles, Review Papers, Book Chapters
- Citation and Referencing Styles: APA, MLA, Chicago, Vancouver.
- Operational editorial management
- Conference Presentations: Poster and oral formats.
- Journal Selection, Peer Review Process, Impact Factor, h-index, i10-index, Altmetrics

Recommended Books:

Indian Authors:

- C.R. Kothari & Gaurav Garg – *Research Methodology: Methods and Techniques* (New Age International)
- Ranjit Kumar – *Research Methodology: A Step-by-Step Guide for Beginners* (Sage India Edition)

Foreign Authors:

- John W. Creswell – *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (Pearson)
- Donald R. Cooper & Pamela S. Schindler – *Business Research Methods* (McGraw Hill)

Paper II: Research and Publication Ethics (RU-700-18-00002)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To provide philosophical and ethical foundations for responsible research.
- To instill awareness of integrity, transparency, and accountability in scholarly work.
- To familiarize scholars with ethical norms in authorship, publication, and peer review.
- To train researchers in identifying, avoiding, and addressing research misconduct.
- To introduce research metrics, global standards, and guidelines for responsible conduct of research.

Course Outcomes (COs):

- **CO1:** Understand philosophical foundations of ethics and their application to research.
- **CO2:** Demonstrate awareness of integrity, transparency, and accountability in scholarly work.
- **CO3:** Apply ethical principles in publishing and peer review.
- **CO4:** Identify and avoid research misconduct including plagiarism, falsification, and fabrication.
- **CO5:** Adhere to national and international standards for responsible research conduct.

Course Content (Syllabus):

Unit I: Philosophy and Ethics in Research

- Research Ethics: Principles, values, and moral codes.
- Importance of Honesty, Integrity, and Accountability in Research
- Academic Freedom vs Academic Responsibility
- Ethical Decision-Making Models
- Case Studies: Ethical dilemmas in different disciplines

Unit II: Publication Ethics and Misconduct

- Meaning and Importance of Publication Ethics
- Authorship Guidelines: ICMJE, COPE, contributorship
- Types of Misconduct: Fabrication, falsification, plagiarism, duplication, redundant publication, salami slicing
- Role of Publishers, Editors, Reviewers
- Case Studies: Retractions and ethical violations

Unit III: Plagiarism and Research Metrics

- Plagiarism: Types, consequences, policies, detection software and prevention methods
- Intellectual Property Rights (IPR): Patents, copyrights, trademarks, GI
- Research Impact: Citation analysis, impact factor, SNIP, SJR, h-index, i10-index
- Alternative Metrics: Altmetrics, PlumX

Unit IV: Regulatory Frameworks and Committees

- UGC Guidelines on Research and Publication Ethics (RPE)
- Institutional Committees: IEC, IAEC, Biosafety Committees
- National and International Ethical Guidelines: ICMR, WHO, OECD
- Academic Integrity Policies in India and Abroad
- Funding Agency Ethical Guidelines: DST, DBT, CSIR

Unit V: Responsible Conduct and Best Practices

- Data Integrity: Collection, storage, sharing, confidentiality
- Conflict of Interest and Disclosure Norms
- Collaborative Research and Multi-Institutional Projects
- Peer Review Ethics and Editorial Responsibilities
- Good Research Practices: Transparency, reproducibility, open science
- Ethical and Responsible Use of Artificial Intelligence (AI) in Research: Fairness, accountability, bias mitigation, data privacy, and academic honesty in AI-assisted work.

Recommended Books:

Indian Authors:

- S.K. Kale – *Research Methodology and Ethics* (Himalaya Publishing)
- Y.K. Singh – *Fundamentals of Research Methodology and Statistics* (New Age International, Ethics Section)

Foreign Authors:

- Nicholas Steneck – *Introduction to the Responsible Conduct of Research* (Office of Research Integrity, USA)
- Day R.A. & Gastel B. – *How to Write and Publish a Scientific Paper* (Cambridge University Press)

Ph.D. Course Work Syllabus

(Subject Specific)

School of Engineering and Technology

Rungta International Skills University (RISU), Bhilai

Ph.D. Course Work Syllabus

(Discipline: Computer Science & Engineering/Information Technology and Computer Applications)

Paper III: Cloud Computing (RU-700-01-00008)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To provide scholars with a comprehensive understanding of cloud computing concepts, service models, and virtualization technologies.
- To develop knowledge of cloud application design and scalable data storage solutions.
- To equip scholars with practical skills in implementing SaaS, PaaS, and IaaS for research and industrial applications.

Course Outcomes (COs):

After completing this course, research scholars will be able to:

- **CO1:** Explain the fundamental concepts, components, and service models of cloud computing.
- **CO2:** Demonstrate knowledge of virtualization technologies and their role in enabling cloud environments.
- **CO3:** Apply SaaS and PaaS solutions for designing scalable and service-oriented applications.
- **CO4:** Analyze IaaS architecture, data storage, load balancing, and cloud-based database services.
- **CO5:** Design and develop cloud-based applications using client–server distributed architectures and web application frameworks.

Course Content (Syllabus):

Unit I: Introduction to Cloud Computing

- Cloud computing components
- Infrastructure services
- Storage applications, database services
- Introduction to SaaS, PaaS, IaaS, IDaaS
- Data storage in cloud

Unit II: Virtualization

- Enabling technologies
- Types of virtualization
- Server virtualization, desktop virtualization, memory virtualization
- Application and storage virtualization
- Tools and products available for virtualization

Unit III: SaaS and PaaS

- Getting started with SaaS
- SaaS solutions, SOA
- PaaS and its benefits

Unit IV: IaaS and Cloud Data Storage

- Understanding IaaS
- Improving performance for load balancing
- Server types within IaaS
- Utilizing cloud-based NAS devices
- Cloud-based data storage and backup services
- Cloud-based block storage and database services

Unit V: Cloud Application Development

- Client–server distributed architecture for cloud
- Designing cloud-based solutions
- Coding cloud-based applications
- Traditional Apps vs Cloud Apps
- Client-side programming
- Server-side programming (overview)
- Fundamental treatment of web application frameworks

Reference Books:

1. Kris Jamsa – *Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More* (Jones & Bartlett Publishers, 2013, Paperback edition)
2. Srinath Perera & Thilina Gunarathne – *Hadoop MapReduce Cookbook* (Packt Publishing)
3. Anthony T. Velte, Toby J. Velte & Robert Elsenpeter – *Cloud Computing: A Practical Approach* (Tata McGraw Hill Edition)

Ph.D. Course Work Syllabus

(Discipline: Computer Science & Engineering/Information Technology and Computer Applications)

Paper III: Data Science and Analytics (RU-700-03-00001)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To equip research scholars with advanced knowledge of data science concepts, tools, and techniques.
- To enable effective analysis, visualization, and interpretation of data for research and industry applications.
- To emphasize statistical methods, exploratory analysis, and predictive modeling for problem-solving.

Course Outcomes (COs):

After successful completion of this course, research scholars will be able to:

- **CO1:** Demonstrate a clear understanding of data science concepts, applications, and the role of big data analytics in research and industry.
- **CO2:** Apply Python and R programming for data cleaning, processing, visualization, and model creation.
- **CO3:** Perform exploratory data analysis (EDA) using statistical tools, visualization techniques, and case studies to identify patterns and insights.
- **CO4:** Apply inferential statistics for hypothesis testing, probability distributions, and A/B testing to validate research outcomes.
- **CO5:** Develop, implement, and interpret linear and logistic regression models for predictive analytics and advanced research applications.

Course Content (Syllabus):

Unit I: Introduction to Data Science
- Skills required for data science
- Applications of data science in different industries
- Big Data Analytics
- Business Intelligence vs Big Data
- Big data frameworks
- Current landscape of analytics

Unit II: Python and R for Data Science

- Data Visualization techniques and software
- Data Visualization in Python
- Introduction to NumPy
- Introduction to Matplotlib
- Introduction to Pandas
- Creation of models in R and Python
- Getting and Cleaning Data
- Data Processing
- Histogram, Seaborn

Unit III: Exploratory Data Analysis (EDA)

- Exploratory Data Analysis (EDA) concepts
- Data Sourcing, Data Cleaning
- Univariate Analysis, Bivariate Analysis
- Statistical measures
- Basic tools of EDA: plots, graphs, summary statistics
- Data Analytics Lifecycle, Discovery
- EDA Case Study

Unit IV: Inferential Statistics

- Basics of Probability
- Discrete Probability Distributions
- Continuous Probability Distributions
- Hypothesis Testing I: Null and Alternate Hypothesis, Decision Making, Critical Value Method
- Hypothesis Testing II: p-Value Method, Types of Errors
- Two-Sample Mean and Proportion Test
- A/B Testing

Unit V: Regression Models

- Linear regression
- Simple Linear Regression (with Python)
- Multiple Linear Regression (with Python)
- Least-squares principle
- Logistic regression
- Multiple correlation, Partial correlation

Reference Books:

1. David Taieb – *Data Analysis with Python: A Modern Approach* (Packt Publishing, ISBN: 9781789950069)

2. Armando Fandango – *Python Data Analysis* (Second Edition, Packt Publishing, ISBN: 9781787127487)

Ph.D. Course Work Syllabus

(Discipline: Computer Science & Engineering/Information Technology and Computer Applications)

Paper III: Artificial Intelligence and Machine Learning (RU-700-02-00001)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To provide research scholars with an in-depth understanding of Artificial Intelligence (AI) and Machine Learning (ML) concepts, algorithms, and applications.
- To develop skills in problem-solving, supervised and unsupervised learning, and neural network models.
- To enhance understanding of expert systems, robotics, and computer vision through real-world case studies.
- To enable application of AI and ML techniques for predictive modeling, automation, and intelligent decision-making.

Course Outcomes (COs):

After completing this course, research scholars will be able to:

- **CO1:** Explain the fundamentals, history, risks, and benefits of AI, along with problem-solving and knowledge representation approaches.
- **CO2:** Apply supervised machine learning algorithms for predictive modeling and performance evaluation.
- **CO3:** Implement unsupervised learning techniques and neural network models including CNNs and RNNs for complex data analysis.
- **CO4:** Analyze real-world AI case studies such as recommendation systems, self-driving cars, and voice assistants.
- **CO5:** Demonstrate understanding of expert systems and robotics, including computer vision and applications in various domains.

Course Content (Syllabus):

Unit I: Introduction to AI

- What is AI? History, risks, and benefits
- Agents and environments, concept of rationality, nature of environments, structure of agents
- Problem-solving agents, search algorithms

- Uninformed and informed search strategies, heuristic functions
- Adversarial search and games
- Backtracking search for constraint satisfaction problems
- Knowledge representation: issues and approaches

Unit II: Machine Learning Fundamentals and Supervised Algorithms

- Introduction to Machine Learning: Supervised, Unsupervised, Semi-supervised, and Reinforcement Learning
- Exploratory Analysis and Visualization, Performance Metrics
- Supervised Learning Algorithms: Linear Regression, Logistic Regression, Support Vector Machines, K-Nearest Neighbors, Decision Trees, Random Forest, Naïve Bayes

Unit III: Unsupervised Learning and Neural Networks

- K-Means Clustering, Hierarchical Clustering, Association Rules
- Principal Component Analysis (PCA)
- Neural Networks: Introduction, ANN, MLP
- Deep Learning: CNN, RNN and their applications

Unit IV: Case Studies of Machine Learning

- Facebook applications
- Voice assistants (Alexa, Siri)
- Recommendation systems (Netflix, Amazon)
- Google Maps and navigation
- Self-driving cars (Tesla)
- Machine translation (Google Translate)
- Gmail spam detection
- Face recognition

Unit V: Expert Systems and Robotics

- Expert Systems: Capabilities, Components, Knowledge Base, Inference Engine, User Interface, Limitations, Applications
- Robotics: Definition, difference between robot systems and AI programs
- Robot locomotion, components of a robot
- Computer Vision: tasks, application domains
- Applications of robotics

Reference Books:

1. Russell, S. & Norvig, P. – *Artificial Intelligence: A Modern Approach* (Prentice Hall, 4th Edition, 2020)
2. Saikat Dutt, Subramanian C., Amit Kumar Das – *Machine Learning* (Pearson, 1st Edition, 2018)

3. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong – *Mathematics for Machine Learning* (Cambridge University Press, 2020)

Ph.D. Course Work Syllabus

(Discipline: Computer Science & Engineering/Information Technology and Computer Applications)

Paper III: Recent Advances in Computer Science (RU-700-03-00002)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To provide research scholars with a comprehensive understanding of modern computational paradigms including Big Data, Cloud Computing, IoT, Machine Learning, and Blockchain.
- To emphasize theoretical foundations, architectures, and applications to enable effective research and innovation in emerging technologies.

Course Outcomes (COs):

After completing this course, scholars will be able to:

- **CO1:** Explain the characteristics, types, infrastructure, and challenges of Big Data.
- **CO2:** Analyze cloud computing models, virtualization, deployment architectures, and their advantages over traditional systems.
- **CO3:** Demonstrate understanding of IoT architecture, applications, protocols, and performance considerations.
- **CO4:** Apply machine learning principles including concept learning, hypothesis space, and inductive bias for building learning systems.
- **CO5:** Understand blockchain fundamentals, consensus mechanisms, transaction processes, and applications in secure distributed systems.

