Syllabi & Scheme of Examination

Learning Outcomes based Curriculum Framework

(LOCF)

For

DOCTORATE OF PHILOSHPHY

COMPUTER SCIENCE AND ENGINEERING

Department of Computer Science and Engineering
Faculty of Engineering and Technology
Chaudhary Devi Lal University
Sirsa (Haryana)
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Table of Contents

1. About the Department

The institute, apart from establishing a robust teaching environment, is keen to facilitate and support cutting edge research in a variety of areas. This aspect will enable the students to acquaint themselves with the latest developments in their respective areas of study and to pursue their own research interests. The institute offers PhD programme in a wide range of areas in Computer Science & Engineering. The broad objective of the PhD programme is not only to keep pace with the expanding frontiers of knowledge but also to provide research training relevant to the present social and economic objectives of the country.

The academic programme leading to PhD degree is broad based and involves a minimum course credit requirement, comprehensive examination and synopsis seminar and thesis submission. The institute also encourages research in interdisciplinary areas through a system of joint supervision and interdepartmental group activities. The presence of highly motivated research oriented faculty members provides excellent opportunities for such programmes. The institute undertakes sponsored research and development projects from industrial and other organizations in public as well as private sector.

Further, every Ph.D. Scholar shall have to earn 14/16 credits in total including Core Courses credits, discipline elective courses Credits and MOOC or Research and Publication Ethics. The Ph.D. CSE programme is dedicated to conducting and reporting on a research problem culminating in a thesis. Further, every Ph.D. Scholar shall have to earn 14/16 credits in total – 08 Core Courses credits, 04 Discipline Specific Elective Courses Credits and 02/04 Credits from Research and Publication Ethics or MOOC.

2. Learning Outcomes based Curriculum Framework

The CBCS evolved into learning outcomes based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the Programme

After completion of their programme, the **research scholars** are expected to:

PEO1: extending the limits of what is currently known through innovative and high-quality work;

PEO2: the capacity to devise, design and conduct research that has real academic weight and shows integrity;

PEO3: systematic understanding of a subject and mastery of the skills and methods associated with this subject;

PEO4: the capacity for critical analysis, assessment and synthesis of new and complex ideas;

PEO5: satisfying standards associated with national and international peer-reviewed publications.

2.2 Programme Outcomes (POs)

The PhD programme of Computer Science and Engineering prepares students to attain the educational objectives by ensuring that students demonstrate achievement of the following student outcomes:

PO1	Advanced Knowledge: A in-depth understanding of a substantial body of knowledge that is at the forefront of professional practice. Scholars in the field of Computer Science and Engineering to acquire positions at top-tier research institutions.
PO2	Research: The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, adjustment of research methodologies in the light of unforeseen problems
PO3	Area of Research: the ability to make acceptable judgments on complex issues in specialized fields; and the ability to produce original research to merit publication.
PO4	Application: The aptitude to undertake basic and/or applied research at an advanced level; and contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials.
PO5	Methods: An understanding of methods of enquiry or creative activity, or both, in their primary area of study that enables the student to evaluate different approaches for problem solving using well established techniques; devise and sustain arguments; and comment upon aspects of current research.
PO6	Professionalism: The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations;
PO7	Knowledge: the ethical behaviour consistent with academic integrity and the use of appropriate guidelines for responsible conduct of research by applying knowledge to particular contexts.
PO8	Intellectual Abilities: Demonstrate skills in oral and written communication sufficient to publish and present work of quality which satisfies peer review and to prepare grant proposals.
PO9	Critical Research Thinking**:** Critically apply theories, methodologies and knowledge to address fundamental questions in their primary area of study.
PO10	Ethics: Apply ethical principles and strictly committed to professional ethics and responsibilities in their field and in academia.
PO11	Self-Managerial Skills: Apply self-reflective and self-critical approach based on research and to act autonomously in the planning and implementation of research.
PO12	Societal Impact: Work collaboratively to develop and exchange research knowledge so as to benefit and influence the society

2.3 Programme Specific Outcomes (PSOs)

The fresh **research scholars** of the Ph.D. programme will have the following discipline-specific graduate attributes:

PSO1	demonstrate proficiency in a specialized area of Computer Science and Engineering;
PSO2	ability to apply principles of computer engineering for the entire life cycle of the project ranging from initial design to the closure of the project;
PSO3	ability to identify and analyze various applications in design and functions of various applications.
PSO4	research and Development: Cultivate the field of computing and its latest trends, to pursue teaching, research & development activities and to work effectively in a team.
PSO5	develop and evaluate effective solutions for real-life and research problems.

3. Programme Structure

Course work of Doctor of Philosophy programme spans over one semester and comprise of 14/16 credits weightage consisting of Core Courses (CC) and Discipline Specific Elective Courses (DSC).

Table 1: Pre-Ph.D. Course Credit Scheme

Scheme of Examination for Ph.D. (Computer Science and Engineering)

Semester	**Core Courses (CC)**		**Discipline Specific Elective Courses (DSC)**		**Total Credits**
I	No. of Courses	Total Credits	No. of Courses	Total Credits	
	03	10/12	01	04	14/16
Total	03	10/12	01	04	14/16
%age	-	71.42/75.0	-	28.58/25.0	100

Table 2: Detailed break-up of Courses' Type (Semester wise)

Semester	Core Courses	Discipline Elective Specific Courses	Skill Enhancement Courses	Total Courses
I	CC CC CC	DSC1	-	04

Table 3: Courses' codes, titles, and credits

Course Code	Course Title	Credit		
	Semester I	**Theory**	**Practical**	**Total**
PH-CSE-01	Research Methodology	4	0	4
PH-CSE-02	Advancements in Computing	4	0	4
RPE-04	Research and Publication Ethics	2/4	0	2/4
PH-CSE-03	Elective	4	0	4

Table 4: Ph.D. Courses' List

Course Code	Course Title	Credits
Core Courses		
PH-CSE-01	Research Methodology	4
PH-CSE-02	Advancements in Computing	4
RPE-04	Research and Publication Ethics	2/4
Discipline Specific Elective Courses'		
PH-CSE-03	Elective	4

List of Elective Courses against PH-CSE-03

PH-CSE-03(i) Simulation and Modeling
PH-CSE-03(ii) Advanced Computer Architecture
PH-CSE-03(iii) Advanced Programming Languages
PH-CSE-03(iv) Data Mining & Data Warehousing
PH-CSE-03(v) Advanced Operating Systems
PH-CSE-03(vi) Advanced Database Systems
PH-CSE-03(vii) Data Communication and Networking
PH-CSE-03(viii) Advanced Software Engineering
PH-CSE-03(ix) Artificial Intelligence
PH-CSE-03(x) Machine Learning
PH-CSE-03(xi) Deep Learning
PH-CSE-03(xii) Data Science
PH-CSE-03(xiii) Big Data Analytics
PH-CSE-03(xiv) Wireless Networks
PH-CSE-03(xv) Network Security
PH-CSE-03(xvi) Cloud Computing
PH-CSE-03(xvii) Internet of Things

Scheme of Examination for Ph.D. (Computer Science and Engineering)

Course Code	Course Type	Nomenclature of Paper	Credit	Int. Marks	Ext. Marks	Total Marks
PH-CSE-01	Core	Research Methodology	04	30	70	100
PH-CSE-02	Core	Advancements in Computing	04	30	70	100
RPE-04	Core	Research and Publication Ethics	02/04	-	-	50/100
PH-CSE-03	Discipline Specific Elective	Elective Paper	04	30	70	100

List of Elective Courses against PH-CSE-03:

PH-CSE-03(i)	Simulation and Modeling
PH-CSE-03(ii)	Advanced Computer Architecture
PH-CSE-03(iii)	Advanced Programming Languages
PH-CSE-03(iv)	Data Mining & Data Warehousing
PH-CSE-03(v)	Advanced Operating Systems
PH-CSE-03(vi)	Advanced Database Systems
PH-CSE-03(vii)	Data Communication and Networking
PH-CSE-03(viii)	Advanced Software Engineering
PH-CSE-03(ix)	Artificial Intelligence
PH-CSE-03(x)	Machine Learning
PH-CSE-03(xi)	Deep Learning
PH-CSE-03(xii)	Data Science
PH-CSE-03(xiii)	Big Data Analytics
PH-CSE-03(xiv)	Wireless Networks
PH-CSE-03(xv)	Network Security
PH-CSE-03(xvi)	Cloud Computing
PH-CSE-03(xvii)	Internet of Things

PH-CSE-01 Research Methodology								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
Core Theory	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final Term Examination: The Final Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with different aspects of research methodology, namely, research design, collection and analysis of data, and interpretation of results.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: objectives, hypothesis, interpretation, data analysis, data collection, research design and method, interpretation, data analysis, sampling.
CO2	describe: objectives, hypothesis, interpretation, data analysis, data collection, research design and method, interpretation, data analysis, sampling.
CO3	illustrate: measurement, data collection, processing, sampling, analysis and its strategies, reports.
CO4	categorize: research, sampling methods, data collection techniques, reports ,and data processing strategies. perform: data analysis.
CO5	compare: sampling methods, data collection techniques, reports and data processing strategies.
CO6	create: thesis/reports, design research tool, interpret(derive) results.

