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शिवाजी विद्यापीठ, कोल्हापूर ४१६ ००४, महाराष्ट्र
दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४. २६०९४८७
वेबसाईट : www.unishivaji.ac.in ईमेल : bos@unishivaji.ac.in

Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SU/BOS/Sci & Tech/ 183 **Date: 10/06/2026**

The Principal / Director,
All Concerned Affiliated Colleges / Institutions,
Shivaji University, Kolhapur.

Subject: Regarding revised syllabus of **B. Tech.** degree **Programme (Affiliated Colleges)** under the Faculty of Science and Technology as per NEP 2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, Nature of Question paper and equivalence of B. Tech. degree programme under the Faculty of Science & Technology as per National Education Policy 2020 (NEP 2020).

Sr. No.	B. Tech Course Syllabus	
1	Civil Engineering	Part-III
2	Mechanical Engineering	Part-III
3	Mechanical and Mechatronic Engineering (Additive Manufacturing)	Part-III
4	Electrical Engineering	Part-III
5	Electrical and Computer Engineering	Part-III
6	Electronics and Telecommunication Engineering	Part-III
7	Electronics & Computer Science Engineering	Part-III
8	Computer Science and Engineering	Part-III
9	Computer Science and Engineering (Artificial Intelligence & Machine Learning) (AIML)	Part-III
10	Computer Science and Engineering (Data Science) (DS)	Part-III
11	Computer Science and Engineering (Artificial Intelligence & Data Science) (AIDS)	Part-III
12	Electronics and communication Engineering (Bio-Medical Engineering)	Part-II

This Syllabus, nature of question and equivalence shall be implemented from the academic year **2026-27** onwards. A soft copy containing the syllabus is attached herewith and it is available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP-2020.**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October/ November 2026 & March / April 2027. These chances are available for repeater students, if any

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy. Registrar

Copy to: for Information and necessary action

1	The I/c Dean, Faculty of Science & Technology	7	Appointment A & B Section
2	Director, Board of Examinations & Evaluation	8	Affiliation (T.1) (T.2) Section
3	The Chairperson, Respective Board of Studies	9	P.G.Admission Section,
4	Other Exam 4 Section,	10	P.G Seminar Section
5	Eligibility Section,	11	Computer Centre/ IT Cell
6	Internal Quality Assurance Cell (IQAC)		

Shivaji University
Kolhapur

Revised Syllabus
as per
National Education Policy-2020
(NEP-2.0)

T.Y.B.Tech.
Computer Science and Engineering (Data Science)

To be implemented from

Academic Year 2026-27

Exit Course for Computer Science and Engineering (Data Science) After 2nd Year

Exit option: Award of UG Diploma in Major with 88 credits and an additional 8 credits from following Exit Courses				
Sr. No	**Course Code**	**Course Title**	**Mode**	**Credits**
1	DS-EC-03	UI/UX Design	Online/offline certification Course or project of total 8 credits	8
		OR		
2	DS-EC-04	DevOps Engineering		8

SCHEME OF INSTRUCTION & SYLLABI

Name of Programme: Computer Science and Engineering(Data Science)

Scheme of Instructions: Third Year B.Tech. Computer Science and Engineering(Data Science)

SEMESTER V

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/ Wk	Course Credits	EXAMSCHEME			
									MSE	ISE/CA	ESE	TOTAL
1	PCC	DS3101	Artificial Intelligence	3	--	--	3	3	30	10	60	100
2	PCC	DS3102	Database Engineering	3	--	--	3	3	30	10	60	100
3	PCC	DS3103	Information Security	3	--	--	3	3	30	10	60	100
4	PEC	DS3104	Elective-I	3	--	--	3	3	30	10	60	100
5	MDM	DS3105	Multi-disciplinaryMinor–03	3	--	--	3	3	30	10	60	100
6	OE	DS3106	Open Elective-03	2	--	--	2	2	30	10	60	100
7	PCC	DS3107	Database Engineering Lab	--	--	1	2	1	--	25	25	50
8	PCC	DS3108	Java Programming Lab	--	--	1	2	1	--	25	25	50
9	PEC	DS3109	Elective-I Lab	--	--	1	2	1	--	25	--	25
10	MDM	DS3110	Multi-disciplinaryMinor–03Lab	--	--	1	2	1	--	50	--	50
11	EL	DS3111	Business English	--	--	1	2	1	--	25	--	25
			Total	**17**	**--**	**05**	**27**	**22**	**180**	**210**	**410**	**800**