Course Content (Syllabus):

Unit I: Big Data

- Definition and explanation of Big Data
- Characteristics of Big Data: Basic, 3V, and 5V
- Importance of Big Data
- Types of Big Data: Structured, Semi-structured, Unstructured
- Big Data Technology Foundation: Physical Infrastructure (Generation, Computation, Communication, Storage), Security Infrastructure
- Current trends and challenges

Unit II: Cloud Computing

- Overview, evolution, and characteristics of cloud computing
- How cloud computing works, pros and cons, challenges
- Comparison with traditional computing architectures (Client/Server) and other computing trends (Grid, Cluster, Distributed Computing)
- Virtualization: Introduction, types, implementation levels
- Cloud Computing Architecture: Cloud computing stack, Service Models (SaaS, PaaS, IaaS)
- Cloud Deployment Models: Public, Private, Hybrid, Community
- Services provided at various levels

Unit III: Internet of Things (IoT)

- IoT definition, overview, applications, potential, and challenges
- IoT architecture, M2M vs IoT
- Internet vs IoT: Layers, protocols, packet-services
- Performance parameters of packet-networks: Web, P2P, Sensor Networks, Multimedia

Unit IV: Machine Learning

- Definition, goals, and applications of learning systems
- Aspects of developing a learning system: Training data, concept representation, function approximation
- Concept learning task, hypothesis space, general-to-specific ordering, maximally specific hypotheses
- Importance of inductive bias

Unit V: Blockchain

- Introduction, advantages over conventional distributed databases
- Blockchain network, mining mechanism, distributed consensus
- Merkle Patricia Tree, gas limit, transactions and fees
- Anonymity, reward, chain policy
- Life cycle of blockchain applications
- Soft & hard fork, private and public blockchain

Reference Books:

1. Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman – *Big Data for Dummies* (John Wiley & Sons, 2013)
2. Nathan Marz & James Warren – *Big Data: Principles and Best Practices of Scalable Real-Time Data Systems* (Dreamtech Press, 2016)
3. Barrie Sosinsky – *Cloud Computing Bible* (Wiley-India, 2010)
4. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski (Editors) – *Cloud Computing: Principles and Paradigms* (Wiley, 2011)

Ph.D. Course Work Syllabus

(Discipline: Computer Science & Engineering/Information Technology and Computer Applications)

Paper III: Blockchain Technology (RU-700-01-00009)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To provide research scholars with a deep understanding of blockchain technology, covering architecture, smart contract development, scalability, security, and real-world applications.
- To prepare scholars to critically analyze current research trends and contribute innovative solutions to emerging challenges in the blockchain domain.

Course Outcomes (COs):

After completing this course, research scholars will be able to:

- **CO1:** Critically evaluate the design and functioning of different blockchain systems and consensus mechanisms.
- **CO2:** Develop and deploy smart contracts using Solidity and understand the operational aspects of blockchain platforms.
- **CO3:** Analyse and propose solutions for scalability, privacy, and interoperability challenges in blockchain networks.
- **CO4:** Apply blockchain technology to solve problems in domains such as supply chain, identity management, and digital governance.
- **CO5:** Conduct original research in emerging areas of blockchain, contributing to academic and industrial advancements.

Course Content (Syllabus):

Unit I: Foundations of Blockchain

- Introduction to Blockchain Technology
- History and Evolution of Blockchain
- Distributed Systems and Consensus Mechanisms
- Cryptographic Primitives: Hashing, Digital Signatures, Merkle Trees
- Blockchain Architecture: Blocks, Chains, Nodes, and Networks
- Types of Blockchains: Public, Private, Consortium

Unit II: Blockchain Platforms and Smart Contracts

- Ethereum and EVM (Ethereum Virtual Machine)
- Smart Contracts: Design, Development, Deployment
- Solidity Programming Language
- Hyperledger Fabric and Sawtooth
- Consensus Algorithms: PoW, PoS, DPoS, PBFT, PoA
- Gas, Transactions, and Token Standards (ERC-20, ERC-721)

Unit III: Advanced Topics in Blockchain

- Layer 2 Solutions: Sidechains, State Channels, Rollups
- Interoperability and Cross-Chain Communication
- Blockchain Scalability and Performance
- Privacy and Security in Blockchain: Zero-Knowledge Proofs, Ring Signatures
- Blockchain and IoT Integration
- Blockchain and AI Convergence

Unit IV: Applications and Use Cases

- Blockchain in Finance: DeFi, Cryptocurrencies, CBDCs
- Supply Chain Management
- Healthcare and Identity Management
- Voting Systems and Governance
- Intellectual Property and Digital Rights Management
- NFTs and Metaverse Applications

Unit V: Research Trends and Future Directions

- Blockchain for Sustainable Development Goals (SDGs)
- Regulatory and Legal Aspects of Blockchain
- Blockchain in Web3 and Decentralized Internet
- Quantum Computing and Blockchain
- Challenges and Open Research Problems

Reference Books:

- IEEE Access – Special Issues on Blockchain Technology
- ACM Journal on Emerging Technologies in Computing Systems
- Springer Lecture Notes in Computer Science (LNCS) – Blockchain-related conference proceedings
- Journal of Blockchain Research
- MIT Technology Review – Blockchain Section
- Imran Bashir – *Mastering Blockchain*
- Daniel Drescher – *Blockchain Basics: A Non-Technical Introduction in 25 Steps*
- Henning Diedrich – *Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations*
- Narayan Prusty – *Building Blockchain Projects*
- Primavera De Filippi & Aaron Wright – *Blockchain and the Law: The Rule of Code*

Ph.D. Course Work Syllabus

(Discipline: Computer Science & Engineering/Information Technology and Computer Applications)

Paper III: Cyber Security (RU-700-04-00001)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives:

- To provide scholars with a comprehensive understanding of foundational principles and contemporary practices in cybersecurity.
- To explore cryptography, access control, network and system defense mechanisms, and advanced threat analysis.
- To develop skills in legal, ethical, and privacy aspects of cybersecurity and prepare scholars to address complex security challenges in modern digital ecosystems.

Course Outcomes (COs):

After completing this course, research scholars will be able to:

- **CO1:** Analyze and apply core cryptographic constructs, including symmetric and asymmetric encryption, hash functions, and cryptographic protocols (SSL/TLS, IPSec), to design secure systems and evaluate security using formal models.
- **CO2:** Design and critique secure network architectures and system defenses, including strategies against advanced network attacks, secure protocol design (SDN, Zero Trust), OS hardening, and implementation of intrusion detection/prevention systems.
- **CO3:** Execute advanced techniques for cyber threat analysis, including static and dynamic malware analysis, reverse engineering, vulnerability discovery, exploitation, and penetration testing to assess system security.
- **CO4:** Evaluate the interplay between digital privacy, cyber laws, and digital forensics, and apply digital forensics and incident response (DFIR) methodologies across platforms such as cloud, IoT, and mobile.
- **CO5:** Critically assess security challenges and solutions in emerging technologies, including AI in cybersecurity (threat detection vs. adversarial AI), cloud virtualization, IoT/SCADA systems, and blockchain-based decentralized systems.

Course Content (Syllabus):

Unit I: Foundations of Cybersecurity & Cryptography

- Classic and modern cryptography (symmetric, asymmetric, hash functions)
- Cryptographic protocols and their analysis (SSL/TLS, IPSec)
- Access control models: MAC, DAC, RBAC, ABAC

- Formal security models and verification

Unit II: Network & System Security

- Advanced network attack vectors and defenses (DDoS, Botnets)
- Secure network architecture and protocol design (SDN, Zero Trust)
- Operating system security hardening and vulnerability analysis
- Intrusion Detection/Prevention Systems (IDS/IPS) and security monitoring

Unit III: Cyber Threats & Vulnerability Research

- Advanced malware analysis: static, dynamic, reverse engineering
- Vulnerability discovery, exploitation, and penetration testing
- Threat intelligence and cybercrime analysis
- Social engineering and human-centric attacks

Unit IV: Privacy, Law, and Cyber Forensics

- Digital privacy models and anonymity techniques (e.g., Differential Privacy)
- Cyber laws, regulations, and ethical hacking frameworks
- Digital forensics and incident response (DFIR) methodology
- Forensics for cloud, IoT, and mobile platforms

Unit V: Emerging Frontiers in Cybersecurity

- AI and machine learning for security (threat detection) and against security (adversarial AI)
- Cloud security and virtualization security
- IoT and critical infrastructure security (SCADA/ICS)
- Blockchain security and decentralized system security

Reference Books:

1. Mayank Bhushan – *Fundamentals of Cyber Security* (BPB Publications)
2. David O. Manz, Thomas W. Edgar – *Research Methods for Cyber Security*

Ph.D. Course Work Syllabus

(Discipline: Electrical Engineering)

Paper III: Electrical Engineering (RU-700-07-00003)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COBs)

The objectives of this course are to:

1. Provide advanced knowledge of power system dynamics, stability, and reliability assessment.
2. Familiarize scholars with the modeling, analysis, and control of electrical machines and modern drive systems.
3. Develop expertise in advanced protection schemes and power quality monitoring for conventional and smart grids.
4. Explore renewable and sustainable energy technologies with emphasis on integration, storage, and microgrids.
5. Introduce advanced control strategies and evolutionary optimization methods applied to electrical engineering research problems.

Course Outcomes (COs)

After successful completion of this course, the Ph.D. scholars will be able to:

- **CO1:** Model and analyze power system dynamics, stability phenomena, and evaluate reliability indices for generation, transmission, and distribution networks.
- **CO2:** Critically analyze electrical machine characteristics and apply advanced drive control methods for efficient and sustainable applications, including EVs.
- **CO3:** Design and evaluate advanced protection and monitoring schemes for power systems, considering renewable integration and smart grid challenges.
- **CO4:** Assess, compare, and propose renewable and sustainable energy technologies with appropriate storage and grid integration strategies.
- **CO5:** Apply advanced control theory and evolutionary optimization techniques for solving complex electrical engineering problems in power, drives, and energy systems.

Course Content (Syllabus)

Unit 1 – Power Systems and Reliability

• Dynamic modelling of synchronous machines, excitation systems, turbines, and loads
• Transient and small-signal stability of power systems, oscillations, and damping

• Reliability evaluation of generation, transmission, and distribution systems (LOLP, frequency & duration methods)
• Load and energy forecasting methods
• Deregulated power systems and electricity market structures

Unit 2 – Electrical Machines and Electric Drives

• Advanced characteristics of DC, induction, synchronous, and special machines (BLDC, SRM, Stepper, LIM)
• Modern drive control methods: vector control, direct torque control, V/f control
• Converter- and inverter-fed drive systems
• Energy efficiency in electric drives, condition monitoring, and predictive maintenance
• Applications in EVs and hybrid electric vehicles

Unit 3 – Power System Protection and Monitoring

• Static and digital relays: comparators, differential and distance protection
• Adaptive and wide-area protection in smart grids
• Protection of generators, transformers, and transmission lines
• Protection challenges with renewable integration and distributed generation
• Power quality issues and monitoring (indices, instruments, mitigation methods)

Unit 4 – Renewable and Sustainable Energy Systems

• Global and Indian energy scenario; environmental impacts of conventional generation
• Solar PV systems: collectors, solar cells, MPPT techniques, PV system integration
• Wind, biomass, geothermal, and hybrid energy systems
• Energy storage systems: batteries, supercapacitors, flywheels
• Grid integration challenges, microgrids, smart energy management systems

Unit 5 – Advanced Control and Optimization in Electrical Engineering

• State-space modelling of electrical systems; controllability & observability
• Nonlinear system analysis: Lyapunov stability, describing function method
• Discrete-time and digital control of electrical systems
• Evolutionary computation techniques (Genetic Algorithm, PSO, DE) applied to power flow optimization, stability enhancement, and renewable integration
• Applications of intelligent control in electrical machines, drives, and renewable systems

Text Books

- *Power System Analysis and Design* – J. Duncan Glover, Mulukutla S. Sarma, Thomas Overbye, Cengage Learning. (Units 1, 3)
- *Electrical Machines and Drives: Fundamentals and Advanced Modelling* – Rik De Doncker, Duco W. J. Pulle, André Veltman, Springer. (Unit 2)

- *Power System Protection and Switchgear* – B. Ravindranath, M. Chander, New Age International. (Unit 3)
- *Renewable Energy Resources* – John Twidell & Tony Weir, Routledge. (Unit 4)
- *Modern Control Engineering* – Katsuhiko Ogata, Prentice Hall. (Unit 5)

Reference Books

- **Prabha Kundur.** *Power System Stability and Control.* McGraw Hill.
- **Roy Billinton and Ronald N. Allan.** *Reliability Evaluation of Power Systems.* Springer.
- **G. K. Dubey.** *Fundamentals of Electric Drives.* Narosa Publishing.
- **R. Krishnan.** *Electric Motor Drives: Modeling, Analysis, and Control.* Pearson.
- **Y. G. Paithankar and S. R. Bhide.** *Fundamentals of Power System Protection.* Prentice Hall.
- **S. R. Bhide.** *Digital Protection: Protective Relaying from Electromechanical to Microprocessor.* PHI.
- **D. S. Chauhan.** *Non-Conventional Energy Resources.* New Age International.
- **Chetan Singh Solanki.** *Renewable Energy Technologies: A Practical Guide for Beginners.* PHI.
- **Frank Kreith.** *Energy Management and Conservation Handbook.* CRC Press.
- **M. Gopal.** *Digital Control and State Variable Methods.* Tata McGraw Hill.
- **J. E. Slotine and W. Li.** *Applied Nonlinear Control.* Prentice Hall.
- **Weerakorn Ongsakul.** *Artificial Intelligence in Power System Optimization.* CRC Press.
- **Timothy J. Ross.** *Fuzzy Logic with Engineering Applications.* Wiley.

Ph.D. Course Work Syllabus

(Discipline: Civil Engineering)

Paper III: Civil Engineering (RU-700-09-00002)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COs):

- Apply soil mechanics principles to solve geotechnical engineering problems and understand their impact on foundation engineering.
- Demonstrate competency in water resources engineering by analyzing fluid mechanics, hydraulics, hydrology, and irrigation systems.
- Describe and apply structural engineering fundamentals, including stress-strain relationships, structural analysis, and design of concrete and steel structures.
- Evaluate and design environmental engineering systems for water supply, wastewater treatment, air pollution control, and solid waste management.
- Plan, design, and analyze transportation engineering systems, including highway geometry, pavement design, traffic management, and infrastructure planning.

Course Outcomes (COs):

After successful completion of this course, PhD scholars will be able to:

- **CO1:** Classify soils, determine key properties, and analyze soil behavior for geotechnical and foundation applications.
- **CO2:** Solve practical problems in fluid and water resources engineering, including flow analysis, channel design, and hydrological estimation.
- **CO3:** Perform structural analyses and design fundamental elements (beams, columns, slabs, trusses) in concrete and steel using relevant methods and codes.
- **CO4:** Assess and design environmental systems for water, air, and solid waste, selecting appropriate processes and interpreting standards.
- **CO5:** Analyze transportation engineering problems, apply pavement and geometric design principles, and manage highway traffic and capacity using engineering tools.