CO-PEO Mapping Matrix for Course PH-CSE-01

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3
Average	2.5	2.5	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-01

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	-	3	-	3	1	3
CO2	2	1	1	3	1	-	-	3	-	3	2	3
CO3	3	1	1	3	3	-	-	3	-	3	3	3
CO4	3	3	1	3	1	-	-	3	-	3	3	3
CO5	3	1	1	3	3	-	-	3	-	3	3	3
CO6	3	3	3	3	3	-	-	3	-	3	3	3
Average	2.5	2	1.3	2.6	2	-	-	3	-	3	2.5	3

CO-PSO Mapping Matrix for Course PH-CSE-01

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	3
CO2	3	3	2	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3
Average	3	3	2.5	3	3

Unit-1

Research an Introduction: Meaning, Characteristics, Classification, Importance.

Research Methods and Techniques: Classification of Research Methods, Advantages and Limitations, Steps Involved.

Research Tools: Library, Internet and Simulation.

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Unit-II

Formulation of Research Problem: Formulation of Research Problem, Considerations in selecting a research problem, Steps in formulation of a research problem, Delimiting problems, Sources of Research Problem, Criteria of a good Research Problem, Formulation and Stating the Problem, Common Errors.

Hypothesis: Meaning, Importance, Types, Sources, Characteristics, Testing.

Research Design: Meaning, Characteristics of a Good Research Design, Components of a Research Design, and Types of Research Design.

Unit-III

Census and Sample Investigation: Meaning of Census and Sampling Investigation, Objective of Sampling, Advantages of Sampling and Census Method, Types of Sampling Techniques, Sampling Errors.

Data Collection: Primary and Secondary Data, Methods of Primary Data Collection, Sources of Secondary Data, Precautions in the use of Secondary Data.

Processing of Data: Editing, Coding, Classification.

Unit-IV

Analysis and Statistical Techniques: Meaning of Analysis, Primary Data Analysis, Secondary Data Analysis, Characteristics of Data Analysis and Statistical Methods in Analysis.

Interpretation of Data: Meaning and Need, Pre-requisites of Interpretation, Sources of Errors, Conclusion and Generalization,

Report Writing: Research Report, Types of Reports, Steps in Report Writing, Format of Research Report, Style and Typing of Research Report, Problems in Preparing Research Report.

Text Books

1. J. Garg, B.L, Karadia, R, Aggarwal F, An Introduction to Research Methodology, RBSA Publishers, 2002.
2. Kothari,C.R, Research Methodology: Methods and Techniques. New Age International, 1990 Santosh Gupta.

Reference Book

1. N. Gurumani, Scientific Thesis Writing and Paper Presentation, MJP Publishers. Montgomery, Douglas C, Design and Analysis of Experiments, Wiley India Pvt. Ltd.

PH-CSE-02 Advancements in Computing

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Core Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final Term Examination: The Final Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with database system concepts and architecture, relational data model, cpu organization, issues, opportunities and constraints in e-commerce and software quality.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: DBMS architecture, CPU organization, Issues, opportunities and constraints in E-commerce and Software Quality factors
CO2	describe: DBMS functions and component modules, functional dependencies, machine instructions, I/O interface, communication technologies of public life and standards of software quality.
CO3	Illustrate: Basic operation of relational algebra, Normal forms, micro programming concept, SEI-CMM Model.
CO4	categorize: Data models, Database languages, CPU memory, Applications of E-governance, Quality factor and quality metrics
CO5	compare: Data models, Database languages, CPU memory, Applications of E-governance, Software standards, Quality factor and quality metrics

CO-PEO Mapping Matrix for Course PH-CSE-02

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Average	2.4	2.4	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-02

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	-	3	-	3	1	3

CO2	2	1	1	3	1	-	-	3	-	3	2	3
CO3	3	1	1	3	3	-	-	3	-	3	3	3
CO4	3	3	1	3	1	-	-	3	-	3	3	3
CO5	3	1	1	3	3	-	-	3	-	3	3	3
Average	2.4	1.8	1	2.6	1.8	-	-	3	-	3	2.4	3

CO-PSO Mapping Matrix for Course PH-CSE-02

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	3
CO2	3	3	2	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Average	3	3	2.4	3	3

Unit-I

Data Base System concepts and Architecture: Data Models, Schemas and Instances, DBMS architecture and Data Independence, Data Base languages & Interfaces, DBMS functions and component modules.
Relational Data Model: Relational Model concepts, Integrity constraints over relations, Relational Algebra, Basic operations, Relational Data Base Design, Functional dependencies, Decomposition, Desirable properties of decomposition, normal forms based on primary keys (I NF, 2 NF, 3 NF and BCNF).

Unit-II

CPU organization: Processor organization, Machine Instructions, Instruction cycle, Instruction Format and addressing mode. Microprogramming concepts and micro program sequencer.
I/O Organization: I/O interface, interrupt structure, transfer of information between CPU/Memory and I/O devices, and IOPs, Memory Organization.
Parallel Architectures: Introduction, Classification, Parallel Techniques, Code Scheduling, Interconnection networks, VLIW Superscalar.

Unit-Ill

Issues, opportunities and constraints in applications of modern information and communication technologies in following domains of public life: commerce (e-commerce), banking (e-banking), teaching-learning (e-learning), Public governance (c-governance) and tourism.

Unit-IV

Software Quality, Software Quality Factors, Software Quality Metrics, Relationship between quality factors and quality metrics, Software standards, Software Reviews, Formal Technical Reviews, Software Quality Assurance, Clean Room Software Engineering, SEI-CMM. Standards of Software Quality, Quality Assurance Standard, Quality Review

Text Books

1. Elmasri & Navathe : Fundamentals of Database System, 3rd Edition, Addison Wesley, New Delhi.
2. Korth & Silbcrschatz: Database System Concept, 4th Edition, McGraw Hill International Edition.

Reference Books

1. Mano M. Morris Digital Logic and Computer Design, Prentice hall of India Pvt. Ltd., 2000.
2. Carpinelli, Computer Systems Organization & Architecture, Pearson Education.
3. Hayes. J.P., Computer Architecture and organisation, McGraw Hill, 1998, Third Ed.

PH-CSE-03(i) Simulation and Modeling

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Core Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final Term Examination: The Final Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with Concept of simulation system, principal used in modeling and illustration of various problems using simulation

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: Construct a model for a given set of data and analyse output produced to test validity of the model .
CO2	describe: numerical methods to interpret, extract, analyse and present simulation result.
CO3	Illustrate: Develop simulation programs to design a system that meets industrial requirements and solves real world problems based on client server communication.
CO4	categorize: Test modern simulation tools and resources to measure the performance of different simulation models.
CO5	compare: Make use of problem solving approaches to work challenges and make decisions in teams.
CO6	design and develop various simulation models, applications.

CO-PEO Mapping Matrix for Course PH-CSE-03(i)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3
Average	2.5	2.5	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(i)

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	-	3	-	3	1	3
CO2	2	1	1	3	1	-	-	3	-	3	2	3
CO3	3	1	1	3	3	-	-	3	-	3	3	3
CO4	3	3	1	3	1	-	-	3	-	3	3	3
CO5	3	1	1	3	3	-	-	3	-	3	3	3
CO6	3	3	3	3	3	-	-	3	-	3	3	3
Average	2.5	2	1.3	2.6	2	-	-	3	-	3	2.5	3

CO-PSO Mapping Matrix for Course PH-CSE-03(i)

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	3
CO2	3	3	2	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3
Average	3	3	2.5	3	3

Unit -1

Introduction: Concept of simulation, steps in simulation experiment, Benefits of simulation and its pitfalls, system modeling, principal used in modeling, Generation of random numbers, Generation of non-uniformly distributed random numbers.

Illustrative examples: Inventory problem. Chemical Reactor, Servo System, Water Reservoir System, Hypothetical Computer.

Unit-II

Simulation of discrete system: Fixed time-step vs. Event-to-Event Model, Monte Carlo computation.

Continuous system simulation: Continuous System models, Differential Equations, Analog Computers, Hybrid Computers, Digital-Analog Simulators.