L-Lecture T-Tutorial P-Practical

MSE-MidSemesterExaminationISE/CAInSemesterEvaluation/ContinuousAssessmentESE-End Semester Examination (For Laboratory End Semester performance)

Course Category	Basic Science Coues(BSC)	Engineering Science Courses(ESC)	Programme Core Course(PCC)	Programme Elective Course (PEC)	Open Elective other than particular programme (OE/MDM)	Vocational and Skill Enhancement Course(VSEC)	Humanities Social Science and Management(HSSM)	Experiential Learning(EL)	Co-curricular and Extra curricular Activities (CCA)
Last Sem.Cumulativesum	**16**	**22**	**20**	**--**	**10**	**04**	**12**	**02**	**02**
SemesterCredits	**--**	**--**	**11**	**4**	**06**	**--**	**-**	**01**	**--**
CumulativeSum	**16**	**22**	**31**	**4**	**16**	**04**	**12**	**03**	**02**

PROGRESSIVE TOTAL CREDITS: 88+22=110

SCHEME OF INSTRUCTION & SYLLABI

Name of Programme: Computer Science and Engineering (Data Science)

Scheme of Instructions: Third Year B.Tech. Computer Science and Engineering (Data Science)

Semester-VI

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/Wk	Course Credits	EXAM SCHEME			
									MSE	ISE/CA	ESE	TOTAL
1	PCC	DS3201	Advanced Database Systems	3	--	--	3	3	30	10	60	100
2	PCC	DS3202	Data Mining & Data Warehousing	3	1	--	4	4	30	10	60	100
3	PCC	DS3203	Feature Engineering	3	--	--	3	3	30	10	60	100
4	PEC	DS3204	Elective -II	3	--	--	3	3	30	10	60	100
5	PEC	DS3205	Elective -III	3	--	--	3	3	30	10	60	100
6	MDM	DS3206	Multi-disciplinary Minor-04	2	--	--	2	2	30	10	60	100
7	PCC	DS3207	Advanced Database Systems Lab	--	--	1	2	1	--	50	25	75
8	PCC	DS3208	R Programming Lab	--	--	1	2	1	--	50	25	75
9	EL	DS3209	Software Testing Tools	--	--	2	4	2	--	50	--	50
			Total	**17**	**1**	**4**	**26**	**22**	**180**	**210**	**410**	**800**

L-Lecture T-Tutorial P-Practical

MSE-MidSemesterExaminationISE/CA-InSemesterEvaluation/ContinuousAssessment ESE-End Semester Examination (For Laboratory End Semester performance)

Course Category	Basic Science Courses (BSC)	Engineerig Science Courses (ESC)	Programme Core Course (PCC)	Programme Elective Course (PEC)	Open Elective other than Particular programme (OE/MDM)	Vocational and Skill Enhancement Course (VSEC)	Humanities Social Science and Management (HSSM)	Experiential Learning (EL)	Co-curricular and Extra-curricular Activities (CCA)
Last Sem. Cumulative sum	**16**	**22**	**31**	**04**	**16**	**04**	**12**	**03**	**02**
Semester Credits	--	--	**12**	**06**	**02**	--	--	**02**	--
Cumulative Sum	**16**	**22**	**43**	**10**	**18**	**04**	**12**	**05**	**02**

PROGRESSIVE TOTAL CREDITS : 110+22=132

PCC DS3101 –Artificial Intelligence

Lectures	**:**3Hrs/Week	**Evaluation Scheme**
Credit	**:**3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite::Basic Programming in Python, Data Structure

Course Objectives:

1. To impart artificial intelligence principles, techniques, and its history.
2. To assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving engineering problems.
3. To develop intelligent systems by assembling solutions to concrete computational problems.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Evaluate Artificial Intelligence (AI) methods and describe their foundations.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.
3. Demonstrate knowledge of reasoning and knowledge representation for solving real world problems.
4. Analyze and illustrate how search algorithms play vital role in problem solving.
5. Illustrate the construction of learning and expert system.
6. Discuss current scope and limitations of AI and societal implications.