Course Content (Syllabus):

Unit I: Geotechnical Engineering

- Soil Mechanics: Origin of soils, classification, three-phase system, fundamental definitions, relationships, permeability, seepage, effective stress, consolidation, compaction, shear strength.

- Foundation Engineering: Sub-surface investigations (boreholes, sampling, penetration tests, plate load test), Earth pressure theories, water table effects, layered soils, slope stability (infinite & finite slopes).
- Shallow Foundations: Bearing capacity, effects of shape and water table, stress distribution, settlement analysis in sands and clays.
- Deep Foundations: Pile types, dynamic & static formulae, load capacity of piles in sands & clays, negative skin friction.

Unit II: Water Resources Engineering

- Fluid Mechanics & Hydraulics: Properties of fluids, conservation of mass, momentum, energy, potential flow, laminar and turbulent flow, flow in pipes, boundary layer concepts, uniform and gradually varied flow, hydraulic jump, forces on immersed bodies, flow measurements, dimensional analysis, hydraulic modeling, velocity triangles, pump & turbine specific speed.
- Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage-discharge relationships, unit hydrographs, flood estimation, reservoir capacity, channel routing, well hydraulics.
- Irrigation: Duty, delta, evapo-transpiration estimation, crop water requirements, design of lined/unlined canals, waterways, headworks, gravity dams, spillways, weirs, types of irrigation systems, waterlogging, and drainage.

Unit III: Structural Engineering

- Mechanics: Bending moments, shear forces, stress-strain relationships, principal stresses, Mohr's circle, flexural and shear stresses, unsymmetrical bending, shear centre, thin-walled pressure vessels, torsion, buckling of columns, combined bending stresses.
- Structural Analysis: Statically determinate/indeterminate trusses, arches, beams, cables, frames; displacement and energy methods; slope-deflection and moment distribution methods; influence lines.
- Concrete Structures: Properties of concrete, mix design, working stress and limit state design, ultimate load capacity, design of members under flexure, shear, compression, and torsion.
- Steel Structures: Analysis and design of tension/compression members, beams, columns, column bases, connections, beam-column connections, plastic analysis of beams and frames.

Unit IV: Environmental Engineering

- Water Requirements: Drinking water standards, water treatment unit processes, distribution systems.
- Wastewater Treatment: Quantity and characteristics, primary, secondary, tertiary treatment, sludge disposal, effluent standards.
- Air Pollution: Types of pollutants, sources, impacts, control measures, air quality standards.
- Municipal Solid Waste: Characteristics, generation, collection, transportation, engineered systems, reuse/recycle, energy recovery, treatment, and disposal.

Unit V: Transportation Engineering

- Highway Planning: Geometric design, testing and specifications of paving materials, flexible and rigid pavement design.
- Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs, signal design, highway capacity.

Reference Books:

1. Punmia, B.C., Jain, A.K., & Jain, A.K. *Soil Mechanics and Foundations*. Laxmi Publications.
2. Asawa, G.L. *Irrigation and Water Resources Engineering*. New Age International.
3. Hibbeler, R.C. *Structural Analysis*. Pearson.
4. Subramanian, N. *Design of Reinforced Concrete Structures*. Oxford University Press.
5. Peavy, H.S., Rowe, D.R., & Tchobanoglous, G. *Environmental Engineering*. McGraw-Hill.
6. Khanna, S.K., & Justo, C.E.G. *Highway Engineering*. Nem Chand & Bros.

Ph.D. Course Work Syllabus

(Discipline: Electronics and Telecommunication Engineering)

Paper III: Electronics and Telecommunication Engineering (RU-700-06-00005)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COBs)

The course aims to:

1. Develop advanced understanding of modern communication systems, networks, and protocols with focus on wireless, optical, and next-generation paradigms.
2. Provide deep knowledge of VLSI devices, IC design, embedded systems, and photonic circuits to enable high-performance system development.
3. Foster expertise in advanced digital signal, speech, and image processing techniques with integration of AI and machine learning.
4. Enhance analytical skills in microwave, RF, and antenna technologies using computational electromagnetics for diverse real-world applications.
5. Expose learners to cutting-edge research and emerging trends in electronics and telecommunication such as quantum electronics, nanoelectronics, and AI-driven systems.
6. Encourage critical thinking through case studies and application of contemporary research findings to practical and futuristic ECE challenges.

Course Outcomes (COs)

On successful completion of this course, the scholar will be able to:

1. Analyze wireless, optical, and next-generation communication systems for performance, reliability, and scalability.
2. Design and evaluate VLSI circuits, ICs, and embedded platforms for advanced electronic and communication applications.
3. Apply advanced signal, speech, and image processing techniques with machine learning models to solve real-world engineering problems.
4. Model and simulate microwave and antenna systems using computational tools for applications in radar, satellite, and biomedical systems.
5. Critically assess recent advances in electronics and telecommunication, including quantum and nanoelectronics, photonics, and AI-driven technologies.
6. Synthesize knowledge from literature, research articles, and case studies to identify new research problems and propose innovative solutions.

Course Content (Syllabus)

Unit I: Communication Systems & Networks

• Wireless and Mobile Communication: fading, diversity, MIMO, OFDM, capacity analysis, 5G/6G concepts.
• Optical and Lightwave Communication: fiber dispersion, nonlinearities, optical amplifiers, WDM systems.
• Network architectures: SONET/SDH, optical transport, IP/MPLS, resilient packet rings.
• IoT and next-generation network paradigms.

Unit II: VLSI, IC Design & Embedded Systems

• VLSI Devices and Modelling: MOS physics, scaling, short-channel effects.
• Analog & Digital IC Design: CMOS op-amps, comparators, high-speed digital design, CAD tools.
• Embedded Systems: microcontrollers, SoCs, FPGA-based systems, real-time operating systems.
• Silicon Photonics and Photonic Integrated Circuits.

Unit III: Signal, Speech & Image Processing

• Advanced Digital Signal Processing techniques.
• Speech Processing & Recognition: LPC, MFCC, HMM, GMM approaches.
• Image Processing: transforms, restoration, segmentation, compression.
• Machine Learning & AI applications in speech, vision, and communication.

Unit IV: Microwave, RF & Antenna Technologies

• Microwave Theory & Techniques: transmission lines, filters, resonators, planar circuits.
• Antenna Theory and Design: dipole, array, microstrip, reflector, and smart antennas.
• Computational Electromagnetics (FDTD, FEM, MoM) for microwave and antenna modelling.
• Applications in radar, satellite, and biomedical communication.

Unit V: Emerging Trends in Electronics & Telecommunication

• Control Systems and Robotics in ECE.
• Quantum Electronics, Nanoelectronics, and advanced semiconductor devices.
• High-speed optical networks and integrated photonics.
• AI-driven wireless networks, autonomous systems, and biomedical signal processing.
• Case studies from recent IEEE/Elsevier research in ECE.

Text Books

- *Wireless Communications: Principles and Practice* – T. S. Rappaport, Pearson.
- *Fundamentals of Modern VLSI Devices* – Yuan Taur & Tak H. Ning, Cambridge University Press.

- *Discrete-Time Signal Processing* – Alan V. Oppenheim & Ronald W. Schafer, Pearson.
- *Microwave Engineering* – David M. Pozar, Wiley.
- *Modern Control Engineering* – K. Ogata, Pearson.

Reference Books

- **Andrea Goldsmith.** *Wireless Communications.* Cambridge University Press.
- **Govind P. Agrawal.** *Fiber-Optic Communication Systems.* Wiley.
- **R. Ramaswami, K. N. Sivarajan, and G. Sasaki.** *Optical Networks: A Practical Perspective.* Morgan Kaufmann.
- **Phillip E. Allen and Douglas R. Holberg.** *CMOS Analog Circuit Design.* Oxford University Press.
- **R. Jacob Baker.** *CMOS: Circuit Design, Layout and Simulation.* Wiley.
- **Wayne Wolf.** *Computers as Components: Principles of Embedded Computing System Design.* Morgan Kaufmann.
- **Lawrence Rabiner and Biing-Hwang Juang.** *Fundamentals of Speech Recognition.* Pearson.
- **Rafael C. Gonzalez and Richard E. Woods.** *Digital Image Processing.* Pearson.
- **Christopher M. Bishop.** *Pattern Recognition and Machine Learning.* Springer.
- **Constantine A. Balanis.** *Antenna Theory: Analysis and Design.* Wiley.
- **R. E. Collin.** *Foundations for Microwave Engineering.* Wiley-IEEE Press.
- **Jia-Sheng Hong.** *Microstrip Filters for RF/Microwave Applications.* Wiley.
- **M. Gopal.** *Digital Control and State Variable Methods.* McGraw Hill.
- **Charles P. Poole.** *Introduction to Nanotechnology.* Wiley.
- **Stuart Russell and Peter Norvig.** *Artificial Intelligence: A Modern Approach.* Pearson.

Ph.D. Course Work Syllabus

(Discipline: Mining Engineering)

Paper III: Mining Engineering (RU-700-10-00002)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COs):

- Explain key concepts of mining geology and ore genesis, developing understanding of minerals, rocks, geological structures, and their role in mineral exploration and mining.
- Describe and apply mine development techniques and surveying methods, covering access methods, drilling, blasting, and modern survey tools like GPS, EDM, and GIS.
- Analyze rock mechanics, ground control, and geomechanical behavior, including stress measurement, mass classification, and safe mine structure design for ground stability and strata control.
- Evaluate mining methods and machinery for varied deposits, understanding layouts, mechanized systems, handling equipment, and selecting/designing systems for both surface and underground operations.
- Apply principles of mine environment, economics, planning, and systems engineering, including ventilation, hazards, economic valuation, resource classification, and optimization in mine management.

Course Outcomes (COs):

After successful completion of this course, PhD scholars will be able to:

- **CO1:** Classify rocks and minerals, explain ore formation, and apply geology knowledge to mining contexts.
- **CO2:** Perform mine development and surveying tasks using appropriate machines, tools, and modern instrumentation.
- **CO3:** Evaluate geomechanics and ground control issues, recommending suitable mine stability, support, and monitoring strategies.
- **CO4:** Compare mining methods and select appropriate machinery for efficient resource extraction in surface and underground scenarios.
- **CO5:** Demonstrate competence in mine planning, environment, and systems engineering, including resource estimation, safety, economic analysis, and managing environmental impacts.

Course Content (Syllabus):

Unit I: Mining Geology, Mine Development and Surveying

- **Mining Geology:** Minerals, rocks and their origin, classification, structural geology, ore genesis.
- **Mine Development:** Methods of access to deposits, drilling methods and machines, underground drivages, rock-tool interaction, explosives and energetics, blasting devices, blast design practices.
- **Mine Surveying:** Levels and levelling, theodolite, tacheometry, triangulation, errors and adjustments, contouring, underground surveying, photogrammetry, EDM, total station, GPS, basics of GIS and remote sensing, correlation, curves.

Unit II: Geomechanics and Ground Control

- **Engineering Mechanics:** Equivalent force systems, 2D frames and trusses, equations of equilibrium, friction forces, particle kinematics and dynamics, free body diagrams, beam analysis.
- **Geomechanics:** Geotechnical properties of rocks, instrumentation and in-situ stress measurement techniques, rock mass classification, ground vibrations, stress distribution around mine openings, slope stability, theories of rock failure, subsidence.
- **Ground Control:** Design of pillars, mine filling, roof supporting systems, strata control, and monitoring plan.

Unit III: Mining Methods and Machinery

- **Mining Methods:** Surface mining – layout, development, loading, transportation, mechanization, continuous surface mining systems, highwall mining; Underground coal mining – bord and pillar, room and pillar, longwall, thick seam methods; Underground metal mining – open, supported, caved stoping, stope mechanization, ore handling systems.
- **Mining Machinery:** Generation and transmission of mechanical, hydraulic, and pneumatic power; materials handling – wire ropes, haulages, conveyors, face and development machinery, hoisting systems, pumps; comminution methods and machinery.

Unit IV: Surface Environment, Mine Ventilation and Underground Hazards

- **Surface Environment:** Air, water, and soil pollution – standards, causes, dispersion, and control; noise pollution and control; land reclamation; environmental impact assessment (EIA).
- **Mine Ventilation:** Underground atmosphere; heat load sources, thermal environment, air cooling; mechanics of airflow, distribution, natural and mechanical ventilation; mine fans and usage; auxiliary ventilation; ventilation survey and planning; ventilation networks.
- **Underground Hazards:** Mine gases, methane drainage, rescue apparatus and practices; hazards from fires, explosions, dust, and inundation; accident data analysis; mine legislation; occupational health and safety; safety management plan; mine lighting.

Unit V: Mineral Economics, Mine Planning, Systems Engineering

- **Mineral Economics:** Mineral resource classification, mine valuation, discounted cash flow analysis, mineral taxation.

- **Mine Planning:** Sampling methods, practices, and interpretation; reserve estimation techniques, geostatistics, and quality control; facility location optimization; mine planning components, determination of mine size and life; ultimate pit configuration, optimum mill cut-off grade, stope planning; haul road design; selection of mining system and equipment.
- **Systems Engineering:** Concepts of reliability, maintainability, availability; linear programming, transportation and assignment problems; network analysis; inventory models; queuing theory; decision trees.

Text and Reference Books:

- H.L. Hartman & J.M. Mutmansky – *Introductory Mining Engineering*, Wiley.
- D.J. Deshmukh – *Elements of Mining Technology Vol. 1 & 2*, Central Techno Publications.
- K.M. Bangur – *Principles of Engineering Geology*, Standard Publishers.
- S. Ghatak – *Mine Surveying*, Kalyani Publishers.
- Debashis Deb & Abhiram K. Verma – *Fundamentals and Applications of Rock Mechanics*, CRC Press.