Queuing Systems: Congestion in systems, Arrival Patterns, Poisson Arrival Patterns, Exponential Distribution, Coefficient of Variation, Erlang Distribution, Service Times, Normal Distribution, Basic concept of queuing theory, Simulation of single server, two servers.

Unit-III

Simulation of PERT Network: Network model of a project, Analysis of an Activity Network, Critical Path Computation, Uncertainties in Activity Durations, Simulation of an Activity Network, Computer Program for Simulation, Resource allocation and Cost Consideration.

Simulation of Inventory Control And Forecasting: Elements of inventory theory, inventory models, Forecasting and aggression analysis.

Design And Evaluation of Simulation Experiments: Length of Simulation Runs, Variance Reduction Techniques and validation.

Unit-IV

Simulation Languages: Continuous and discrete simulation languages, Block Structured continuous simulation languages, Expression based languages, Discrete system simulation languages**,** GPSS SIMCRIPT SIMULA, Factors in selection of discrete system simulation languages**.**

Text Books

1. Narsing Deo, System Simulation with Digital Computers, PHI New Delhi.
2. Avrill M. Law & Kelton, Simulation Modeling and Analysis, McGraw Hill.

Reference Books

1. Jerry Banks et. al., Discrete Event System Simulation, Prentice Hall of India
2. Gordon Geoferry: "System Simulation, Prentice-Hall of India Pvt Ltd New Delhi-1993

PH-CSE-03(ii) Advanced Computer Architecture							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment(s) / Attendance

Instructions to paper setter for Final Term Examination: Final Term examination shall cover the whole content of the course. Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with different concepts related to computer architecture.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: concepts of parallel processing, computer architecture, principles of pipeline, collision free scheduling, ILP processors, branch handling, TLB, paging, segmentation, memory hierarchy technology, distributed and shared MIMD.
CO2	understand and explain: parallel processing, computer architecture, principles of pipeline, collision free scheduling, ILP processors, branch handling, TLB, paging, segmentation, memory hierarchy technology, switching and routing techniques, distributed and shared MIMD.
CO3	illustrate different types of: computational models, pipeline, scheduling, TLB, paging, segmentation, cache performance, network interconnection topologies, cache coherence problem and switching network.
CO4	categorize: level of parallelism, linear and non-linear pipeline, code scheduling, TLB, paging and segmentation, UMA, NUMA, CC-NUMA and COMA multiprocessors.
CO5	relate: concurrent and parallel execution, dependencies between instruction, synchronous and asynchronous pipeline, different code scheduling and hardware based cache coherence protocols.

CO-PEO Mapping Matrix for Course PH-CSE-03(ii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	1	3	3	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3
Average	2.4	1	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(ii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1	3	1	1	1	-	-	-	-	-	1	3
CO2	2	1	1	3	1	-	-	-	-	-	2	3
CO3	3	1	1	3	3	-	-	-	-	-	3	3
CO4	3	3	1	3	1	-	-	-	-	-	3	3
CO5	3	1	1	3	3	-	-	-	-	-	3	3
Average	2.4	1.8	1	2.6	1.8	-	-	-	-	-	2.4	3

CO-PSO Mapping Matrix for Course PH-CSE-03(ii)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	-	3
CO2	3	1	2	-	3
CO3	3	1	3	-	3
CO4	3	1	3	-	3
CO5	3	1	3	-	3
Average	3	1	2.4	-	3

Unit-I

Fundamentals: Computational model, Evolution of computer architecture, process, program thread, concurrent and parallel execution, types and levels of parallelism, classifications of parallel architectures, Relationships between languages and parallel architectures.

Unit-II

Instruction-Level-Parallel Processors: Evolution and overview, Dependencies between instructions, Instruction Scheduling, Preserving Sequential Consistency, Speed-up Potential of ILP Processing.

Pipelined Processors: Basic concepts, Principles of Pipelined instruction processing, synchronous & asynchronous pipelining. Linear Pipeline-clocking and timing control, speedup efficiency & throughput. Nonlinear pipeline, reservation table, latency analysis, collision free scheduling, internal data forwarding.

Unit-III

Superscalar pipeline Design- Structure data dependencies pipeline stalling, in order issue, out of order issue, VLIW architecture. Branch handling delayed handling, branch processing multi way branching, guarded execution, code scheduling basis, block scheduling, loop scheduling, and global scheduling.

Memory Hierarchy Technology: Inclusion, coherence and locality, virtual memory models, TLB, paging and segmentation, memory replacement policies, cache addressing models, cache performance issues, interleaved memory organization.

Unit-IV

MIMD Architectures: Architectural concepts, Problems of scalable computers, Main design issues of scalable MIMD computers.

Distributed Memory MIMD Architectures: Introduction, Direct Connection networks, Shared Memory MIMD Architectures, Dynamic interconnection networks-shared path, switching networks, crossbar &

multistage networks, Cache coherence problem, Hardware based cache coherence protocol-Snoopy cache protocol directory scheme, scalable coherent interface, and hierarchical cache coherence protocol. UMA, NUMA, CC-NUMA and COMA multiprocessors.

Text Books

1. Sima, Dietal, Advanced Computer Architecture, Addison Wesley, 2000.
2. Wang, Kai, Advanced Computer Architecture, McGraw Hill, International Ed.

Reference Books

1. Wang Kai, Brings Faye A., Computer Architecture and Parallel Processing, McGraw Hill, International Ed.
2. Main, Richard Ya**,** Advanced Computer Architecture PHI 1999

PH-CSE-03(iii) Advanced Programming Languages

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Core Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final Term Examination: The Final Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with Concept of Programming Languages, Structured Data Types, Sequence Control and Storage Management.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: An ability to program in different language paradigms and evaluate their relative benefits.
CO2	describe: An understanding of the key concepts in the implementation of common features of programming languages. Skills gained.
CO3	illustrate: Investigate semantic issues in programming languages by studying implementations in an interpreter.
CO4	categorize: Define the semantics of a programming language using a definitional interpreter. Competency developed..
CO5	compare: Solve problems using a range of programming paradigms and assess the effectiveness of each paradigm for a particular problem.
CO6	develop: applications using various languages.

CO-PEO Mapping Matrix for Course PH-CSE-03(iii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3
Average	2.5	2.5	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(iii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1	3	1	1	1	-	-	3	-	3	1	3
CO2	2	1	1	3	1	-	-	3	-	3	2	3
CO3	3	1	1	3	3	-	-	3	-	3	3	3
CO4	3	3	1	3	1	-	-	3	-	3	3	3
CO5	3	1	1	3	3	-	-	3	-	3	3	3
CO6	3	3	3	3	3	-	-	3	-	3	3	3
Average	2.5	2	1.3	2.6	2	-	-	3	-	3	2.5	3

CO-PSO Mapping Matrix for Course PH-CSE-03(iii)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	3
CO2	3	3	2	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3
Average	3	3	2.5	3	3

Unit-I

Introduction: Brief history of Programming Language, Characteristics of programming language. Programming Language Processors: The structure and operation of a computer, Hardware and firmware computers, Translator and simulator computers, Syntax, semantics and virtual computers, hierarchies of computers, binding and binding time.

Elementary Data Types: Data object, variable and constants, data types, specification of elementary data types, declarations, type checking and type conversion, assignment and initialization, numeric data types, enumerations, Boolean, characters.

Unit-II

Structured Data Types: Structured data object and data types, specification of data structure types, implementation of data structure types, declarations and type checking for data structures, vector and arrays, record, character strings, variable sized data structures, pointers and programmer-constructed data objects, sets, file and input/output.

Subprogram And Programmer-Defined Data Types: Evolution of the data type concept, Abstraction, encapsulation, and information hiding, subprogram, type definitions, abstract data types.

Unit-III

Sequence Control: Implicit and explicit sequence control, sequence control within expression, sequence control between statements, subprogram sequence control, recursive subprogram, exceptions and exception handlers, Co-routines, scheduled subprograms, tasks and concurrent execution, data structures and sequence control.

Data Control: names and referencing environments, static and dynamic scope, block structure, local data and local referencing environments, shared data, task and shared data.

Unit-IV

Storage Management: Major Runtime elements requiring storage, programmer and system controlled storage management, storage management phases, static storage management, stack based storage management, heap storage management

Syntax And Translation: General syntactic criteria, syntactic elements of language, stages in translation, formal definition of syntax.

Operating and Programming Environment: Batch processing environment, interactive environments, embedded system environments, programming environments.

Theoretical Models: Problem in syntax and translation, problem in semantics.