Unit No.	Unit Name and Contents	No. of Lectures
1.	**Artificial Intelligence and Its Issues**: Definitions - Importance of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment, Knowledge Inferring systems and Planning, Uncertainty and towards Learning Systems	06
2.	**Overview to Problem Solving & Heuristic Search**: Problem solving by Search, Problem space - State space, Blind Search - Types, Performance measurement. Types, Game playing mini-max algorithm, Alpha-Beta Pruning.	07
3.	**Probabilistic Reasoning & Markov Decision process**: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model. MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.	08
4.	**Learning Systems & Expert Systems**: Forms of Learning Types - Supervised, Unsupervised, Reinforcement Learning, Learning Decision Trees. Expert Systems - Stages in the development of an Expert System - Probability based Expert Systems - Expert System Tools - Difficulties in Developing Expert Systems - Applications of Expert Systems.	07
5.	**Reinforcement Learning**: Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.	07
6.	**AI with Python**: Study of important inbuilt libraries of Python like NumPy, SciPy, matplotlib, nltk, Simple AI. Installing Python. Setting up PATH. Running Python. Study of real time applications of AI with Python, Case Studies: AI Platforms-Azure ML, Google AI, Swift AI, Tensorflow.	07

TEXT BOOKS:

1 Artificial Intelligence - A Modern Approach- Russell, S. and Norvig, P.- 3rd edition, Prentice Hall.2015
2. Artificial Intelligence: Foundations of Computational Agents- Poole, D. and Mackworth, A.- Cambridge University Press.2010

REFERENCE BOOKS:

1. Artificial Intelligence, Ric, E., Knight, K and Shankar, B. Tata McGraw Hill.2009 3rd edition
2. Artificial Intelligence - Structures and Strategies for Complex Problem Solving Luger, G.F. 6th edition, Pearson.2008
3. Knowledge Representation and Reasoning Brachman, R. and Levesque, H. Morgan Kaufmann.2004
4. Artificial Intelligence with Python: A Comprehensive Guide to Building Intelligent Apps for Python Beginners and Developers Prateek Joshi Packt publication January 2017 Edition
5. Reinforcement Learning: An Introduction Sutton R.S. and Barto, A.G. MIT Press.1998
6. Artificial Intelligence and Intelligent Systems Padhy, N.P. Oxford University Press.2009

PCC DS3102 –Database Engineering

Lectures	**:**3Hrs/Week	**Evaluation Scheme**
Credit	**:**3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Basic Mathematics

Course Objectives:

1. To understand fundamental concepts and algorithms of Database Systems.
2. To gain familiarity with SQL and DBMS.
3. To learn database design techniques.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Understand fundamentals of database management systems.
2. Represent logical design of database using E-R Diagram.
3. Analyze & construct good database design.
4. Apply SQL queries to design & manage the database.
5. Understand transactions, concurrency control and apply to database system.
6. Understand failures in database and appropriate recovery techniques.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Unit I :Introduction to DBMS** Introduction, Traditional file system v/s DBMS, views of data, instance and schema, Data Models – Relational and ER model, Keys, Database design process, Schema diagram, Extended E-R Features- Specialization, Generalization and Aggregation, Database system structure, Database users. Relational algebra, Tuple relational calculus, Domain relational calculus.	07
2	**Unit II: Structured Query Language** Introduction to SQL, data types. DDL Statements – Create, Alter, Drop, Rename, Truncate. DML Statements- Select, Insert, Update, Delete. DCL Statements – Commit, Rollback. Aggregate functions, Group by clause, having clause, order by clause, set operations, Joins, Nested Queries, Views PL/SQL- Functions, Procedures, Triggers, Cursors	07
3	**Unit III: Functional Dependency and Normalization** Integrity constraints – domain constraints, referential integrity, Pitfalls in Relational-Database Design, Functional dependency, types of functional dependency, closure of set of functional dependency, Closure of Attribute Sets, canonical cover. Normalization – Purpose of normalization, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form(3NF), Boyce-Codd Normal Form (BCNF), Fourth Normal Form (4NF), Fifth Normal Form (5NF)	06
4	**Unit IV: Data Storage & Indexing** File organization, Organization of records in file, Buffer Management. Indexing – Ordered indices – primary indices, secondary indices, dense and sparse indices, multilevel indexing, B tree indexing, B+ tree indexing and multiple key access. Hashing – static hashing – open hashing, closed hashing, dynamic hashing,Bitmap indices.	07
5	**Unit V: Transaction Processing and Concurrency Control** Transaction Processing – Concept, ACID properties, Transaction model, Schedule, Serializability – conflict and view Serializability, Recoverable schedule. Concurrency Control Mechanisms – Lock based protocols, Multiple Granularity, Timestamp based protocols, Thomas's Write Rule, Validation based protocols	08
6	**Unit VI: Deadlock Handling and Data Recovery** Deadlock Handling – Deadlock prevention, deadlock detection and deadlock recovery. Data Recovery – Failure Classification, Storage, Log based recovery.	07