Ph.D. Course Work Syllabus

(Discipline: Mechanical Engineering)

Paper II: Mechanical Engineering and Smart Manufacturing (RU-700-08-00004)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COBs):

- **COB1:** Strengthen fundamental and advanced knowledge of core domains in Mechanical Engineering.
- **COB2:** Familiarize scholars with latest research trends, tools, and methodologies across Mechanical Engineering fields.
- **COB3:** Develop ability to identify research problems, formulate objectives, and design effective investigation methodologies.
- **COB4:** Enhance analytical, experimental, and computational research skills.
- **COB5:** Inculcate ethical practices, scientific writing, and presentation skills required for successful doctoral research.

Course Outcomes (COs):

After successful completion of this course, PhD scholars will be able to:

- **CO1:** Apply research methodologies, tools, and statistical techniques to formulate and solve research problems.
- **CO2:** Demonstrate advanced knowledge in thermo-fluid sciences, solid mechanics, materials, and manufacturing processes relevant to their research area.
- **CO3:** Use modern computational and experimental techniques for conducting high-quality research in Mechanical Engineering.
- **CO4:** Design innovative and sustainable solutions for engineering problems through critical analysis of literature and advanced methods.
- **CO5:** Prepare high-quality research publications, patents, and dissertations adhering to ethical and professional standards.

Course Content (Syllabus):

Unit I: Research Methodology in Mechanical Engineering

- Fundamentals of research: Experimental, analytical, simulation-based, interdisciplinary.
- Research design: Problem identification, literature review (Scopus, Web of Science).
- Research gaps and hypothesis formulation.

- Research ethics: Plagiarism, data integrity, IPR, patents in engineering research.
- Statistical tools: Probability distributions, hypothesis testing, regression, ANOVA, Design of Experiments (DOE).

Unit II: Advanced Thermo-Fluid Sciences

- Heat transfer at micro and nano scales.
- Advanced refrigeration, cryogenics, energy-efficient cooling technologies.
- Computational Fluid Dynamics (CFD) for turbulent, multiphase, and reactive flows.
- Renewable energy systems: solar thermal, wind, biomass, hybrid technologies.
- Exergy analysis and energy optimization.

Unit III: Advanced Solid Mechanics and Materials

- Continuum mechanics and constitutive modeling.
- Fracture mechanics, fatigue, creep behavior.
- Smart and functional materials, composites, nanomaterials.
- Finite Element Analysis (FEA) in structural, thermal, and dynamic problems.
- Experimental techniques: strain measurement, photoelasticity, Digital Image Correlation (DIC).

Unit IV: Manufacturing Science and Industrial Engineering

- Advanced manufacturing processes: additive manufacturing, micro/nano-machining, non-traditional machining.
- Smart manufacturing and Industry 4.0: IoT, automation, robotics, cyber-physical systems.
- Optimization techniques in manufacturing and production systems.
- Reliability engineering and maintenance optimization.
- Sustainable manufacturing and lifecycle assessment (LCA).

Unit V: Computational Methods and Research Tools

- Numerical methods in engineering research: FEM, FVM, BEM, meshless methods.
- Optimization and AI techniques: Genetic Algorithms, Neural Networks, Machine Learning applications in Mechanical Engineering.
- Software tools: MATLAB, Python, ANSYS, COMSOL, ABAQUS.
- Data analytics and big data applications in mechanical systems.
- Scientific communication: research paper writing, conference presentations, thesis writing.

Text and Reference Books:

Textbooks:

- C.R. Kothari & Gaurav Garg – *Research Methodology: Methods and Techniques*. New Age International.
- R. Panneerselvam – *Research Methodology*. PHI Learning.

- Yunus A. Çengel & Afshin J. Ghajar – *Heat and Mass Transfer: Fundamentals and Applications*. McGraw Hill.
- S.K. Som & Gautam Biswas – *Introduction to Fluid Mechanics and Fluid Machines*. McGraw Hill.
- L.S. Srinath – *Advanced Mechanics of Solids*. McGraw Hill.
- Timoshenko & Goodier – *Theory of Elasticity*. McGraw Hill.
- P.N. Rao – *Manufacturing Technology*. McGraw Hill.
- Mikell P. Groover – *Fundamentals of Modern Manufacturing*. Wiley.
- S.S. Rao – *Applied Numerical Methods for Engineers and Scientists*. Pearson.
- Steven C. Chapra – *Applied Numerical Methods with MATLAB*. McGraw Hill.

References:

- Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams – *The Craft of Research*. University of Chicago Press.
- Ranjit Kumar – *Research Methodology: A Step-by-Step Guide for Beginners*. Sage.
- Elsevier & Springer Journals (plagiarism, ethics, scientific writing standards).
- Frank P. Incropera & David P. DeWitt – *Fundamentals of Heat and Mass Transfer*. Wiley.
- John D. Anderson – *Computational Fluid Dynamics: The Basics with Applications*. McGraw Hill.
- Ibrahim Dincer & Marc Rosen – *Exergy: Energy, Environment and Sustainable Development*. Elsevier.
- Robert D. Cook – *Concepts and Applications of Finite Element Analysis*. Wiley.
- Lawrence E. Murr – *Mechanical Behavior of Materials*. Cambridge University Press.
- Anderson T.L. – *Fracture Mechanics: Fundamentals and Applications*. CRC Press.
- Journals: *International Journal of Solids and Structures*, *Materials & Design*.
- Kalpakjian & Schmid – *Manufacturing Engineering and Technology*. Pearson.
- Chris A. Brown – *Advanced Manufacturing Processes*. Wiley.
- Shimon Y. Nof – *Springer Handbook of Automation*. Springer.
- Journals: *Journal of Manufacturing Processes*, *CIRP Annals – Manufacturing Technology*.
- J.N. Reddy – *An Introduction to the Finite Element Method*. McGraw Hill.
- Holger Wendland – *Numerical Methods for Partial Differential Equations*. Cambridge University Press.
- S.S. Rao – *Engineering Optimization: Theory and Practice*. Wiley.
- Rajesh Kumar – *Artificial Intelligence and Machine Learning for Engineers*. Cambridge University Press.
- Software manuals & online resources: MATLAB, ANSYS, COMSOL, Python scientific libraries.

School of Humanities and Social Sciences

Rungta International Skills University (RISU), Bhilai

Ph.D. Course Work Syllabus

(Discipline: English Literature)

Paper III: English Literature (RU-700-16-00004)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objective:

The objective of this course is to extend the limits of current knowledge through innovative, high-quality research and develop the capacity to devise, design, and conduct research with academic weight. The Ph.D. in English aims to cultivate both educational and intellectual thought processes in theory and practice.

Course Outcomes:

At the end of the course, scholars will be able to:

- Learn about the different literary theories that have significantly influenced literature.
- Apply these theories and incorporate relevant literature reviews in their research papers.

Course Content (Syllabus):

Unit 1: Marxism and Postmodernism

- Introduction to Marxism
- Fundamentals of Marxism
- Significance of Marxism in literature
- Introduction to Postmodernism
- Influential postmodern thinkers
- Criticisms and significance in literature

Unit 2: Psychoanalytic Criticism and Formalism

- Introduction to Psychoanalytic Criticism
- Psychoanalytic Literary Criticism
- Psychological Approach in Literary Criticism
- Introduction to Formalism
- Influence in Literature

Unit 3: Structuralism and Deconstruction

- Introduction to the movements
- In Literary Theory and Criticism
- Interpretations and General Criticisms

Unit 4: Feminist Criticism & Reader-Response and Reception Theory

- Introduction to the Theories
- Feminism: Movements and Ideologies
- Reader-Response Criticism
- The Reception of Reader-Response Theory
- The Importance of Reader-Response Theory

Unit 5: A. Postcolonial Criticism & Cultural Studies and New Historicism

- Introduction to the Topics
- Purpose and Basic Concepts of the Topics
- Postcolonial Literary Study: Criticism, Literature, Application
- Cultural Studies: Significance in Literature
- New Historicism: Significance in Literature

B. Contemporary & Niche Theories

- Exploration of newer and specialized fields such as Queer Theory, Posthumanism
- Ecocriticism, Disability Studies
- Digital Humanities, Graphic Novels

Text Books:

- Prasad B – *An Introduction to English Criticism*, Paperback
- Andrew Bennett & Nicholas Royle – *An Introduction to Literature, Criticism and Theory*, Routledge
- Julian Wolfreys (ed) – *Literary Theories: A Reader and Guide*, New York University Press
- Nayar – *Contemporary Literary and Cultural Theory: From Structuralism to Ecocriticism*, Pearson

Reference Books:

- Raman Selden – *A Reader's Guide to Contemporary Literary Theory*, University Press Kentucky
- N. Krishnaswamy, John Varghese, Sunita Mishra – *Contemporary Literary Theory: A Student's Companion*, Macmillan
- G. N. Devy (ed) – *Indian Literary Criticism: Theory and Interpretation*, Longman
- M. S. Nagarajan – *English Literary Criticism and Theory*, Orient BlackSwan
- Terry Eagleton – *Literary Theory: An Introduction*, Blackwell Publishers
- *The Norton Anthology of Theory and Criticism*, edited by Vincent B. Leitch

- Gayatri Chakravorty Spivak – *Can the Subaltern Speak?*
- Homi K. Bhabha – *The Location of Culture*
- Simone de Beauvoir – *The Second Sex*
- Sandra M. Gilbert & Susan Gubar – *The Madwoman in the Attic: The Woman Writer and the Nineteenth-Century Literary Imagination*
- Terry Eagleton – *Marxism and Literary Criticism*
- Theodor Adorno, Walter Benjamin et al. – *Aesthetics and Politics*
- Judith Butler – *Gender Trouble: Feminism and the Subversion of Identity*, Routledge Classics Edition
- José Esteban Muñoz – *Cruising Utopia: The Then and There of Queer Futurity*
- N. Katherine Hayles – *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*
- Cary Wolfe – *What Is Posthumanism?*
- Greg Garrard – *Ecocriticism*
- Tobin Siebers – *Disability Theory*
- Eli Clare – *Exile and Pride: Disability, Queerness, and Liberation*
- Susan Schreibman, Ray Siemens, John Unsworth – *Digital Humanities*
- James O'Sullivan – *The Digital Literary Studies Handbook*
- Stephen Weiner – *Graphic Novels: A Guide to Comic Book Literacy*
- Scott McCloud – *Understanding Comics: The Invisible Art*

Ph.D. Course Work Syllabus

(Discipline: Psychology)

Paper III: Psychology (RU-700-16-00007)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objective:

The objective of this course is to develop advanced knowledge in core domains of psychology, including cognitive, developmental, social, personality, abnormal, and neuropsychology. It aims to equip scholars with the ability to design, conduct, and analyze research of academic significance while fostering ethical and evidence-based practice.

Course Outcomes (COs):

At the end of the course, scholars will be able to:

- Analyse major cognitive, developmental, social, personality, abnormal, and neuropsychological processes.
- Apply psychological theories and research findings to real-world contexts.
- Evaluate experimental and clinical findings using ethical and scientific standards.
- Design interventions, assessments, and studies in applied psychology.
- Develop scholarly publications, case formulations, and research outputs adhering to professional standards.

Course Content (Syllabus):

Unit 1: Cognitive Psychology

- Perception, Attention, and Consciousness
- Memory Systems and Models
- Language Acquisition and Processing
- Problem Solving and Decision Making
- Cognitive Neuroscience

Unit 2: Developmental Psychology

- Theories of Human Development
- Prenatal to Late Adulthood Stages
- Attachment and Socialisation
- Cognitive and Emotional Development

- Ageing and Neurodevelopmental Disorders

Unit 3: Social Psychology

- Attitudes, Persuasion, and Social Influence
- Group Dynamics and Leadership
- Prejudice, Discrimination, and Stereotyping
- Interpersonal Relationships
- Cultural and Cross-Cultural Psychology

Unit 4: Personality Psychology

- Major Theories: Trait, Psychodynamic, Humanistic, Social-Cognitive
- Personality Assessment
- Biological and Cultural Influences
- Personality Disorders
- Contemporary Research in Personality

Unit 5: Abnormal and Clinical Psychology

- Classification and Diagnosis (DSM-5, ICD-11)
- Anxiety, Mood, and Personality Disorders
- Schizophrenia and Psychotic Disorders
- Psychotherapeutic Approaches
- Psychological Assessment and Ethics

Unit 6: Neuropsychology

- Brain Structure and Function
- Neurotransmitters and Hormonal Systems
- Brain Injury and Cognitive Deficits

Text Books:

- Sternberg, R.J. – *Cognitive Psychology*
- Solso, R.L. – *Cognitive Psychology*
- Anderson, J.R. – *Cognitive Psychology and Its Implications*
- Berk, L.E. – *Development Through the Lifespan*
- Santrock, J.W. – *Life-Span Development*
- Siegler, R. et al. – *How Children Develop*
- Myers, D.G. – *Social Psychology*
- Baron, R.A. – *Social Psychology*
- Hogg, M.A. & Vaughan, G.M. – *Social Psychology*
- Feist, J., Feist, G.J., & Roberts, T.A. – *Theories of Personality*
- Carver, C.S. & Scheier, M.F. – *Perspectives on Personality*

- Pervin, L.A. & John, O.P. – *Handbook of Personality: Theory and Research*
- Davison, G.C. & Neale, J.M. – *Abnormal Psychology*
- Sue, D., Sue, D.W., & Sue, S. – *Understanding Abnormal Behaviour*
- American Psychiatric Association – *DSM-5*
- Barlow, D.H. & Durand, V.M. – *Abnormal Psychology: An Integrative Approach*
- Kolb, B. & Whishaw, I.Q. – *Fundamentals of Human Neuropsychology*
- Carlson, N.R. – *Physiology of Behaviour*
- APA – *Publication Manual of the APA*
- Biggs, J. & Tang, C. – *Teaching for Quality Learning at University*
- Resnik, D.B. – *The Ethics of Science*

पी.एच.डी. कोर्स वर्क पाठ्यक्रम - विषय: हिंदी

(विषय: हिंदी)

Paper III: हिंदी (RU-700-16-00006)

Total Credits: 4
Total Contact Hours: 60

पीएच.डी. कार्यक्रम के अधिगम परिणाम (Learning Outcomes)

1. **अनुसंधान क्षमता:**
   शोधार्थी मौलिक और स्वतंत्र अनुसंधान करने में सक्षम होंगे तथा अपने विषय में नई ज्ञान-संरचना का विकास कर पाएंगे।