Text Books

1. Sebessa W. Robert, Concepts of programming languages 4th edition, (Addison Wesley 2000)
2. Sethi Ravi, Programming languages 2nd edition, (Addison Wesley-2000)

Reference book

1. Programming Languages, design and implementation second edition by Terrence W. Pratt Prentice Hall of India private limited, New Delhi

PH-CSE-03(iv) Data Mining & Data Warehousing							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Optional Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Instructions to paper setter for Final Term Examination: Final Term examination shall cover the whole content of the course. Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with different concepts of data warehouse and data mining, namely, OLAP, Association rule mining, classification and prediction.

Course Outcomes	At the end of this course, the student able to :
CO1	define: the concepts of data mining, data pre-processing, outliers, data warehouse, OLAP, association rule mining, data classification prediction and cluster Analysis.
CO2	describe: key process of data mining ,data warehousing, OLAP, data warehousing to data mining , association rule, classification and prediction methods.
CO3	apply: OLAP technology and association rules. use: decision induction, bayesion and back propagation classification methods.
CO4	differentiate: operational database systems and data warehousing, single dimensional and multidimensional association rules, and between various data mining classification methods.
CO5	evaluate: data mining and data warehouse, OLAP technology, single and multi-dimensional association rule.

CO-PEO Mapping Matrix for Course PH-CSE-03(iv)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Average	2.4	2.4	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(iv)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	-	-	-	-	1	3
CO2	2	1	1	3	1	-	-	-	-	-	2	3
CO3	3	1	1	3	3	-	-	-	-	-	3	3
CO4	3	3	1	3	1	-	-	-	-	-	3	3
CO5	3	1	1	3	3	-	-	-	-	-	3	3
Average	2.4	1.8	1	2.6	1.8	-	-	-	-	-	2.4	3

CO-PSO Mapping Matrix for Course PH-CSE-03(iv)					
COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	-	3
CO2	3	3	2	-	3
CO3	3	3	3	-	3
CO4	3	3	3	-	3
CO5	3	3	3	-	3
Average	3	3	2.4	-	3

Unit-I

Introduction, Evolution of Data Warehousing, Principles of Data Warehousing, Types of Data and their uses, conceptual Data Architecture, Design Techniques, introduction to the Logical Architecture, Creating the Data Asset, Business Data Warehouse Design, Populating the Data Warehouse.

Unit-II

Implementation of Warehouse, Obstacles to Implementation, Planning your implementation, justifying the warehouse, Organizational Implications of Data Warehousing, The Data Warehouse in your Organization, Data Warehouse Management, Locking to the Future.

Data Mining: Motivation, Importance, data mining, kind of data, Functionalities, interesting patterns, classification of data mining system, Major issues.

Unit-III

Data warehouse and OLAP Technology for data mining: data warehouse, operational data base systems and data warehouse, Architecture, Implementation, development of data cube technology, data warehousing to data mining, Data warehouse usage.

Data Preparation: Preprocess, Data cleaning, Data Integration and transformation, Data reduction.

Unit-IV

Concept Description: Characterization and Comparison, Data Generalization and summarization-based characterization, Analytical characterization, analysis of attribute relevance, mining class comparisons, and mining descriptive statistical measures in large databases.

Mining Association Rules in Large Database, Mining single-dimensional Boolean association rules from transactional databases, mining multilevel association rules from transaction databases, Mining multidimensional association rules from relational databases and data warehouses, From association mining to correlation analysis, constraint-based association. Classification and prediction, issues, classification by decision induction, Bayesian classification, classification by back propagation, classification based on concepts crom association rule mining other classification methods.

Text Books

1. Ale Berson, Stephen Smith, KorthTheorling, Data Mining,TMH.
2. Adruaans, Longman, Addison-wesley Data Mining,
3. Addison-Wesley Longman, Data Warehousing in the Real World.

Reference Book

1. Chanchal Singh, Data Mining and Warehousing, Wiley.
2. Jiawei Han and MichelineKamber, Data Mining: Concepts and Techniques, San Francisco: Morgan Kaufmann Publishers, 2001.

PH-CSE-03(v) Advanced Operating Systems								
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
Compulsory Theory	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final Term Examination: The Final Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to study, learn, and understand the major concepts of advanced operating systems, namely, multimedia operating systems, distributed and real time operating systems, threads, security and design issues in operating systems.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: kernel, threads, concept of multimedia, distributed and real time operating system, issues in design, security and performance of operating system.
CO2	understand and describe: kernel, threads, deadlock, virtualization, concept of multimedia, distributed and real time operating system, issues in design, security and performance of operating system.
CO3	demonstrate/illustrate: process scheduling, disk scheduling ,real time scheduling, mutual exclusion, deadlock, security and protection mechanism in operating system.
CO4	classify algorithm for: process scheduling and disk scheduling, mutual exclusion, deadlock, security and protection.
CO5	compare algorithm for: process scheduling and disk scheduling, mutual exclusion, deadlock, security and protection.

CO-PEO Mapping Matrix for Course PH-CSE-03(v)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Average	2.4	2.4	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(v)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	1	-	-	-	-	1	3
CO2	2	1	1	3	1	1	-	-	-	-	2	3
CO3	3	1	1	3	3	1	-	-	-	-	3	3
CO4	3	3	1	3	1	1	-	-	-	-	3	3
CO5	3	1	1	3	3	1	-	-	-	-	3	3

Average	2.4	1.8	1	2.6	1.8	1	-	-	-	-	2.4	3

CO-PSO Mapping Matrix for Course PH-CSE-03(v)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	-	3
CO2	3	2	2	-	3
CO3	3	2	3	-	3
CO4	3	2	3	-	3
CO5	3	2	3	-	3
Average	3	2	2.4	-	3

Unit-I

Graphical User Interface and the Operating System: Windowing Technology, Graphical User Interface, relationship between Operating System and the Windows, Components of GUI, requirement of a Windows based GUI

Security and Protection: Security Threats, Attacks on Security, Security Violation through Parameters, Computer Worms, Computer Viruses, Security Design Principles, Authentication, Protection Mechanism, Encryption, Security in Distributed Environment.

Unit-II

Processes: Process Model, Implementation of Processes, Threads, Inter-process Communication, Race Condition, Critical Section, Mutual Exclusion with Busy waiting, Sleep and Wakeup, Semaphores, Monitors, Message Passing. Classical IPC Problems, Process Scheduling, Round Robin, Priority, Multiple Queues, Shortest Job First, Guaranteed, Lottery, Real Time and Two-Level Scheduling.

Disk Performance Optimization: Moving Head Disk Storage, Disk Scheduling, Seek Optimization, Rotational Optimization, Disk Caching.

Unit-III

Distributed and Parallel Processing: Parallel Processing, Distributed Processing, Difference between Distributed and Parallel Processing, Advantages of Parallel Processing, Writing Programs for Parallel Processing, Machine Architecture supporting Parallel Processing, Operating System for Parallel Processors, Issues in Operating System in Parallel Processing.

Unit-IV

Distributed Operating Systems: Architecture of Distributed Systems, Networking, Interprocess Communication Protocols, Distributed Computation Paradigm, Network Operating System, Design issues in Distributed Operating System, Theoretical issues in Distributed Systems, Distributed Control Algorithms, Distributed Mutual Exclusion, Distributed Deadlock Handling, Distributed Scheduling Algorithms, Recovery and Fault Tolerance. Distributed File System, Distributed system Security.

Text Books

1. Operating Systems; Achyut S Godbole; Tata McGraw Hill Publishing Company Limited, New Delhi.

2. Operating Systems; A Concept based Approach; D. M. Dhamdhere; Tata McGraw Hill Publishing Company Limited, New Delhi.

Reference Book

1. Operating Systems-2nd Edition; H. M. Deitel; Pearson Education.

PH-CSE-03(vi) Advanced Database Systems

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Instructions to paper setter for Final Term Examination: Final Term examination shall cover the whole content of the course. Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with different concepts related to database.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: 3-schema architecture, ER diagrams, EER model, functional dependencies, normal forms, data types, views in SQL, concurrency control techniques, database security issues, semantic data models, and client server architecture.
CO2	discuss: ER diagram, relational model, EER model, functional dependencies, normal forms, SQL constraints and views, recovery techniques, data warehouse, and distributed databases.
CO3	apply: inheritance, SQL statements, normal forms, SQL constraints, dependencies, data security, concurrency control and recovery techniques on database.
CO4	categorized: subclass, super class, inheritance, SQL statements, normal forms, SQL constraints, dependencies, data security, concurrency control and recovery techniques.
CO5	justify: subclass, super class, inheritance, SQL queries, normal forms, SQL constraints, functional dependencies, security, concurrency control and recovery techniques.
CO6	design: database for a particular application.