Text Books:

1. “Database System Concepts”, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, 6th edition, McGraw- Hill.
2. “Database Systems - A Practical Approach to Design, Implementation and Management”, Thomas Connolly, Carolyn Begg, 4th Edition, Addison Wesley.
3. “MySQL Cookbook”, Paul DuBois, 3rd edition, O’REILLY.

References Books:

1. “Fundamentals of Database Systems”, Ramez, Elmasri, Shamkant B. Navathe, 6th Edition, Addison Wesley.
2. “Database Systems – Design, Implementation and Management”, Rob & Coronel, 5th Edition, Thomson Course Technology.

PCC DS3103-Information Security

Lectures	**:**3Hrs./Week	**Evaluation Scheme**
Credit	**:**3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Computer Network, Modular Arithmetic &Number Theory, C / C++

Course Objectives:

1. To introduce the principles of Crypto-Systems.
2. To expose students to various security services and mechanisms used.
3. To make the students aware of the security features of PGP, S/MIME, Digital Signatures, IPSec& SSL.
4. To make the students understand the system level security issues concerning threats, intruders and use of firewalls and trusted systems.
5. To make students to explore non-cryptographic and software vulnerabilities

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Understand principles of Crypto-systems.
2. Compare and analyze various security services and mechanisms.
3. Apply and use the features of PGP, S/MIME, DSA, IPSec, SSL in their profession.
4. Take precautions of their personal computing system from possible threats and attacks.
5. Explore newer vulnerabilities and provide the solutions to them

Unit No.	Unit Name and Contents	No. of Lectures
1.	**Classical Encryption Techniques and DES**: The OSI Security Architecture, Symmetric Cipher Models: Substitution Techniques, Transposition Techniques, Block Cipher Principles, The Data Encryption Standard.	7
2	**Public-Key Cryptosystems, Key Management and Authentication** : Principles of Public-Key Cryptosystems, The RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Authentication requirements, Authentication functions, MAC and Hash functions and their requirements	8
3	**Digital Signatures and Authentication Applications**: Digital Signature, Digital Signature Standard, Authentication applications - Kerberos, X.509 Authentication service.	6
4	**Electronic mail and IP security**: Email Security - PGP, S/MIME, IP Security-IP Security Architecture, Authentication Header and Encapsulating Security Payload.	6
5	**Web and System Security**: Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction, Intruders, Intruder Detection, Password Management, Firewall Design Principles, Trusted Systems.	8
6	**Non-Cryptographic Protocol Vulnerabilities**: DoS and DDoS, Session Hijacking and Spoofing, Pharming attacks. Software Vulnerabilities - Phishing, Buffer Overflow, Format String attacks, SQL Injection	7

Text Books:

1 Cryptography and Network Security William Stallings Pearson Edition (Unit I to V)
2 Network Security and Cryptography Bernard Menezes Cengage Learning Unit –VI

Reference Books:

1 Cryptography and network security Atul Kahate TMGH
2 Cryptography and Network Security B. A. Forouzan TMGH
3 Network Security Know it All Joshi et. al Morgan Kaufmann Publications

PEC DS3104-Elective-01

1. Machine Learning

Lecture	**:**3 Hrs./Week	**Evaluation Scheme**
Credit	**:**3	**MSE:**30 Marks
		ISE/CA:10Marks
		ESE : 60 Marks

Prerequisite: Linear Algebra, Statistics, Probability Theory.