2. **आलोचनात्मक चिंतन:**
   विद्यमान सिद्धांतों, पद्धतियों और विचारों का समीक्षात्मक मूल्यांकन करने और नवीन दृष्टिकोण प्रस्तुत करने की क्षमता विकसित करेंगे।

3. **ज्ञान का योगदान:**
   शोधार्थी अपने शोध क्षेत्र में नई जानकारियाँ, सिद्धांत या अनुप्रयोग जोड़कर साहित्य और समाज में सार्थक योगदान देंगे।

4. **अनुसंधान पद्धति का ज्ञान:**
   गुणात्मक और मात्रात्मक शोध विधियों का सही प्रयोग करना सीखेंगे।

5. **नैतिक बोध:**
   अनुसंधान कार्य में शैक्षणिक ईमानदारी, कॉपीराइट नियम और नैतिक मूल्यों का पालन करेंगे।

6. **संचार कौशल:**
   शोधार्थी अपने निष्कर्षों को राष्ट्रीय और अंतरराष्ट्रीय स्तर पर प्रभावी ढंग से प्रस्तुत करने और प्रकाशित करने में सक्षम होंगे।

पीएच.डी. विषय हिंदी के अधिगम परिणाम (Subject-Specific Learning Outcomes)

1. **साहित्यिक ज्ञान का विस्तार:**
   शोधार्थी हिंदी साहित्य की विभिन्न विधाओं (काव्य, कथा, नाटक, आलोचना आदि) में गहन और विश्लेषणात्मक अध्ययन करने में सक्षम होंगे।

2. **समीक्षात्मक दृष्टि:**
   हिंदी साहित्य के सिद्धांतों, विचारधाराओं, आंदोलनों और प्रवृत्तियों का समीक्षात्मक विवेचन कर सकेंगे।

3. **भाषावैज्ञानिक समझ:**
   हिंदी भाषा की संरचना, व्याकरण, भाषाविज्ञान और उपभाषाओं का वैज्ञानिक एवं ऐतिहासिक अध्ययन कर पाएंगे।

4. **अनुसंधान कौशल:**
   शोधार्थी स्वतंत्र और मौलिक शोध कार्य करने में दक्ष होंगे तथा शोध विधियों का प्रयोग कर सकेंगे।

5. **सांस्कृतिक बोध:**
   हिंदी साहित्य और भाषा के अध्ययन के माध्यम से भारतीय समाज, संस्कृति, परंपरा और मूल्यबोध को समझने और विश्लेषित करने की क्षमता विकसित करेंगे।

6. **तुलनात्मक साहित्य दृष्टिकोण:**
   हिंदी साहित्य को अन्य भारतीय और विश्व साहित्य के साथ तुलनात्मक दृष्टि से देखने में सक्षम होंगे।

7. **अनुप्रयुक्त हिंदी:**
   अनुवाद, रचनात्मक लेखन, पत्रकारिता, भाषा-प्रौद्योगिकी तथा व्यावहारिक क्षेत्रों में हिंदी का प्रभावी प्रयोग करने में दक्ष होंगे।

विषय संरचना

Unit I – हिंदी अनुसंधान में विभिन्न उपागम

- समाजशास्त्रीय दृष्टि, मनोवैज्ञानिक दृष्टि, विश्लेषणवादी दृष्टि और ऐतिहासिक दृष्टि।
- अनुसंधान में संप्रेषण की पद्धतियाँ।
- साहित्यिक विधाओं के अनुसंधान की समस्याएँ।
- अनुसंधान और ज्ञान के नए क्षेत्र।

Unit II – विचारधारा और साहित्य

- मध्यकालीन दिशा का स्वरूप।
- विविध धर्म साधनाएँ और वैष्णव भक्ति आंदोलन।
- मध्ययुगीन बोध से आधुनिकता बोध की ओर प्रस्थान।
- आधुनिकीकरण की प्रक्रिया और औद्योगिक संस्कृति का साहित्य पर प्रभाव।
- भारतीय पाश्चात्य चिंतन परंपरा और हिंदी साहित्य सृजन का वैश्विक परिप्रेक्ष्य।
- पुनरुत्थान, पुनर्जागरण, लोक जागरण और हिंदी नवजागरण।

Unit III – आधुनिक भारत और साहित्य

- सामाजिक, आर्थिक, सांस्कृतिक और राजनीतिक पृष्ठभूमि पर साहित्य का प्रभाव।
- भारतीय स्वाधीनता संग्राम का साहित्य पर प्रभाव।
- विभिन्न मतवाद: गांधीवाद, मार्क्सवाद, रहस्यवाद, प्रयोगवाद, प्रगतिवाद, अध्यात्मवाद, मनोविश्लेषणवाद, मानवतावाद, अस्तित्ववाद, उत्तर-आधुनिकतावाद।

Unit IV – समकालीन अस्मिता मूलक चिंतन

- हिंदी साहित्य में दलित चेतना।
- आदिवासी जनचेतना।
- अल्पसंख्यक चेतना और स्त्री विमर्श।
- आंचलिक एवं महानगरी दिशा।
- पर्यावरण दिशा और हिंदी कविता में उत्तर-आधुनिकता।
- पर्यावरणीय संकट और हिंदी कविता।
- आदिवासी साहित्य में परंपरा और आधुनिकता।

Unit V – विभिन्न विधाओं का विकास और अध्ययन

- भाषा वैज्ञानिक और शैली वैज्ञानिक अध्ययन।
- हिंदी साहित्य और मास मीडिया का अंतर्विषयक अध्ययन।
- नई कविता और सामाजिक चेतना।
- विभिन्न भाषाओं का समायोजन।
- सोशल मीडिया और वेब साहित्य की चुनौतियाँ।
- प्रवासी हिंदी साहित्य: अनुभव और अभिव्यक्ति।
- सांस्कृतिक और सामाजिक अध्ययन।

Reference Books

1. महावीर प्रसाद द्विवेदी के श्रेष्ठ निबंध लोग भारतीय प्रकाशन प्रयागराज प्रथम संस्करण 2016

2. रामचंद्र शुक्ल ,रस मीमांसा (शुक्ल ग्रंथावली) www.hindisamay.com

3. हजारी प्रसाद द्विवेदी, मधुबन दिशा का स्वरूप,राजकमल प्रकाशन दिल्ली ,4th 2010

4. रामविलास शर्मा आस्था और सौंदर्य, राजकमल प्रकाशन, दिल्ली ,छठा संस्करण 2019

5. नामवर सिंह, इतिहास और आलोचना,राजकमल प्रकाशन दिल्ली दसवां संस्करण 2018

6. नामवर सिंह, वाद विवाद संवाद, राजकमल प्रकाशन छठवा ससंस्करण 2016

7. रामविलास शर्मा, मार्क्सवाद और प्रगतिशील साहित्य राजकमल प्रकाशन दिल्ली,5ᵗʰ 2015

8. मैनेजर पांडेय ,साहित्य और इतिहास दृष्टि ,वाणी प्रकाशन,दिल्ली ,चतुर संस्करण 2018

9. मैनेजर पांडेय , साहित्य और समाजशास्त्रीय दृष्टि, वाणी प्रकाशन, दिल्ली 5th2019

10. मैनेजर पांडे आलोचना और सामाजिकता वाणी प्रकाशन दिल्ली सेकंड 2018

11. सुधीर पचौरी, निर्मल वर्मा और उपनिवेशवाद, वर्मा राधा कृष्ण प्रकाशन दिल्ली, 2003

12. दिनकर, कविता और शुद्ध कविता ,लोग भारतीय प्रकाशन ,प्रयागराज 2016

13. वीर भारत तलवार, रस्सा कसी, वाणी प्रकाशन, दिल्ली द्वितीय संस्करण 2017

14. मैनेजर पांडेय ,संकट के बावजूद ,वाणी प्रकाशन ,दिल्ली ड्यूटी संस्करण 2015

15. मैनेजर पांडे शब्द और कर्म वाणी प्रकाशन दिल्ली चतुर्थ संस्करण 2017

Ph.D. Course Work Syllabus

(Discipline: Economics)

Paper III: Economics (RU-700-16-00008)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COBs):

- Develop advanced understanding of microeconomic and macroeconomic theories and their applications.
- Equip scholars with quantitative and econometric tools for empirical economic research.
- Analyze development, environmental, and international economic issues critically.
- Prepare students for independent, high-quality doctoral research in Economics.

Course Outcomes (COs):

After successful completion of this course, PhD scholars will be able to:

- **CO1:** Analyze individual, firm, and market behavior under various economic conditions.
- **CO2:** Apply macroeconomic models and policy tools to assess economic stability and growth.
- **CO3:** Use quantitative and econometric techniques for economic data analysis.
- **CO4:** Evaluate development strategies, sustainability, and environmental policies.
- **CO5:** Examine international trade, finance, and contemporary economic issues.

Course Content (Syllabus):

Unit I: Microeconomic Theory

- Consumer and Producer Theory
- Market Structures and Game Theory
- General Equilibrium and Welfare Economics
- Asymmetric Information and Behavioral Economics

Unit II: Macroeconomic Theory and Policy

- Classical and Keynesian Models
- IS-LM and AD-AS Frameworks
- Inflation, Unemployment, and Monetary Policy

- Open Economy Macroeconomics and Exchange Rates

Unit III: Quantitative Techniques and Econometrics

- Probability and Statistical Inference
- Classical Linear Regression Model
- Time Series and Panel Data Analysis
- Instrumental Variables and Causality

Unit IV: Development and Environmental Economics

- Theories of Economic Development
- Poverty, Inequality, and Human Development
- Sustainable Development and Climate Change
- Environmental Valuation and Policy Instruments

Unit V: International Economics and Contemporary Issues

- Trade Theories and Policies
- Balance of Payments and Exchange Rate Systems
- WTO and Global Trade Institutions
- Contemporary Issues: Globalization, Financial Crises, Digital Economy

Text Books:

- Varian, H.R. – *Microeconomic Analysis*
- Nicholson, W. & Snyder, C. – *Microeconomic Theory: Basic Principles and Extensions*
- Mankiw, N.G. – *Macroeconomics*
- Dornbusch, R., Fischer, S., & Startz, R. – *Macroeconomics*
- Gujarati, D.N. & Porter, D.C. – *Basic Econometrics*
- Wooldridge, J.M. – *Introductory Econometrics: A Modern Approach*
- Todaro, M.P. & Smith, S.C. – *Economic Development*
- Perman, R. et al. – *Natural Resource and Environmental Economics*
- Krugman, P.R. & Obstfeld, M. – *International Economics: Theory and Policy*

Reference Books:

- Mas-Colell, A., Whinston, M.D., & Green, J.R. – *Microeconomic Theory*
- Kreps, D.M. – *A Course in Microeconomic Theory*
- Romer, D. – *Advanced Macroeconomics*
- Blanchard, O. – *Macroeconomics*
- Greene, W.H. – *Econometric Analysis*
- Hayashi, F. – *Econometrics*
- Sen, A. – *Development as Freedom*
- Dasgupta, P. – *Economics of the Environment*
- Bhagwati, J. – *In Defense of Globalization*

School of Sciences

Rungta International Skills University (RISU), Bhilai

Ph.D. Course Work Syllabus

(Discipline: Forensic Science)

Paper III: Forensic Science (RU-700-14-00003)

Total Credits: 4
Total Contact Hours: 60

Course Objectives (CEOs)

This course aims to:

- Provide advanced knowledge in forensic science, including biology, chemistry, physics, digital, and molecular techniques.
- Develop critical analytical and practical skills in microscopy, DNA analysis, toxicology, ballistics, electrophoretic, and digital forensics.
- Equip scholars to handle complex forensic investigations and integrate interdisciplinary approaches for legal and criminal applications.
- Familiarize scholars with modern instruments, software, and laboratory methods in forensic analysis.
- Prepare scholars for independent research, case evaluation, and application of forensic science in court and investigative settings.

Course Outcomes (COs)

After successful completion, scholars will be able to:

- **CO1:** Apply advanced microscopy, serology, DNA profiling, and molecular techniques in forensic investigations.
- **CO2:** Perform toxicological, chemical, and physical analyses using advanced instrumentation.
- **CO3:** Conduct ballistic, electrophoretic, and crime scene reconstruction analyses.
- **CO4:** Evaluate and apply digital forensic tools for cybercrime and evidence analysis.
- **CO5:** Integrate theoretical knowledge and practical skills to solve complex forensic cases and support legal proceedings.

Course Content (Syllabus)

Unit I – Advanced Forensic Science, Microscopy & Criminology

- Nature, scope, and principles of forensic science and criminology.

- Forensic microscopy: comparison, stereoscopic, fluorescent, IR microscopy; SEM and TEM imaging.
- Immuno-chemical techniques: antigen–antibody binding, precipitation, agglutination, complement fixation, gel immunodiffusion, immunoelectrophoresis, RIA, ELISA, FACS.
- Criminology: theories of criminal behavior, victimology, crime scene management, profiling.
- Advanced instrumentation: forensic microscopes, Automated Fingerprint Identification Systems (AFIS).
- Applications in court and case studies.

Unit II – Advanced Biology, Serology & DNA Forensics

- Forensic serology: blood composition, histology, examination of body fluids (menstrual blood, semen, saliva, sweat, tear, pus, vomit, hair, bone, nail).
- Immunology: immune cells, hematopoiesis, innate and acquired immunity, antigens, immunoglobulins, MHC, autoimmunity, apoptosis.
- DNA forensics: structure, properties, extraction, quantification.
- Sequence variations: VNTRs, STRs, Mini-STRs, SNPs, mitochondrial DNA.
- DNA profiling: STR multiplexes, interpretation, frequency estimation, statistical assessment.
- Advanced DNA techniques: RFLP, PCR, massive parallel sequencing, Y-STR, microarrays, RNAseq, chip-seq, cfDNA, miRNA.
- Advanced instrumentation: PCR, RT-PCR, capillary electrophoresis, NGS, FACS.
- Applications: paternity disputes, missing persons, wildlife forensics.