CO-PEO Mapping Matrix for Course PH-CSE-03(vi)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO 6	3	3	3	3	3
Average	2.5	2.5	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(vi)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	1	-	-	-	-	1	3
CO2	2	1	1	3	1	1	-	-	-	-	2	3
CO3	3	1	1	3	3	1	-	-	-	-	3	3
CO4	3	3	1	3	1	1	-	-	-	-	3	3

CO5	3	1	1	1	3	1	-	-	-	-	3	3
CO6	3	3	3	3	3	1	-	-	-	-	3	3
Average	2.5	2	1.33	2.33	2	1	-	-	-	-	2.5	3

CO-PSO Mapping Matrix for Course: PH-CSE-03(vi)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	-	3
CO2	3	2	2	-	3
CO3	3	2	3	-	3
CO4	3	2	3	-	3
CO5	3	2	3	-	3
CO6	3	2	3	-	3
Average	3	2	2.5	-	3

Unit-I

Extended E-R Model: Subclasses, super classes and Inheritance, Specialization and Generalization, Constraints and Characteristics of Specialization and generalization.

Object-oriented Data Model : Object Identity, Object Structure, and Type constructors, Encapsulation of Operations, Methods and Persistence, Type Hierarchies and Inheritance, Complex Objects, Polymorphism, Multiple Inheritance, Versions and Configurations,

Object Relational Databases: Basic Concepts of Object-Relational systems, Object-Relational features of Oracle, An overview of SQL3, Object-Relational support in SOL3, Relational Data Model.

Unit-II

Further Normalization: Higher Normal Forms, Multivalued Dependencies and 4^{th} normal Form, Join Dependencies and 5^{th} Normal Form, Domain-key Normal Form.

Database System Architectures: Centralized systems, Client-Server Systems, Server System Architecture, Parallel Systems, and Distributed Systems.

Unit-III

Distributed Database and Client-Server Architecture: Distributed Database concepts. Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design, Type of Distributed Database System, Overview of Concurrency Control and recovery in Distributed Databases. An Overview of Client-Server Architectures, Distributed Databases in Oracle.

Unit-IV

Data warehousing Concepts: Architecture, Data flows, Tools & Technologies, Data Marts, Data Mining & Online Analytical Processing

Web Interfaces to Databases: Web Fundamentals, Databases and the Web, Web Servers and Sessions, Providing access to Database on WWW. The Oracle Web server. Performance Tuning, Performance Benchmarks.

Enhance Data models for Advanced Applications: An Overview of active Databases. Spatial Databases, Deductive Databases, Multimedia Databases, Mobile Computing & Mobile Databases.

Text Books

1. Elmasri & Navathe: Fundamentals of Database systems, 3^{rd} Edition, Addison Wesley New Delhi.
2. Korth & Siiberschatz: Database System Concepts, McGraw Hill International Edition.

Reference Books

1. Raghu Ramakrishnan & Johannes Gchrke: Database Management Systems, **2*** edition, McGraw Hill International Edition.
2. Bipin C. Desai: An Introduction to Database System Galgotia Publication, New Delhi.

PH-CSE-03(vii) Data Communication and Networking									
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Core Compulsory Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to make the students familiar with the topics of networking, data communication, modes of transmission, communication media, routing, error control and congestion control.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define the terms and concepts of data communication and computer networking including types of network topologies, reference models, protocols used in data communication, transmission modes and media, switching and multiplexing.
CO.2	understand and describe various concepts of data communication and computer networking including network topologies, reference models, protocols used in data communication, data transmission modes and transmission media, switching and multiplexing.
CO3	apply the techniques learnt here in the design and evaluation of computer and communication networks and decide which competing communication media, and network topology/switching/protocol/technology will suit a particular situation.
CO4	differentiate various types of: computer and data communication networks, network topologies, switching and multiplexing mechanisms, error control mechanisms, routing protocols, transmission modes, transmission media, congestion control techniques.
CO5	compare, evaluate and choose between candidate: network topologies, transmission media, switching and multiplexing techniques, protocols and different layers, error control mechanisms, congestion control techniques.

CO-PEO Mapping Matrix for Course PH-CSE-03(vii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO.2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(vii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	1	-	2	-	-
CO2	2	1	1	3	1	-	3	2	-	2	-	-
CO3	3	1	1	3	3	-	3	3	-	2	-	-
CO4	2	1	1	3	1	-	3	3	-	2	-	-
CO5	2	1	3	1	3	-	3	3	-	2	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	2.4	-	2	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(vii)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	-
CO.2	3	2	3	2	-
CO3	3	2	3	3	-
CO4	3	2	3	3	-
CO5	3	2	3	3	-
Average	3	2	3	2.4	-

Unit-I

Basic concepts of analog and digital signals, data transmission concepts, Analog and digital data transmission, Analog to digital conversion, Digital to Analog conversion, transmission media, Shannon Capacity, Network Topologies, Switching, Multiplexing, Protocols and Standards, OSI (model, Transmission Media, Modems.

Unit-II

Data Link Layer: Data Link Layer Design issues, Error - detection and correction, Data Link Protocols, Sliding Windows Protocols, Protocols specification and Verification, Example Data Link Protocols, Medium Access Sublayer (Channel Allocation Problem, Multiple Access Protocols).

Unit-III

Network Layer: Network Layer Design Issues, Routing Algorithms, Congestion Control Algorithms, Network Layer in ATM Networks. Transport Layer - Transport Service, Elements of Transport Protocols, Performance Issues.

Unit-IV

Application Layer: Network Security, Domain Name System, SNMP, Electronic Mail, Multimedia. Mobile Databases.

Satellite Systems: History, Applications, Basics, Routing, Localization, Handover Broadcast Systems: Overview, Cyclic repetition of Data, Digital audio broadcasting, Digital video broadcasting, convergence of broadcasting and mobile communication.

Text Books

1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw-Hill, 2004.
2. Andrew S. Tanenbaum, "Computer Networks", PHI, Fourth Edition, 2003.

Reference Book

1. William Stallings, "Data and Computer Communication", Sixth Edition, Pearson Education, 2000

PH-CSE-03(viii) Advanced Software Engineering

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Core Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to make the students familiar with the topics of software crisis, software engineering paradigms, software configuration management, design, coding, testing and maintenance.

Course Outcomes	At the end of this course, the student will be able to:
CO1	enumerate/define the concepts of: software and software engineering, software development paradigms, phases of software development, methods of assessing quality and reliability.
CO2	describe and summarize: phases of software development process, testing techniques, relationship between reliability and quality.
CO3	illustrate various techniques of: requirement analysis, design, coding, testing and maintenance, quality and reliability.
CO4	analyse and classify: software engineering paradigms, cost estimation models, design methodologies, testing techniques, maintenance process, reliability and quality models.
CO5	compare and select from amongst candidate: software engineering paradigms, cost estimation models, design methodologies, testing techniques, maintenance process, reliability and quality models.

CO-PEO Mapping Matrix for Course PH-CSE-03(viii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	3	3	3
CO2	2	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Average	2.4	3	3	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(viii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	2	1	-	2	-

CO2	2	1	1	3	1	-	3	2	1	-	2	-
CO3	3	1	1	3	3	-	3	2	1	-	2	-
CO4	2	1	1	3	1	-	3	2	1	-	2	-
CO5	2	1	3	1	3	-	3	2	1	-	2	-
Average	2	1.4	1.4	2.2	1.8	-	3	2	1	-	2	-

CO-PSO Mapping Matrix for Course PH-CSE-03(viii)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	-
CO2	3	3	3	2	-
CO3	3	3	3	3	-
CO4	3	3	3	3	-
CO5	3	3	3	3	-
Average	3	3	3	2.4	-

Unit-I

Introduction: Life cycle models, Requirement Analysis and specification, Formal requirements specification. Fundamental issues in software design, goodness of design, cohesions, coupling. Function-oriented design.

Unit-II

Structured analysis and design, overview of object -oriented concepts. Unified Modeling Language, unified design process.

Unit-III

User interface design, coding standards and guidelines, code walkthrough and reviews. Unit testing, black box and white box testing, integration and system testing. Software quality assurance and reliability modeling.

Unit-IV

SEI CMM, ISO 9001 and Six Sigma, clean room testing technique. Software maintenance issues and techniques. Software reuse. Client-Server software development, Personnel Software process, Soft Computing

Text Books

1. Mall, Rajib, Fundamentals of Software Engineering, PHI Learning Pvt. Ltd
2. Aggarwal, K.K, and Singh, Yogesh, Software Engineering, New Age International
3. Jalote, Pankaj, An Integrated Approach to Software Engineering, Narosa Publishing House.