Course Objectives:

1. To understand Machine Learning Aspects.
2. To understand primitives in learning process by Computer.
3. To understand nature of problems solved with Machine Learning.

Course Outcomes:

On completion of the course, student will be able to

1. Explain Machine Learning concepts.
2. Analyze the Machine Learning model.
3. Design solution using Machine Learning techniques.
4. To tackle real world problems in domain of data mining, information retrieval, computer vision, linguistics and bioinformatics, etc

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction to Machine Learning**: Definition, Terminology, Types of learning, Machine Learning Problem categories, Machine learning architecture, process, Lifecyle, Performance measures, tools and framework, data visualization	07
2	**Regression**: Simple regression – hypothesis, cost function, parameter learning with gradient descent, learning rate, Gradient Descent for linear regression, examples, simple regression in matrix form. Multivariate Linear Regression – multiple features, hypothesis functions, Gradient Descent for multiple variables, Feature scaling, polynomial regression.	07
3	**Classification- logistic regression & Naïve Bayes** : Definition, logistic regression – hypothesis representation, decision boundary, cost function, gradient descent for logistic regression. multiclass classification, Regularization - Overfitting & Underfitting, cost function, Regularized Linear Regression, Regularized Logistic Regression Neural Networks- Neuron representation and model, Hypothesis for neuron, cost function, solution of a problem using single neuron. Gradient descent for a neuron. Neural network, Multiclass classification with neural network. Learning in neural network-back propagation algorithm.	08
4	**Classification- Decision trees and Naïve Bayes Decision trees**: definition, terminology, the need, advantages, and limitations. Constructing and understanding Decision trees, common problems with Decision trees, Decision tree algorithms, random forest, and examples. Conditional probability and Naïve Bayes Classifier Instance-based classifier – K- Nearest Neighbors Classifier	07
5	**Unsupervised learning** : Clustering, K Means clustering, Hierarchical clustering, Association	07

	Rule mining	
6	**Introduction to Graphical Models-** Bayesian Networks, Markov Random Field (MRF), Hidden Markov Model, Training HMM: Viterbi, Baum-welch algorithm	06

Text Books

1. Machine Learning with Python- an approach to applied ML, by Abhishek Vijayvargia, BPB publications
2. Practical Machine Learning by Sunila Gollapudi Packt Publishing Ltd
3. Machine Learning by Tom M. Mitchell, McGraw Hill Education; First edition

Reference Books

1. Machine Learning for dummies John Paul Muller, Willey Publication
2. EthemAlpaydin : Introduction to Machine Learning, PHI 2nd Edition-2013

References:

1. http://neuralnetworksanddeeplearning.com/.

PEC DS3104- Elective-01
2. Advanced Computer Networks

Lecture	**:** 3 Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE:** 30 Marks
		ISE/CA: 10Marks
		ESE: 60 Marks

Prerequisite: Computer Networks
Course Objectives:

1. To provide in-depth understanding of computer network architecture, Internet structure, networking models (OSI, TCP/IP), networking devices, and packet-switched network performance parameters.
2. To analyze link-layer and network-layer protocols**,** including error control, multiple access mechanisms, routing algorithms, congestion control, and internetworking techniques.
3. To explain Internet addressing, transport, and application-layer protocols, enabling the design and implementation of end-to-end communication and network applications.
4. To expose learners to advanced networking concepts, including wireless and mobile networks, optical networks, VPNs, multimedia networking, ad-hoc networks, and sensor networks.

Course Outcomes:
Upon successful completion of this course, the student will be able to –
1: Explain the structure and functioning of the Internet, networking models, protocols, and networking devices, and analyze performance issues such as delay, loss, and throughput.

2: Analyze and compare link-layer and network-layer mechanisms including error detection, multiple access protocols, routing algorithms, congestion control, and LAN technologies.

3: Design and implement network-based applications using transport and application-layer protocols such as TCP, UDP, HTTP, FTP, DNS, and socket programming.