Unit III – Advanced Chemistry, Toxicology & Forensic Medicine

- Forensic chemistry: analysis of paints, glass, soil, explosives, narcotics, hallucinogens, stimulants, depressants, steroids, designer drugs.
- Forensic toxicology: classification of poisons, collection/preservation, plant poisons, opium, benzodiazepines, metals, pesticides, food/animal/mushroom poisons, snake venom.
- Forensic medicine: postmortem examination, types of death, ante-mortem vs postmortem injuries, burn classification.
- Pharmacology in forensics: drug metabolism and detection.
- Advanced instrumentation: UV-Vis, FTIR, AAS, ICP-MS, LC-MS/MS, GC-MS, HPTLC.
- Applications: autopsy interpretation, poisoning case studies, medico-legal injury reports.

Unit IV – Advanced Physics, Ballistics & Electrophoretic Techniques

- Forensic physics: optical, radiation, and spectroscopic methods.
- Ballistics: internal, external, terminal ballistics, firearms/ammunition, rifling, wound ballistics, GSR analysis.
- Explosives: types, blast physics, IEDs, TNT, RDX.
- Electrophoresis: principles, high-voltage, PAGE, IEF, iso-electrophoresis, horizontal/vertical systems.

- Advanced instrumentation: comparison microscopes, 3D laser scanners, IBIS, ballistic simulators, electrophoresis apparatus.
- Applications: firearm crime scene reconstruction, bullet trajectory mapping, DNA/protein separation.

Unit V – Advanced Digital Forensics & Applied Molecular Techniques

- Digital forensics: scope, principles, cyber laws.
- Cybercrime typologies: frauds, ransomware, online grooming, cyberstalking, dark web.
- Computer/mobile forensics: file recovery, app forensics, GPS, SIM analysis.
- Network/cloud forensics: IDS, VPN, packet analysis, blockchain/cryptocurrency forensics.
- Molecular forensics: gene cloning, cloning vectors (plasmids, cosmids, phagemids, BAC, YAC), mutagenesis, gene libraries, colony hybridization, expression analysis.
- Advanced tools: EnCase, FTK, Cellebrite, Magnet AXIOM, Wireshark, sequencers, microarrays.
- Applications: digital evidence presentation, DNA/RNA sequencing in investigations, wildlife DNA typing.

Recommended Books

- Burgess, C., & Knowle, A. (1981). *Technique in Visible and Ultraviolet Absorption Spectroscopy*. Chapman and Hall.
- Chapman, R. (1985). *Practical Organic Mass Spectrometry*. Wiley & Sons.
- Claridge, T.D.W. (2000). *High-Resolution NMR Techniques in Organic Chemistry*. Oxford University Press.
- Cottrell, C.T., Irish, D., Masters, V.M., & Steward, J.E. (1985). *Introduction to Ultraviolet and Visible Spectrophotometry* (2nd ed.). Pye Unicam.
- Coyle, H. (Ed.). *Nonhuman DNA Typing*. CRC Press, International Forensic Science and Investigation Series.
- Davis, R., & Frearson, M. (1987). *Mass Spectrometry*. Wiley.
- DeHaan, J.D. *Kirk's Fire Investigation*. Prentice Hall, Englewood Cliffs, N.J.
- Gunther, H. (1995). *NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry* (2nd ed.). Wiley.

Ph.D. Course Work Syllabus

(Discipline: Mathematics & Statistics)

Paper III: Mathematics & Statistics (RU-700-15-00015)

Total Credits: 4
Total Contact Hours: 60

Course Objectives (CEOs)

- To provide scholars with a solid foundation in advanced algebra, linear algebra, and vector spaces for research applications.
- To introduce topological concepts and fixed point theory for analytical problem solving.
- To strengthen knowledge of probability, statistics, and stochastic methods applicable in research data analysis.
- To develop competency in optimization techniques including operations research, queuing, and inventory models.
- To familiarize scholars with fuzzy sets, fuzzy logic, and their application in decision-making and computational problems.

Course Outcomes (COs)

After successful completion of this course, scholars will be able to:

- **CO1:** Apply group, ring, field, and vector space concepts to abstract algebra problems.
- **CO2:** Understand topological spaces, limits, continuity, and fixed point theorems in mathematical analysis.
- **CO3:** Analyse and interpret statistical data using probability distributions, central tendency, and dispersion measures.
- **CO4:** Formulate and solve linear programming, transportation, assignment, and inventory optimization problems.
- **CO5:** Utilize fuzzy set theory and inference rules for modeling and decision-making in research contexts.

Course Content (Syllabus)

Unit I – Algebra

- Groups: definitions, subgroups, cyclic groups, permutation groups, normal subgroups, quotient groups.
- Rings and Fields: ideals, quotient rings.
- Vector Spaces: linear transformations, eigenvalues, and eigenvectors.

Unit II – Fix Point Theory

- Introduction to Topological Sapces, Normed Spaces
- Inner Product spaces
- Banach Contraction Mapping Theorem, Brouwer Fixed Point Theorem, Leray-Shauder Fixed Point Theorem
- Implicit Function Theorem with Applications.

Unit III – Statistics

- Basics of Probability
- Graphical Representation of Data
- Sample Space
- Random Experiments
- Bayes' Theorem
- Random Variables
- Probability Density Function (PDF)
- Cumulative Distribution Function (CDF)
- Discrete Random Variables
- Continuous Random Variables

Unit IV – Optimization Techniques

- Introduction to Operations Research
- Linear Programming Problems (LPP) – Formulation
- Simplex Method – Introduction and Procedure
- Transportation Problems
- Assignment Problems
- Basics of Queuing Theory
- Introduction to PERT and CPM

Unit V – Fuzzy Sets and Systems

- Classical vs. fuzzy sets: definitions, properties, membership functions.
- Operations on fuzzy sets: union, intersection, complement.
- Fuzzy relations, fuzzy rules, and inference systems.

Recommended Books

- Herstein, I.N. (1999). *Topics in Algebra*. Wiley India.
- Hoffman, K., & Kunze, R. (2015). *Linear Algebra*. Pearson.
- Munkres, J.R. (2018). *Topology*. Pearson.
- Kreyszig, E. (2011). *Advanced Engineering Mathematics*. Wiley.

- Ross, S. (2014). *Introduction to Probability and Statistics for Engineers and Scientists*. Academic Press.
- Gupta, S.C., & Kapoor, V.K. (2020). *Fundamentals of Mathematical Statistics*. Sultan Chand.
- Taha, H.A. (2017). *Operations Research: An Introduction*. Pearson.
- Kanti Swarup, Gupta, P.K., & Man Mohan. (2022). *Operations Research*. Sultan Chand.
- Zimmermann, H.J. (2010). *Fuzzy Set Theory and Its Applications*. Springer.

Ph.D. Course Work Syllabus

(Discipline: Physics)

Paper III: Advanced Physics (RU-700-15-00013)

Total Credits: 4
Total Contact Hours: 60

Course Objectives (CEOs)

- To understand different methods of synthesis of materials.
- To understand various characterization techniques of materials.
- To impart knowledge of different luminescent materials.
- To understand basic concepts of nanotechnology and its applications.
- To understand X-rays and their applications.

Course Outcomes (COs)

At the end of the course, scholars will be able to:

- **CO1:** Understand the properties of thin films and their synthesis methods.
- **CO2:** Learn and interpret structural and optical properties of materials.
- **CO3:** Understand different types of luminescent materials.
- **CO4:** Explain nanostructured materials and their applications.
- **CO5:** Analyze the behavior and applications of X-rays.

Course Content (Syllabus)

Unit I – Synthesis of Thin Films

- Introduction to two-dimensional nanostructured thin films.
- Fundamentals of film growth.

- Methods of synthesis: Chemical Bath Deposition (CBD), Sol-Gel, Ultrasonication bath, Spray Pyrolysis, Physical Vapor Deposition (PVD), Spin Coating.

Unit II – Characterization of Thin Films/Materials

- **Structural Characterization:** XRD, SEM, TEM, AFM, Raman effect.
- **Optical Characterization:** UV-Vis Spectrophotometry, Photoconductivity.
- **Electrical:** Conductivity measurements.

Unit III – Luminescence

- Luminescent materials and types of luminescence.
- Photoluminescence: Fluorescence, Phosphorescence.
- Electroluminescence, Mechano-luminescence, Thermoluminescence.

Unit IV – Nanotechnology

- Introduction to nanotechnology: Bottom-up and Top-down approaches, Quantum confinement.
- Zero-dimensional nanostructures, nanoparticles, one-dimensional nanostructures.
- Synthesis and applications of nanoparticles: Molecular electronics, nanoelectronics, nanodots, environmental and biological applications, nanostructured quantum devices.

Unit V – X-Rays

- Duane-Hunt limit for continuous X-rays.
- Moseley's law for characteristic X-rays.
- Bragg's law and X-ray diffraction.
- Bragg's X-ray spectrometer and applications of X-rays.

Recommended Books

Textbooks

- Goswami, A. – *Thin Film Fundamentals*.
- Cullity, B. D. – *Elements of X-ray Diffraction*.

References

- Wolf, E. L. – *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*.
- Goldstein, J. – *Scanning Electron Microscopy and X-ray Microanalysis*.

PhD Course Work Syllabus

(Discipline: Chemistry)

Paper II – Advanced Chemistry (RU-700-15-00014)

Total Credits: 4
Total Contact Hours: 60

Course Objectives

- To provide advanced knowledge of modern chemistry aligned with current research trends.
- To train research scholars in frontier areas such as advanced spectroscopy, computational methods, sustainable chemistry, and nanoscience.
- To bridge fundamental chemistry concepts with practical applications in materials, environment, energy, and biological systems.

Course Outcomes (COs)

- **CO1:** Demonstrate advanced knowledge of inorganic, organometallic, and bioinorganic systems in modern research.
- **CO2:** Apply organic and biomolecular chemistry concepts to design and analyze complex reactions and systems.
- **CO3:** Utilize physical and theoretical chemistry tools, including computational models, to solve research-level problems.
- **CO4:** Master modern analytical and spectroscopic techniques for advanced material and molecular characterization.
- **CO5:** Critically analyze frontier areas of sustainable, industrial, and environmental chemistry with applications in energy and nanoscience.

Course Content (Syllabus)

Unit 1: Advanced Inorganic and Bioinorganic Chemistry

- Modern periodic trends and bonding theories.
- Coordination chemistry: crystal field, ligand field, and MO theory.
- Organometallic chemistry in homogeneous/heterogeneous catalysis.
- Transition metals, lanthanides & actinides in energy and materials.
- Bioinorganic systems: metalloproteins, enzymes, and medicinal applications.

Unit 2: Advanced Organic and Biomolecular Chemistry

- Stereochemistry, conformational dynamics, and supramolecular chemistry.

- Reaction mechanisms: modern approaches in substitution, addition, elimination, and rearrangements.
- Aromaticity and heterocyclic systems.
- Modern named and catalytic organic reactions.
- Biomolecular chemistry: peptides, nucleic acids, and interface with chemical biology.

Unit 3: Modern Physical and Theoretical Chemistry

- Thermodynamics of complex systems and free energy landscapes.
- Reaction dynamics, catalysis, and kinetics in advanced materials.
- Quantum chemistry and computational modeling of molecules/materials.
- Electrochemistry in renewable energy: batteries, supercapacitors, fuel cells.
- Surface and nanocatalysis – adsorption, kinetics, and mechanistic insights.

Unit 4: Advanced Analytical and Spectroscopic Techniques

- UV-Vis, IR, Raman, and advanced NMR (1D, 2D, solid-state).
- Mass spectrometry (LC-MS, GC-MS, MALDI).
- Advanced separation science: UPLC, capillary electrophoresis.
- Electroanalytical techniques: cyclic voltammetry, potentiometry.
- Materials characterization: XRD, SEM, TEM, AFM, XPS.

Unit 5: Frontier Areas in Industrial, Environmental, and Sustainable Chemistry

- Industrial catalytic processes and green innovations.
- Environmental monitoring and advanced remediation strategies.
- Green chemistry principles for sustainable industries.
- Renewable energy: hydrogen economy, perovskite solar cells, advanced electrolytes.
- Nanochemistry, functional polymers, and smart materials for emerging technologies.

References

1. Miessler, G.L., Fischer, P.J., & Tarr, D.A. **Inorganic Chemistry.** Pearson.
   (Inorganic chemistry & coordination chemistry basics)
2. Carey, F.A. & Sundberg, R.J. **Advanced Organic Chemistry (Parts A & B).** Springer.
   (Organic reaction mechanisms & biomolecules)
3. Atkins, P. & de Paula, J. **Atkins' Physical Chemistry.** Oxford University Press.
   (Thermodynamics, kinetics, quantum chemistry)
4. Skoog, D.A., Holler, F.J., & Crouch, S.R. **Principles of Instrumental Analysis.** Cengage.
   (Spectroscopy & analytical methods)
5. Anastas, P.T. & Warner, J.C. **Green Chemistry: Theory and Practice.** Oxford University Press.
   (Sustainability & industrial chemistry)

Suggested Journals / Reviews

6. *Coordination Chemistry Reviews* (Elsevier) – Inorganic & bioinorganic focus.
7. *Accounts of Chemical Research* (ACS) – Organic/Physical chemistry mini-reviews.
8. *Journal of Physical Chemistry A/B/C* (ACS) – Physical & theoretical chemistry.
9. *Analytical Chemistry* (ACS) – Modern analytical techniques.
10. *Green Chemistry* (RSC) – Sustainable & frontier chemistry.

Ph.D. Course Work Syllabus

(Discipline: Biotechnology)

Paper III: Biotechnology (RU-700-13-00010)
Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (COBs):

- Provide doctoral scholars with an advanced and integrative understanding of fundamental and applied aspects of biotechnology.
- Strengthen knowledge in cell and molecular biology, genetics, immunology, microbiology, and bioprocess technology.
- Introduce modern tools of genetic engineering, recombinant DNA technology, and bioinformatics.
- Build a foundation for independent research in cellular mechanisms, genetic regulation, microbial diversity, and applied biotechnology.
- Expose scholars to emerging areas such as stem cell biology, regenerative medicine, genome editing, and sustainable biotechnological innovations.