Reference Book

1. Pressman, S. Roger, Software Engineering, Tata McGraw-Hill.

PH-CSE-03(ix) Artificial Intelligence

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide an understanding of Artificial Intelligence techniques and their applications. Various search techniques and expert systems along with other components of artificial intelligence in computer science will be covered.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: artificial intelligence terms, types of search strategy, production system, knowledge representation, learning techniques and genetic algorithm terminologies.
CO2	explain: the types and properties of search algorithm, predicate calculus, knowledge representation and explore the theories that demonstrate intelligent behavior including intelligent editor, learning by induction and dealing with uncertainty.
CO3	use: search strategy/genetic algorithm/ fuzzy logic and learning technique.
CO4	classify types of: search strategy, production system, learning, operator of genetic algorithm, knowledge representation and approaches that deals with uncertainty.
CO5	compare and select types of: search strategy, production system, learning, operator of genetic algorithm, knowledge representation and approaches that deals with uncertainty.

CO-PEO Mapping Matrix for Course PH-CSE-03(ix)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(ix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	-	-	2	-	-

CO2	2	1	1	3	1	-	3	-	-	2	-	-
CO3	3	1	1	3	3	-	3	-	-	2	-	-
CO4	2	1	1	3	1	-	3	-	-	2	-	-
CO5	2	1	3	1	3	-	3	-	-	2	-	-
Average	2	1.4	1.4	2.2	1.5	-	3	-	-	2	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(ix)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	-
CO2	3	1	3	2	-
CO3	3	1	3	3	-
CO4	3	1	3	3	-
CO5	3	1	3	3	-
Average	3	1	3	2.4	-

Unit I

Introduction: background and history, overview of AI applications areas.

The predicate calculus: syntax and semantic for propositional logic and FOPL, clausal form, inference rules, resolution and unification.

Knowledge representation: network representation, associative network & conceptual graphs, structured representation, frames & scripts.

Unit II

Search strategies: strategies for state space search, data-driven and goal driven search,

Search algorithms: uninformed search (depth-first, breadth-first, depth-first with iterative deepening) and informed search (hill climbing, best first, A* algorithm, mini-max etc.), computational complexity, properties of search algorithms, admissibility, monotonicity, optimality, dominance.

Unit III

Production system: types of production system-commutative and non-commutative production systems, decomposable and non-decomposable production systems, control of search in production systems.

Rule-based expert systems: architecture, development, managing uncertainty in expert systems, Bayesian probability theory, Stanford certainty factor algebra, nonmonotonic logic and reasoning with beliefs, Fuzzy logic, Dempster/Shaffer and other approaches to uncertainty.

Unit IV

Knowledge acquisition: types of learning, learning by automata, intelligent editors, learning by induction.

Genetic algorithms: problem representation, encoding schemes, operators: selection, crossover, mutation, replacement etc.

Text Books

1. George F. Luger, Artificial Intelligence, Pearson Education.
2. Dan W. Patterson Introduction to Artificial Intelligence and Expert system, PHI.

Reference Books

1. Eugene Charniak, Drew McDermott, Introduction to Artificial Intelligence" Addison Wesley.
2. Wils J. Nilsson, Principles of Artificial Intelligence, Narosa Publishing house.
3. Jackson Peter, Introduction to Expert systems, 3e, Addison Wesley, 2000.

PH-CSE-03(x)Machine Learning									
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Optional Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: the terms of machine learning: types of machine learning, data preprocessing, classification, regression, and neurons.
CO2	explain: learning types, data preprocessing and architecture of ANN.
CO3	apply: training and testing data using data pre processing and model selection techniques and classification, regression, clustering techniques according to their problem.
CO4	Classify: data preprocessing, model selection, major architecture of deep networks;
CO5	compare: data preprocessing techniques, neural network, deep network.

CO-PEO Mapping Matrix for Course PH-CSE-03(x)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(x)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	-	-	-	-	-
CO2	2	1	1	3	1	-	3	-	-	-	-	-
CO3	3	1	1	3	3	-	3	-	-	-	-	-
CO4	2	1	1	3	1	-	3	-	-	-	-	-
CO5	2	1	3	1	3	-	3	-	-	-	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	-	-	-	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(x)					
COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	-
CO2	3	1	3	2	-
CO3	3	1	3	3	-
CO4	3	1	3	3	-
CO5	3	1	3	3	-
Average	3	1	3	2.6	-

Unit I

Basics of Machine Learning: Introduction to artificial Intelligence and machine learning, types of machine learning and its comparisons, applications of machine learning, issues in machine learning.

Unit II

Preparing to Model: Introduction, machine learning activities, types of data in machine learning, exploring structure of data, data pre-processing (dimension reduction and feature subset selection), model selection.

Unit III

Supervised Learning: Introduction, classification (introduction, classification model, learning steps, common classification algorithm), regression (linear regression, multivariable regression, logistic regression).

Unit IV

Unsupervised Learning: Introduction and its applications, techniques in unsupervised learning (clustering, K-means).

Neural Network: Introduction, architecture of artificial neural network.

Text Books

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited.
2. Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press.

Reference Books

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press.
2. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press.
3. Peter Harrington, Machine Learning in Action, Manning Shai Shalev Shwartz and Shai Ben David,
4. Understanding Machine Learning From Theory to Algorithms, Cambridge University Press

PH-CSE-03(xi) Deep Learning

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Optional Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: the terms of machine learning and deep learning, data preprocessing, classification, regression, neural network;
CO2	explain: learning types, data preprocessing and architecture of ANN.
CO3	apply: training and testing data using data preprocessing and model selection techniques and classification, regression, clustering techniques, CNN, RNN, according to their problem.
CO4	classify: data preprocessing, model selection,
CO5	compare: data preprocessing techniques, Supervised and unsupervised learning.

CO-PEO Mapping Matrix for Course PH-CSE-03(xi)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xi)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	-	-	-	-	-
CO2	2	1	1	3	1	-	3	-	-	-	-	-
CO3	3	1	1	3	3	-	3	-	-	-	-	-
CO4	2	1	1	3	1	-	3	-	-	-	-	-
CO5	2	1	3	1	3	-	3	-	-	-	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	-	-	-	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xi)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	-
CO2	3	1	3	2	-
CO3	3	1	3	3	-
CO4	3	1	3	3	-
CO5	3	1	3	3	-
Average	3	1	3	2.6	-

Unit I

Machine Learning Review: Introduction, math behind machine learning (vector, scalars, matrices, statistics, probability), How Machine Learning works: Regression, Classification, Underfitting, overfitting, gradient descent, logistic regression, confusion matrix.

Unit II

Foundation of Deep Learning: neural network, activation function (linear, sigmoid, tanh, softmax), loss function for (notation, regression, classification, recontruction), hyperparameters (learning rate, regularization, momentum, sparsity).

Unit III

Fundamental of Deep Networks: common architectural principles, building block of deep network;
Major architectures of Deep Network: unsupervised pretrained network, generative adversarial network, convolutional neural network, recurrent neural network, recursive neural network;

Unit IV

Building Deep Networks: columnar data and multilayer perceptron, images and CNN, time series sequences and RNN, modeling csv data with multilayer perceptron network, modeling handwritten images using CNN, modeling sequence data using RNN, application of deep learning in NLP.

Text Books

1. Josh Patterson & Adam Gibson, Deep Learning A Practitioner's Approach, O'Reilly Publishers, 2017.
2. Nikhil Buduma, Fundamentals of Deep Learning, O'Reilly, 2017.

Reference Book

1. Ian Goodfellow, Deep Learning (Adaptive, computation and machine learning), The MIT Press, 2016

PH-CSE-03(xii) Data Science

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Optional Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment / Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with the concepts and processes of Data Science including collection, filtering, processing, analysis and visualization.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: data science process, classification of data, big data, web data, sampling, data analysis techniques-correlation, regression, mean, mode, kurtosis, Bayesian inference etc., neural network, fuzzy logic, rule of mining, hadoop, hive, cloud database, and visualization.
CO2	understand and describe: graphical representation of data, storage and retrieval of data, evolution of analytic scalability, sampling distribution, data analysis techniques, Bayesian model and network, induction rule, neural network, fuzzy logic, data mining techniques, data analysis framework and visualization.
CO3	use: data science process, modern data analytic tools, statistical concepts, data analysis techniques, Bayesian network, induction rule, fuzzy logic, data mining techniques, hadoop file system, hive, S3, cloud database, inference and visualization.
CO4	categorize: analytic processes and tools, analysis, reporting, sampling and re-sampling, data analysis techniques, linear and non-linear time series, sequential, temporal and spatial mining, egonets systems and application.
CO5	choose: data science process, data storage, data analytic tools and processes, sampling method, data analysis technique, time series, mining techniques, visual data analysis framework and technique suitable in given situation.

CO-PEO Mapping Matrix for Course PH-CSE-03(xii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xii)												
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	-	-	1	-	-
CO2	2	1	1	3	1	-	3	-	-	1	-	-
CO3	3	1	1	3	3	-	3	-	-	1	-	-
CO4	2	1	1	3	1	-	3	-	-	1	-	-
CO5	2	1	3	1	3	-	3	-	-	1	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	-	-	1	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xii)					
COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	-
CO2	3	1	3	2	-
CO3	3	1	3	3	-
CO4	3	1	3	3	-
CO5	3	1	3	3	-
Average	3	1	3	2.4	-

Unit I

Introduction to Data Science : data science process, exploratory data analysis, collection of data, graphical presentation of data, classification of data, storage and retrieval of data, big data, challenges of conventional systems, web data, evolution of analytic scalability, analytic processes and tools, analysis vs reporting, modern data analytic tools;

Statistical Concepts: sampling distributions, re-sampling, statistical inference, prediction error.

Unit II

Data Analysis: Correlation, regression, probability, Conditional probability, random variables, analysis using mean, median, mode, standard deviation, skewness, kurtosis, regression modeling, multivariate analysis, Bayesian modeling, inference and Bayesian networks, support vector and kernel methods;

Analysis of Time Series: linear systems analysis, nonlinear dynamics.

Unit III

Data Mining Techniques: Rule induction: neural networks: learning and generalization, competitive learning, principal component analysis and neural networks;

Fuzzy Logic: extracting fuzzy models from data, fuzzy decision trees, stochastic search methods, neuro fuzzy modeling,

Association Rule Mining: clustering, outlier analysis, sequential pattern mining, temporal mining, spatial mining, web mining

Unit IV

Data Analysis Frameworks and Visualization: Map Reduce, Hadoop, Hive, sharding, NoSQLdatabases, cloud databases, S3, Hadoop Distributed File Systems, visualizations, visual data analysis techniques, interaction techniques, social network analysis, collective inferencing, Egonets systems and applications.

Text Books

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.

2. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.

Reference Books

1. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & Sons, 2012.
2. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, 2e, Elsevier.
3. Rachel Schutt, Cathy O'Neil, “Doing Data Science”, O'Reilly Publishers, 2013.
4. Foster Provost, Tom Fawcet, “Data Science for Business”, O'Reilly Publishers, 2013.

PH-CSE-03(xiii) Big Data Analytics

Course Type	Course Credits	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Optional Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with different concepts of Big Data and their realization/implementation using Hadoop and Map Reduce tool sets.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: Big Data and Hadoop, digital data, Apache Hadoop, analysing Data with Unix tools and Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, HDFS, Hadoop Ecosystem, Pig, Hive shell and services, HBasics, Big SQL.
CO2	understand and describe: Big Data and Hadoop, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Hadoop Distributed File System, command line interface, job scheduling, shuffle and sort, task execution, Hadoop Ecosystem, Pig, HiveQL, Hbase.
CO3	apply and use: Apache Hadoop, HDFC,HBasic, Big Data and Hadoop,HDFS command line interface, Hadoop file system interfaces, data flow, Hive services.
CO4	classify: Big Data and Hadoop, Big Data Analytics, Apache Hadoop, HDFS ,Hive shell, Hive services.
CO5	Compare feature set of Pig, Hadoop, HDFS.

CO-PEO Mapping Matrix for Course PH-CSE-03(xiii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xiii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	-	-	1	-	-
CO2	2	1	1	3	1	-	3	-	-	1	-	-
CO3	3	1	1	3	3	-	3	-	-	1	-	-

CO4	2	1	1	3	1	-	3	-	-	1	-	-
CO5	2	1	3	1	3	-	3	-	-	1	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	-	-	1	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xiii)

COs	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	1	3	1	-	
CO2	3	1	3	2	-	
CO3	3	1	3	3	-	
CO4	3	1	3	3	-	
CO5	3	1	3	3	-	
Average	3	1	3	2.4	-	

Unit I

Introduction to Big Data and Hadoop**,** Types of digital data, introduction to Big Data,Vs of Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy,Big Data applications.

Unit II

HDFS (Hadoop Distributed File System), design of HDFS, HDFS concepts, command line interface, Hadoop file system interfaces, data flow, data ingest with flume and Scoop and Hadoop archives, Hadoop I/O: compression, serialization, Avro and file-based data structures.

Unit III

Map Reduce: Anatomy of a Map Reduce job run, failures, job scheduling, shuffle and sort, task execution, Map Reduce types and formats, Map Reduce features.

Unit IV

Hadoop Ecosystem, Introduction to Pig, execution modes of Pig, comparison of Pig with databases, grunt, Pig latin, user defined functions, data processing operators. Hive, Hive shell, Hive services, Hive metastore, comparison with traditional databases, HiveQL, tables, querying data and user defined functions.

Text Books

1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'Reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics", Wiley 2015.
3. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", MC Press

Reference Books

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
3. Anand Rajaraman and Jeffrey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.

PH-CSE-03(xiv) Wireless Networks

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Optional Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study fundamental concepts in wireless network, various LAN standards, IP and IPV6 Layer, Transmission protocols and WAN standards.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: wireless LAN, architecture, mobile network layer, mobile transport layer and wireless wide area network.
CO2	describe: WLAN technologies, IEEE 802.11 types , IEEE 802.16, Bluetooth, IPV6, mobile ad-hoc network, TCP enhancements for wireless network, UTMS, 3G-MSC, 3G-SGSN, 3G-GGSN, applications of 4G, features and challenges of 5G.
CO3	illustrate: wireless LAN, system architecture, physical layer, Mac layer, Bluetooth architecture, mobile IP, mobile ad-hoc network, mobile transport layer, TCP improvements, wireless wide area network, HSDPA, features and challenges of 4G, 5G.
CO4	analyze: WLAN technologies, 802.11b, 802.11a, IEEE 802.16, IPV6, Routing, TCP enhancements, TCP improvements, UMTS core network architecture, firewall, 3G, 4G and 5G networks.
CO5	compare: different Wireless LAN technologies, mobile network layer, mobile transport layer, Mobile IP, mobile ad-hoc networks, protocols, TCP improvements and wireless WAN types.

CO-PEO Mapping Matrix for Course PH-CSE-03(xiv)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xiv)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	1	-	2	-	-
CO2	2	1	1	3	1	-	3	2	-	2	-	-
CO3	3	1	1	3	3	-	3	3	-	2	-	-
CO4	2	1	1	3	1	-	3	3	-	2	-	-
CO5	2	1	3	1	3	-	3	3	-	2	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	2.4	-	2	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xiv)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	-
CO2	3	2	3	2	-
CO3	3	2	3	3	-
CO4	3	2	3	3	-
CO5	3	2	3	3	-
Average	3	2	3	2.4	-

Unit I

Wireless LAN: Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum - IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security - IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX.

Unit II

Mobile Network Layer: Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6- Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing.

Unit III

Mobile Transport Layer :TCP enhancements for wireless protocols, Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP, TCP over 3G wireless networks.

Unit IV

Wireless Wide Area Network: Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)- LTE network architecture and protocol, features and challenges of 4G, Applications of 4G, Introduction to 5G vision,5G features and challenges.

Text Books

1. Jochen Schiller, ”Mobile Communications”, 2e, Pearson Education 2012.
2. Vijay Garg, “Wireless Communications and Networking”, 1e, Elsevier, 2007.

Reference Books

1. William Stallings, Wireless Communications and Networks, Pearson/Prentice Hall of India.
2. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", 2e, Academic Press, 2008.
3. Anurag Kumar, D. Manjunath, Joy Kuri, "Wireless Networking", 1e, Elsevier 2011.
4. Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications", 1e, Pearson Education, 2013.

PH-CSE-03(xv) Network Security

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
Optional Theory	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment(s)/ Attendance
					20	5 5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study fundamental concepts in Network Security, security attack, cryptography, authentication, web security, system and email security.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: computer security, security standards, cipher model, encryption techniques, data encryption standards, public-key cryptography, security at transport layer, SSL/TSL attacks, wireless security and IEEE 802.11i.
CO2	explain: computer concepts related with the security, symmetric techniques, advanced encryption standard, RSA, concept of digital signature, security protocols, wireless security measures and email security.
CO3	illustrate: the different features related with computer security, encryption and symmetric techniques, data encryption standards, security at transport layer and wireless LAN security.
CO4	classify: the information about security, its architecture, types of attacks, security mechanism, encryption standards, protocols at transport layer and wireless LAN security.
CO5	evaluate:the security trends, security mechanisms, cipher model, RSA, Diffie-Hellman key exchange, transport layer security, SSL/TSL attacks, wireless security and IP security.