Course Outcomes (COs):

After successful completion of the course, scholars will be able to:

- **CO1:** Differentiate between prokaryotic and eukaryotic cell structures and explain key molecular processes.
- **CO2:** Analyze principles of genetics, chromosome organization, mutations, and immune system mechanisms.
- **CO3:** Apply microbiological and bioprocess concepts for industrial and research applications.
- **CO4:** Demonstrate knowledge of molecular cloning tools, PCR, sequencing, and genetic engineering strategies.
- **CO5:** Use bioinformatics databases and computational tools for sequence analysis and interpretation.
- **CO6:** Evaluate the role of advanced biotechnological applications in medicine, agriculture, food, and environmental sustainability.

Course Content (Syllabus):

Unit I: Cell & Molecular Biology

- Comparative structure and function of prokaryotic and eukaryotic cells
- Cell organelles and their roles in homeostasis
- Cell cycle phases and molecular regulation (checkpoints, cyclins, CDKs, apoptosis)
- Membrane structure: fluid mosaic model, membrane dynamics, receptors
- Transport mechanisms: passive, active, facilitated, endocytosis and exocytosis
- Molecular biology central dogma: DNA replication, transcription, and translation
- Regulation of gene expression in prokaryotes and eukaryotes

Unit II: Genetics & Immunology

- Mendelian principles of inheritance, deviations, and gene interactions
- Chromosome organization in prokaryotes and eukaryotes; chromatin remodeling
- Types of mutations and DNA repair mechanisms
- Innate immunity: barriers, phagocytosis, complement system
- Adaptive immunity: B and T cell development, activation, clonal selection
- Antigens and antibodies: structure, diversity, and function
- Major Histocompatibility Complex (MHC) and antigen presentation
- Principles of immunization and vaccines (traditional and modern approaches)

Unit III: Microbiology & Bioprocess Technology

- Microbial diversity: bacteria, archaea, fungi, protozoa, viruses
- Growth kinetics: bacterial growth curve, continuous and batch cultures
- Control of microorganisms: sterilization, disinfection, antibiotics, resistance mechanisms
- Fermentation: basic principles, types, upstream processing (media preparation, inoculation), and downstream processing (product recovery, purification)
- Bioreactors: design and operation (introductory concepts)
- Industrial microbiology applications: enzyme production, antibiotics, biofuels, organic acids, bioplastics

Unit IV: Genetic Engineering & Recombinant DNA Technology

- Tools of genetic engineering: restriction enzymes, ligases, vectors (plasmids, phages, cosmids, artificial chromosomes)
- Recombinant DNA methods: cloning basics, transformation, selection markers
- Molecular techniques: PCR, RT-PCR, electrophoresis, blotting, sequencing methods (Sanger, NGS overview)
- Transgenics: generation of genetically modified plants, animals, and microbes
- Applications: gene therapy, vaccines, GM crops, bioremediation, biosensors

Unit V: Bioinformatics & Emerging Biotechnological Applications

- Introduction to bioinformatics: databases (GenBank, EMBL, PDB), tools (BLAST, FASTA)

- Omics technologies: genomics, transcriptomics, proteomics, metabolomics
- Stem cells and regenerative medicine: types, applications, ethical aspects
- Genome editing technologies: CRISPR-Cas9, TALENs, ZFNs (basics)
- Applications: diagnostics, personalized medicine, GM foods, nutraceuticals, waste management

Text Books:

- Alberts B., Johnson A., Lewis J. – *Molecular Biology of the Cell*, Garland Science
- Karp G. – *Cell and Molecular Biology: Concepts and Experiments*, Wiley
- Brown T.A. – *Genomes*, Garland Science
- Nelson D.L., Cox M.M. – *Lehninger Principles of Biochemistry*, W.H. Freeman
- Glick B.R., Pasternak J.J. – *Molecular Biotechnology: Principles and Applications*, ASM Press

Reference Books:

- Watson J.D., Baker T.A., et al. – *Molecular Biology of the Gene*, Pearson
- Lodish H., Berk A., et al. – *Molecular Cell Biology*, W.H. Freeman
- Madigan M., Bender K., Buckley D. – *Brock Biology of Microorganisms*, Pearson
- Old R.W., Primrose S.B. – *Principles of Gene Manipulation and Genomics*, Wiley-Blackwell
- Campbell A.M., Heyer L.J. – *Discovering Genomics, Proteomics, and Bioinformatics*, Benjamin Cummings
- Dubey R.C. – *A Textbook of Biotechnology*, S. Chand Publications
- Satyanarayana U., Chakrapani U. – *Biotechnology*, Books & Allied

PhD Course Work Syllabus

(Discipline: Zoology)

Paper II – Zoology (RU-700-13-00012)

Total Credits: 4
Total Contact Hours: 60

Course Content (Syllabus)

Unit 1: Instrumentations Modern periodic trends and bonding theories.

- Principles and types of chromatography
- Thin layer chromatography (TLC), two dimensional and column chromatography
- High Performance Liquid Chromatography (HPLC), Gas liquid chromatography (GLC)
- Autoclave, Laminar Air flow, PCR
- Analytical instruments: UV Spectrophotometer, colorimeter, NMR
- Microscopes: Compound Microscope, Phase Contrast Microscope, Confocal Microscope, Fluorescence and Electron microscopes (TEM and SEM).

Unit 2: Biorhythm and Chronobiology

- Biological clocks and circadian rhythms
- Molecular mechanisms of circadian regulation (clock genes and proteins)
- Seasonal and lunar rhythms in animals
- Sleep–wake cycles and hormonal regulation
- Applications of chronobiology in animal behaviour, health, and aquaculture

Unit 3: Contemporary approaches to animal taxonomy and systematics Thermodynamics of complex systems and free energy landscapes.

- Integrative taxonomy, molecular phylogenetics.
- Patterns and processes of evolution: speciation, adaptation, co-evolution, and evolutionary developmental biology.
- Biodiversity assessment methodologies and conservation strategies.
- Global biodiversity hotspots, biogeography, and faunal endemism.
- Role of zoological collections, museums, and digital databases in evolutionary studies.

Unit 4 : Behavioural Ecology and Conservation Biology

- Principles of Animal Behaviour.
- Natural selection and Animal behavioural Adaptations.
- Preset behaviour, learning and habituation
- Aggregation and social behaviour in fishes, birds, and mammals
- Behavioural approaches to wildlife conservation

Unit 5: Fish Biology and Parasitology Industrial catalytic processes and green innovations.

- Breeding methods: induced breeding, stripping methods
- Developmental stages and growth marker studies
- Breeding and conservation of indigenous fishes
- Parasitic life cycles and host–parasite interactions
- Toxicology: parameters and impact on aquatic organisms

References

6. Miessler, G.L., Fischer, P.J., & Tarr, D.A. **Inorganic Chemistry.** Pearson.
   (Inorganic chemistry & coordination chemistry basics)
7. Carey, F.A. & Sundberg, R.J. **Advanced Organic Chemistry (Parts A & B).** Springer.
   (Organic reaction mechanisms & biomolecules)
8. Atkins, P. & de Paula, J. **Atkins' Physical Chemistry.** Oxford University Press.
   (Thermodynamics, kinetics, quantum chemistry)
9. Skoog, D.A., Holler, F.J., & Crouch, S.R. **Principles of Instrumental Analysis.** Cengage.
   (Spectroscopy & analytical methods)
10. Anastas, P.T. & Warner, J.C. **Green Chemistry: Theory and Practice.** Oxford University Press.
    (Sustainability & industrial chemistry)

Suggested Journals / Reviews

11. *Coordination Chemistry Reviews* (Elsevier) – Inorganic & bioinorganic focus.
12. *Accounts of Chemical Research* (ACS) – Organic/Physical chemistry mini-reviews.
13. *Journal of Physical Chemistry A/B/C* (ACS) – Physical & theoretical chemistry.
14. *Analytical Chemistry* (ACS) – Modern analytical techniques.
15. *Green Chemistry* (RSC) – Sustainable & frontier chemistry.

PhD Course Work Syllabus

(Discipline: Botany)

Paper II – Botany (RU-700-13-00011)

Total Credits: 4
Total Contact Hours: 60

Course Content (Syllabus)

Unit 1: Instrumentation and Analytical Techniques.

- Different types of microscopes: Compound Microscope, Phase Contrast Microscope
- Chromatographic techniques: Thin layer chromatography (TLC), two dimensional and column chromatography
- Centrifugation techniques
- Electrophoresis and spectroscopic techniques
- General protocol for extraction, separation, purification, and identification of phytochemicals from higher plants
- Modern techniques for qualitative and quantitative analysis of secondary metabolites, proteins, pathogen-related proteins, and amino acids

Unit 2: Microbial Culture techniques

- Preparation of culture media: complex and defined media
- Selective and differential growth media
- Establishing pure cultures: streak plate, pour plate methods
- Preservation of cultures: establishment of stock cultures

Unit 3: Process of Identifications

- Major problems in taxonomy teaching and research in India and possible remedies
- Role of plant taxonomy in different branches of plant research, including medicinal plant research
- Taxonomic literature and online databases/websites
- Herbarium techniques: methods of collection, identification, and documentation
- Digital herbaria; roles and importance of herbaria, botanical gardens, and museums in taxonomic studies

Unit 4: **Field Survey and ecological research method.**

- Field sampling (soil, plant, and water samples) and their physico-chemical analysis
- Overview of phytosociological methods used in ecological studies
- Vegetation and community analysis methods
- Ethics in ecological research
- Identifying research problems and knowledge gaps

Unit 5: Ecology and Environmental Botany

- Plant–environment interactions under climate change scenarios
- Pollution biology: phytoremediation, bioindicators, and impact of pollutants on plants
- Conservation biology: in situ and ex situ strategies
- Medicinal botany and ethnopharmacology

References

11. Miessler, G.L., Fischer, P.J., & Tarr, D.A. **Inorganic Chemistry.** Pearson.
    (Inorganic chemistry & coordination chemistry basics)
12. Carey, F.A. & Sundberg, R.J. **Advanced Organic Chemistry (Parts A & B).** Springer.
    (Organic reaction mechanisms & biomolecules)
13. Atkins, P. & de Paula, J. **Atkins' Physical Chemistry.** Oxford University Press.
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14. Skoog, D.A., Holler, F.J., & Crouch, S.R. **Principles of Instrumental Analysis.** Cengage.
    (Spectroscopy & analytical methods)
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18. *Journal of Physical Chemistry A/B/C* (ACS) – Physical & theoretical chemistry.
19. *Analytical Chemistry* (ACS) – Modern analytical techniques.
20. *Green Chemistry* (RSC) – Sustainable & frontier chemistry.

School of Management and commerce

Rungta International Skills University (RISU), Bhilai

Ph.D. Course Work Syllabus

(Discipline: Management)

Paper III: Advanced Studies in Management (RU-700-11-00022)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (CEOs):

- Enable scholars to understand and critically evaluate advanced concepts, theories, and practices in management.
- Expose scholars to contemporary issues and debates in management research.
- Provide a foundation for identifying research gaps in core areas of management.

Course Outcomes (Cos):

After successful completion of the course, scholars will be able to:

- **CO1:** Critically analyse major theories and frameworks in management.
- **CO2:** Evaluate contemporary research trends in management domains.
- **CO3:** Identify and develop potential research areas in strategic, human resource, financial, and operational management.
- **CO4:** Apply management theories to 71rganizational problem-solving and research design.
- **CO5:** Write literature reviews and research proposals with conceptual clarity.

Course Content (Syllabus):

Unit I: Foundations of Management Research

- Evolution of management thought: Classical, Behavioural, Systems, Contingency, Modern approaches
- Emerging perspectives: Knowledge management, Sustainable management, Digital transformation in organisations
- Linking theory with management practice

Unit II: Strategic and Organisational Management

- Strategic management theories & frameworks
- Competitive advantage, core competencies, dynamic capabilities
- Organisational culture, leadership, and change management
- Current debates: Agile strategy, Globalisation vs. Localisation

Unit III: Human Resource and Organisational Behaviour

- Advanced HRM theories: Strategic HRM, Talent Management, HR Analytics
- Motivation, engagement, emotional intelligence, and leadership theories
- Workplace diversity, inclusion, and ethics
- Future of work: AI, gig economy, hybrid workplaces

Unit IV: Financial and Operations Management

- Theories in financial decision-making, corporate governance, and value creation
- Risk management and sustainable finance
- Operations management frameworks: Lean, Six Sigma, Supply Chain Analytics
- Research frontiers: Green supply chains, digital operations

Unit V: Contemporary Research Areas in Management

- Business sustainability and CSR
- Innovation and digital business models
- Research gaps in global management practice
- Developing research questions, conceptual frameworks, and propositions

Text Books:

- Koontz, H., & Weihrich, H. – *Essentials of Management*, McGraw-Hill
- Robbins, S. P., & Judge, T. A. – *Organisational Behaviour*, Pearson
- Wheelen, T. L., & Hunger, J. D. – *Strategic Management and Business Policy*, Pearson
- Hill, C. W. L., & Jones, G. R. – *Strategic Management: Theory*, Cengage

Reference Books:

- Barney, J. – *Gaining and Sustaining Competitive Advantage*, Pearson
- Mintzberg, H., Lampel, J., Quinn, J. B., Ghoshal, S. – *The Strategy Process*, Pearson
- Dessler, G. – *Human Resource Management*, Pearson
- Kaplan, R. S., & Norton, D. P. – *The Balanced Scorecard*, Harvard Business Press
- Drucker, P. – *Management: Tasks, Responsibilities, Practices*, Harper Business
- Selected articles from *Academy of Management Review*, *Strategic Management Journal*, *Journal of Management Studies*

Ph.D. Course Work Syllabus

(Discipline: Commerce)

Paper III: Advanced Studies in Commerce (RU-700-11-00023)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (CEOs):

- Provide scholars with an in-depth understanding of theoretical foundations in commerce and trade.
- Analyze contemporary practices in accounting, finance, and taxation.
- Identify research issues in corporate governance, sustainability, and financial innovations.

Course Outcomes (COs):

After successful completion of the course, scholars will be able to:

- **CO1:** Demonstrate advanced knowledge in accounting, finance, and taxation.
- **CO2:** Critically examine global trends in trade and commerce.
- **CO3:** Identify research gaps in commerce-related disciplines.
- **CO4:** Apply theoretical and empirical approaches to commerce research problems.
- **CO5:** Develop research-based solutions for policy and practice.