CO-PEO Mapping Matrix for Course PH-CSE-03(xv)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xv)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	1	-	2	-	-
CO2	2	1	1	3	1	-	3	2	-	2	-	-
CO3	3	1	1	3	3	-	3	3	-	2	-	-

CO4	2	1	1	3	1	-	3	3	-	2	-	-
CO5	2	1	3	1	3	-	3	3	-	2	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	2.4	-	2	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xv)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	-
CO2	3	2	3	2	-
CO3	3	2	3	3	-
CO4	3	2	3	3	-
CO5	3	2	3	3	-
Average	3	2	3	2.4	-

Unit I

Computer Security Concepts – Introduction, security, security trends, components of information system, OSI security architecture, security attacks, goals for security, security mechanisms, security standards.

Cipher model, cryptanalysis and brute-force attack, classical encryption techniques – symmetric techniques – substitution techniques, transposition techniques, rotor machines, steganography.

Unit II

Traditional block cipher, data encryption standard, encryption and decryption, advanced encryption standard, structure and expansion functions.

Public-key cryptography, principles, applications and requirements, RSA, Diffie-Hellman key exchange. Concept of digital signature.

Unit III

Security at Transport Layer, web security considerations, Transport Layer Security, TLS record protocol, change cipher spec protocol, alert protocol, handshake protocol, heart-beat protocol; SSL/TSL attacks; HTTPS; Secure shell; user authentication protocol, connection protocol.

Unit IV

Wireless Security, wireless security measures, mobile device security - threats and strategy.

Wireless LAN security, IEEE 802.11i - services, operation and phases.

Email security, S/MIME, PGP, overview of IP security.

Text Books

1. William Stallings, Cryptography And Network Security Principles And Practice, Pearson Education
2. Forouzan, Mukhopadhyay, Cryptography & Network Security, McGraw Hill

Reference Book

1. Atul Kahate, Cryptography and Network Security, TMH Godbole,
2. Information Systems Security, Wiley India Mark Stamp, Information Security Principles and Practice, Willy India

PH-CSE-03(xvi) Cloud Computing

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
Compulsory Theory	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study the fundamental concepts of cloud computing, its enabling technologies, cloud service models and security concerns, to learn core issues of Internet of Things, IOT communication protocols and security concerns.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define cloud computing: evolution, characteristics, working, service models, virtualization, architecture, security challenges and risks.
CO2	understand and describe cloud computing: evolution, characteristics, working, service models, virtualization, architecture, security challenges and risks.
CO3	use: cloud computing services in different fields of applications.
CO4	classify: cloud computing: service models, service-oriented architecture.
CO5	compare cloud computing: service models. virtualization, and hypervisors.

CO-PEO Mapping Matrix for Course PH-CSE-03(xvi)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xvi)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	1	-	2	-	-
CO2	2	1	1	3	1	-	3	2	-	2	-	-
CO3	3	1	1	3	3	-	3	3	-	2	-	-
CO4	2	1	1	3	1	-	3	3	-	2	-	-
CO5	2	1	3	1	3	-	3	3	-	2	-	-
Average	2	1.4	1.4	2.2	1.8	-	3	2.4	-	2	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xvi)					
COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	-
CO2	3	3	3	2	-
CO3	3	3	3	3	-
CO4	3	3	3	3	-
CO5	3	3	3	3	-
Average	3	3	3	2.4	-

UNIT I

Introduction, Essentials, Benefits and need for Cloud Computing, Business and IT Perspective, Cloud and Virtualization, Cloud Services Requirements, Cloud and Dynamic Infrastructure, Cloud Computing Characteristics Cloud Adoption. Cloud Characteristics, Measured Service, Cloud Models, Security in a Public Cloud Public versus Private Clouds, Principal Technologies, Cloud Strategy Cloud Design and Implementation using SOA, Conceptual Cloud Model, Cloud Service.

UNIT II

Cloud Solutions**,** Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management, Cloud Stack, Computing on Demand (CoD), Cloud sourcing, Cloud Offerings, Information Storage, Retrieval, Archive and Protection, Cloud Analytics Testing under Cloud, Information Security, Cloud Governance, High Availability and Disaster Recovery, Charging Models, Usage Reporting, Billing and Metering.

UNIT III

Virtualization, Benefits, Server Virtualization, Virtualization for x 86 Architecture, Hypervisor Management Software, Logical Partitioning (LPAR), VIO Server, Virtual Infrastructure Requirements, Storage virtualization, Storage Area Networks, Network-Attached storage, Cloud Server Virtualization, Virtualized Data Centre.

UNIT IV

SOA Journey to Infrastructure, SOA and Cloud, SOA Defined, SOA and IaaS, SOA-based Cloud Infrastructure Steps, SOA Business and IT Services, OLTP Benchmark, Business Intelligence Benchmark, e-Business Benchmark, ISV Benchmarks, Cloud Performance Data Collection and Performance Monitoring Commands, Benchmark Tools.

Text Books

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing a Practical Approach, Tata McGraw Hill, New Delhi, 2010
2. Robert Elsenpeter, Toby J. Velte, Anthony T. Velte, Cloud Computing: A Practical Approach, 1e, Tata McGraw Hill Education, 2011.
3. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, Cloud Computing for Dummies, Wiley Publishing, 2010

Reference Books

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing- Principles and Paradigms, Wiley, 2011.
2. Raj Kamal, Internet of Things-Architectures and Design Principles, McGraw Hill Education, 2017.

PH-CSE-03(xvii) Internet of Things

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
Compulsory Theory	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study the fundamental concepts of cloud computing, its enabling technologies, cloud service models and security concerns, to learn core issues of Internet of Things, IOT communication protocols and security concerns.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: framework, architecture, design, communication challenges, applications, principles of web connectivity.
CO2	understand and describe: framework, architecture, design, communication challenges, applications, principles of web connectivity.
CO3	use: for Wireless Technologies and Applications of IoT in various fields
CO4	classify: framework, architecture, physical and logical design.
CO5	compare: communication challenges, security issues, enabling technologies, application areas, and protocols.

CO-PEO Mapping Matrix for Course PH-CSE-03(xvii)

COs	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	1	3	1	3	3
CO2	2	3	1	3	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3
Average	2.4	3	1	3	3

CO-PO Mapping Matrix for Course PH-CSE-03(xvii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	1	1	-	3	1	-	2	-	-
CO2	2	1	1	3	1	-	3	2	-	2	-	-
CO3	3	1	1	3	3	-	3	3	-	2	-	-
CO4	2	1	1	3	1	-	3	3	-	2	-	-
CO5	2	1	3	1	3	-	3	3	-	2	-	-

Average	2	1.4	1.4	2.2	1.8	-	3	2.4	-	2	-	-

CO-PSO Mapping Matrix for Course PH-CSE-03(xvii)

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	-
CO2	3	3	3	2	-
CO3	3	3	3	3	-
CO4	3	3	3	3	-
CO5	3	3	3	3	-
Average	3	3	3	2.4	-

UNIT I

Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.

UNIT II

Sensors Networks : Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.

UNIT III

Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

UNIT IV

Data Handling & Analytics: Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications, Applications of IoT, Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

Text Books

1. Hakima Chaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN: 978-1- 84821-140-7, Wiley Publications
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", Wiley Publications
3. Vijay Madisetti and ArshdeepBahga, — "Internet of Things (A Hands-on-Approach)", First Edition, VPT, 2014.
4. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.

References Books

1. Daniel Minoli, — "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publications
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.

RPE-04 (Research and Publication Ethics)

Credits: 2 **Marks: 50**

Time: 3 Hrs. **Theory: 30 IA: 20**

Note: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

UNIT-I

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP), Redundant publication: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data

UNIT-II

Publication ethics: definition, introduction and importance, Best practices standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals, Open access publications and initiatives, SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies.

UNIT-III

Software tool to identify predatory publications developed by SPPU, Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Suggester, etc., Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Use of plagiarism software like Turnitin, Ouriginal/Urkund, Viper, iThenticate and other open source software tools

UNIT-IV

Indexing databases; Citation databases: Web of Science, Scopus, Pubmed, ICI etc., Impact Factor of journal as per Journal Citation Reports. SNIP, SJR, IPP: Cite Score, Metrics: h-index, g index, i10 index, altmetrics.

Text Books

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865

Reference Books

1. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
2. Resnik, D. B. (2011). What is ethics in research & why is it Important. National Institute of Environmental Health Sciences, 1-10.https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
3. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
4. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019). ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics Book.pdf