Course Content (Syllabus):

Unit I: Foundations of Commerce Research

- Evolution of commerce as a discipline
- Theories of trade, commerce, and business growth
- Contemporary issues in global trade and e-commerce

Unit II: Advanced Accounting and Auditing

- Theories of financial reporting and disclosure
- International Financial Reporting Standards (IFRS)
- Forensic accounting, corporate frauds, and governance
- Research directions in sustainability accounting

Unit III: Financial Management and Corporate Finance

- Capital structure theories, cost of capital, and valuation
- Financial derivatives and innovations
- Behavioural finance and investor psychology
- Research frontiers in fintech and blockchain finance

Unit IV: Taxation and Policy Studies

- Direct and indirect tax frameworks
- International taxation and transfer pricing
- GST and its implications on trade and industry
- Emerging areas: Green taxation, digital economy taxation

Unit V: Contemporary Issues in Commerce

- Corporate governance and business ethics
- Mergers, acquisitions, and restructuring research
- E-commerce, digital platforms, and new-age business models
- Research proposal development in commerce

Text Books:

- Gupta, S. P. – *Statistical Methods*, Sultan Chand
- Bhattacharya, A. K. – *Financial Accounting for Business Managers*, Prentice Hall
- Khan, M. Y., & Jain, P. K. – *Financial Management: Text, Problems and Cases*, McGraw-Hill
- Lal, J., & Srivastava, S. – *Cost Accounting*, Tata McGraw Hill

Reference Books:

- Anthony, R. N., Hawkins, D., & Merchant, K. – *Accounting: Text and Cases*, McGraw-Hill
- Nobes, C., & Parker, R. – *Comparative International Accounting*, Pearson
- Damodaran, A. – *Corporate Finance: Theory and Practice*, Wiley
- Glautier, M. W. E., & Underdown, B. – *Accounting Theory and Practice*, FT Prentice Hall
- Gupta, S. – *Corporate Governance and Business Ethics*, Oxford University Press
- Journals: *Journal of Commerce & Accounting Research*, *The Accounting Review*, *Journal of Corporate Finance*

Ph.D. Course Work Syllabus
(Discipline: Entrepreneurship)

Paper III: Advanced Studies in Entrepreneurship and Innovation (RU-700-11-00024)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (CEOs):
• To explore advanced theories and models of entrepreneurship and innovation.
• To analyze entrepreneurial ecosystems and policy frameworks.
• To equip scholars with skills to identify research problems in entrepreneurship and startups.

Course Outcomes (COs):
After completion, scholars will be able to:
• CO1: Critically analyze entrepreneurship theories and practices.
• CO2: Assess global and local entrepreneurial ecosystems.
• CO3: Identify gaps in innovation and startup research.
• CO4: Apply entrepreneurship research to policy and practice.
• CO5: Develop research-based models for entrepreneurial growth.

Course Content (Syllabus):
Unit I – Theoretical Foundations of Entrepreneurship
• Evolution of entrepreneurship thought
• Entrepreneurial traits, behaviors, and competencies
• Theories of entrepreneurship: economic, sociological, psychological, resource-based

Unit II – Entrepreneurial Ecosystem and Policy
• Role of institutions, incubators, and accelerators
• Government policies for entrepreneurship and startups
• International best practices in entrepreneurship promotion
• Case studies of successful ecosystems

Unit III – Innovation and Technology Management
• Theories of innovation: Schumpeterian, Disruptive, Open innovation
• Technology adoption and diffusion models
• Digital entrepreneurship and platform-based businesses
• Research in intellectual property, patents, and commercialization

Unit IV – Financing and Scaling Startups
• Angel investors, venture capital, crowdfunding, and private equity
• Entrepreneurial finance theories
• Scaling strategies for startups
• Risk management in entrepreneurial ventures

Unit V – Contemporary Research in Entrepreneurship
• Social entrepreneurship and sustainable ventures
• Women and minority entrepreneurship
• Global entrepreneurship trends: AI, blockchain, green entrepreneurship
• Identifying research problems and framing proposals

Textbooks:
• Hisrich, R. D., Peters, M. P., Shepherd, D. A. – *Entrepreneurship*, McGraw Hill
• Kuratko, D. F. – *Entrepreneurship: Theory, Process and Practice*, Cengage
• Barringer, B. R., Ireland, R. D. – *Entrepreneurship: Successfully Launching New Ventures*, Pearson
• Drucker, P. – *Innovation and Entrepreneurship*, Harper Business

Reference Books:
• Shane, S. – *A General Theory of Entrepreneurship*, Edward Elgar
• Bygrave, W., Zacharakis, A. – *The Portable MBA in Entrepreneurship*, Wiley
• Ries, E. – *The Lean Startup*, Crown Business
• Osterwalder, A., Pigneur, Y. – *Business Model Generation*, Wiley
• Timmons, J. A., Spinelli, S. – *New Venture Creation: Entrepreneurship for the 21st Century*, McGraw Hill

Journals:
Journal of Business Venturing, Entrepreneurship Theory and Practice, International Small Business Journal

Ph.D. Course Work Syllabus

(Discipline: Law)

Paper III: Advanced Studies in Law and Legal Research (RU-700-19-00001)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives (CEOs):

• To provide an advanced understanding of jurisprudence, legal theories, and contemporary legal debates.
• To develop critical awareness of constitutional, criminal, corporate, and international law dimensions.
• To enable scholars to identify research gaps in legal studies and contribute to law and policy development.
• To build capacity in interdisciplinary legal research, comparative law, and emerging areas of law.

Course Outcomes (COs):

After completion, scholars will be able to:
• CO1: Critically analyze jurisprudential concepts and evolving legal theories.
• CO2: Evaluate constitutional, corporate, criminal, and international legal frameworks.
• CO3: Identify gaps in existing law and propose research-based reforms.
• CO4: Apply interdisciplinary and comparative approaches in legal research.
• CO5: Develop original research questions and proposals in law.

Course Content (Syllabus):

Unit I – Foundations of Jurisprudence and Legal Theory
• Nature, scope, and sources of law
• Schools of jurisprudence: Natural law, Positivism, Realism, Marxist and Critical Legal Studies
• Rights, duties, justice, liability, and sovereignty
• Contemporary legal theories: Feminist jurisprudence, Postmodernism, Law & Economics

Unit II – Constitutional and Administrative Law

• Advanced constitutional principles: Rule of law, separation of powers, federalism, judicial review
• Fundamental rights and directive principles
• Administrative law: Delegated legislation, tribunals, judicial control of administrative action
• Comparative constitutionalism (USA, UK, India, EU)

Unit III – Criminal and Corporate Law Dimensions

• Criminal justice theories: Retributive, deterrent, reformative approaches
• Contemporary issues: Cybercrime, white-collar crime, victimology
• Corporate law: Corporate governance, mergers & acquisitions, securities regulation
• Research areas: Corporate social responsibility, competition law, insolvency law

Unit IV – International and Comparative Law

• Public International Law: Sources, subjects, UN, and international dispute resolution
• Private International Law: Jurisdiction, choice of law, recognition of judgments
• WTO and international trade law
• Comparative law: Civil law vs. Common law systems, global legal transplants

Unit V – Contemporary Issues and Emerging Areas in Law

• Human rights, environmental law, climate justice
• Technology law: AI, data privacy, intellectual property in the digital age
• Alternative Dispute Resolution (ADR), arbitration, mediation
• Identifying research problems, framing researchable questions, and proposal writing in law

Suggested Textbooks:

• Salmond, J. W. – *Jurisprudence*, Sweet & Maxwell
• Friedman, W. – *Legal Theory*, Universal Law Publishing
• H. L. A. Hart – *The Concept of Law*, Oxford University Press
• V. D. Mahajan – *Constitutional Law of India*, Eastern Book Company
• M. P. Jain – *Indian Constitutional Law*, LexisNexis

Reference Books:

• Dicey, A. V. – *Introduction to the Study of the Law of the Constitution*, Liberty Classics
• Glanville Williams – *Learning the Law*, Sweet & Maxwell
• Aggarwal, K. N. C. – *Constitutional Development and National Building in India*
• Avtar Singh – *Company Law*, Eastern Book Company
• Starke, J. G. – *Introduction to International Law*, Oxford University Press
• Malcolm Shaw – *International Law*, Cambridge University Press

School of Pharmacy

Rungta International Skills University (RISU), Bhilai

Ph.D. Course Work Syllabus

(Discipline: Pharmacy)

Paper III: Advanced Pharmaceutical Sciences (RU-700-12-00028)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives

This course aims to:

- Provide advanced knowledge of molecular pharmacology, toxicology, and drug–target interactions relevant to modern therapeutics.
- Develop expertise in analytical and computational tools (spectroscopy, chromatography, molecular modeling, QSAR, docking) for drug design and impurity profiling.
- Train students in Design of Experiments (DoE) and Quality by Design (QbD) approaches for optimizing pharmaceutical formulations and processes.
- Equip scholars with insights into novel dosage forms, nanotechnology-based carriers, BA/BE studies, clinical trials, and global regulatory frameworks.
- Introduce modern pharmacognosy, phytochemistry, and biotechnology for natural product standardization, herbal drug discovery, and biotechnological applications in pharmacy.

Course Outcomes (COs)

After completion, Ph.D. scholars will be able to:

- CO1: Demonstrate comprehensive understanding of drug action mechanisms, PK/PD modeling, and pharmacovigilance systems for ensuring drug safety and efficacy.
- CO2: Apply advanced spectroscopic, chromatographic, and computational techniques (molecular docking, QSAR, CADD) for drug discovery, stability studies, and impurity profiling.
- CO3: Design, analyze, and optimize pharmaceutical experiments using DoE and QbD principles, with application to dosage form development and manufacturing.
- CO4: Critically evaluate novel drug delivery systems, clinical trial methodologies, and international regulatory guidelines, linking formulation science to global drug approval processes.
- CO5: Integrate knowledge of pharmacognosy, phytochemistry, and biotechnology to explore natural products and herbal medicines as potential leads for modern drug discovery.

Course Content (Syllabus)

Unit I – Molecular Pharmacology and Targeted Therapeutics

Drug action at molecular and cellular levels; principles of toxicology; PK/PD modeling (non-linear kinetics, PBPK); molecular mechanisms of drug-target interactions; targeted pharmacology of CNS, autonomic, and cardiovascular systems; principles of chemotherapy for cancer and infectious diseases; ADRs and drug interactions; pharmacovigilance systems and drug safety monitoring protocols.

Unit II – Advanced Pharmaceutical Chemistry and Molecular Design

Interpretation of spectral data (NMR, Mass, UV-Vis, IR) and chromatographic techniques (HPLC, UPLC) for impurity profiling and stability; molecular modelling, docking, QSAR, and solution-phase ADME studies using CADD-based software.

Unit III – Design of Experiments (DoE) and Quality by Design (QbD)

Principles of DoE: factorial, fractional factorial, central composite, Box-Behnken. Response surface methodology in formulation development. QbD approaches in pharmaceutical R&D and manufacturing. Case studies using DoE in dosage form design and optimization.

Unit IV – Advanced Pharmaceutics, Biopharmaceutics, and Regulatory Affairs

Design and characterization of advanced dosage forms; nanotechnology-based carriers (liposomes, nanoparticles) for targeted delivery; ADME processes and BA/BE studies for generic/modified products; clinical trials (Phases I–IV); regulatory guidelines (ICH, WHO, CDSCO); global drug approval processes (Indian and international perspectives).

Unit V – Pharmacognosy, Phytochemistry, and Biotechnology

Modern isolation, purification, and structural elucidation of phytochemicals (alkaloids, glycosides, tannins, flavonoids); scientific methodologies for herbal standardization and QC parameters; role of Ayurveda, Siddha, and Unani in modern drug discovery; biotechnological applications (cell culture, genetic modification) for medicinal plant optimization and compound production.

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Ph.D. Course Work Syllabus

(Discipline: **Education**)

Paper III: Education (RU-700-21-00001)

Credits: 4
Teaching Hours: 60 (15 Hours per credit)

Course Objectives

- To develop an advanced understanding of the philosophical, sociological, and psychological foundations of education.
- To equip scholars with advanced research skills, methods, and ethics in educational research.
- To analyze educational policy, planning, and reforms with critical insight.
- To understand teacher education, curriculum development, and innovations in pedagogy.
- To prepare students for independent and original doctoral research in education.

Course Content (Syllabus)

Unit I: Philosophical and Sociological Foundations of Education

- Indian Philosophical Schools: Vedanta, Buddhism, Jainism, Islamic Thought.
- Western Philosophical Schools: Idealism, Pragmatism, Naturalism, Marxism, Existentialism.
- Education as a social subsystem; Education and social change.
- Social equity, equality, justice, and inclusion in education.

Unit II: Psychological Foundations of Education

- Learning theories: Behaviorism, Cognitivism, Constructivism.
- Developmental theories: Piaget, Vygotsky, Bruner, Erikson.
- Motivation, intelligence, creativity, and personality.
- Psychological testing and assessment in education.
- Emotional and social intelligence in child development.

Unit III: Teacher Education and Curriculum Studies

- Teacher education: Concept, need, pre-service and in-service training.
- National and International perspectives on teacher education.
- Curriculum development: Approaches, models, and evaluation.

- ICT and digital pedagogy in teacher education.
- Quality assurance and accreditation (NCTE, NAAC).

Unit IV: Educational Policy, Planning, and Administration

- Historical development of Indian education: Ancient, medieval, colonial, and post-independence.
- Key documents: Kothari Commission (1964–66), NPE 1986, NCF 2005, NEP 2020.
- Policy perspectives on equity, access, quality, and inclusion.
- Educational planning and leadership in India.
- Globalization, privatization, and international trends in education.

Unit V: Contemporary Issues and Innovations

- Issues in Indian education: Gender, caste, class, language, and regional disparities.
- Inclusive education and education for sustainable development.
- Innovations in higher education: MOOCs, blended learning, outcome-based education.
- Future directions in educational research and policy.

Suggested References

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