4: Evaluate advanced networking technologies such as wireless and mobile networks, optical networks, VPNs, MPLS, multimedia networking, ad-hoc networks, and wireless sensor networks for real-world applications.

Unit No.	Unit Name and Contents	No. of Lectures
1.	**UNIT I- Computer Networks and the Internet**: What is the Internet, The Network edge, The Network core, Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss in Packet-Switched Networks, History of Computer Networking and the Internet - Foundation of Networking Protocols: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing, Equal-Sized Packets Model: ATM - Networking Devices: Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure.	07
2.	**UNIT II- The Link Layer and Local Area Networks**: Link Layer: Introduction and Services, Error-Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization - Routing and Internetworking: Network–Layer Routing, Least-Cost-Path algorithms, Non-Least-Cost-Path algorithms,	08

	Intradomain Routing Protocols, Interdomain Routing Protocols, Congestion Control at Network Layer	
3.	**UNIT III- Logical Addressing**: IPv4 Addresses, IPv6 Addresses - Internet Protocol: Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6 – Multicasting Techniques and Protocols: Basic Definitions and Techniques, Intradomain Multicast Protocols, Interdomain Multicast Protocols, Node-Level Multicast algorithms - Transport and End-to-End Protocols: Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control – Application Layer: Principles of Network Applications, The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System (DNS), P2P File Sharing, Socket Programming with TCP and UDP, Building a Simple Web Server	08
4.	**UNIT IV- Wireless Networks and Mobile IP**: Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standard, Cellular Networks, Mobile IP, Wireless Mesh Networks (WMNs) - Optical Networks and WDM Systems: Overview of Optical Networks, Basic Optical Networking Devices, Large-Scale Optical Switches, Optical Routers, Wavelength Allocation in Networks, Case Study: An All-Optical Switch	08
5.	**UNIT V - VPNs, Tunneling and Overlay Networks**: Virtual Private Networks (VPNs), Multiprotocol Label Switching (MPLS), Overlay Networks – VoIP and Multimedia Networking: Overview of IP Telephony, VoIP Signaling Protocols, Real-Time Media Transport Protocols, Distributed Multimedia Networking, Ad-Hoc Networks, Routing in Ad-Hoc Networks, Routing Protocols for Ad-Hoc Networks –	06
6.	**UNIT V - Mobile Ad-Hoc Networks**: Stream Control Transmission Protocol - Mobile Ad-Hoc Networks: Overview of Wireless Ad-Hoc Wireless Sensor Networks: Sensor Networks and Protocol Structures, Communication Energy Model, Clustering Protocols, Routing Protocols	05

TEXT BOOKS:

1. Computer Networking: A Top-Down Approach Featuring the Internet, James F. Kurose,Keith W.Ross, Third Edition, Pearson Education, 2007
2. Computer and Communication Networks, Nader F. Mir, Pearson Education, 2007.

REFERENCE BOOKS:

1. Data Communications and Networking, Behrouz A. Forouzan, Fourth Edition, TataMcGraw Hill, 2007
2. Guide to Networking Essentials, Greg Tomsho,Ed Tittel, David Johnson,Fifth Edition,Thomson.
3. An Engineering Approach to Computer Networking , S.Keshav, Pearson Education.
4. Campus Network Design Fundamentals, Diane Teare, Catherine Paquet, PearsonEducation (CISCO Press)
5. Computer Networks, Andrew S. Tanenbaum, Fourth Edition, Prentice Hall.
6. The Internet and Its Protocols, A. Farrel, Elsevier.

PEC DS3104- Elective-01

3. Internet of Things

Lectures	**:**3Hrs/Week	**Evaluation Scheme**
Credit	**:**3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite:: Knowledge of Computer Networking, Knowledge of Micro Processors, Micro Controllers, Knowledge of Programming languages such as C, Assembly level.

Course Objectives:

1. To learn basic concepts of Internet of Things (IoT) Technology
2. To become familiar with the basics of RFID, sensor and GPS technologies
3. To Analyze and choose different wireless technologies and IoT applications.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Explain key concepts and terminologies related to Internet of Things (IoT).
2. Compare different wireless technologies related to IoT.
3. Propose IoT solution for real life problems.

Unit No.	Unit Name and Contents	No. of Lectures
1.	**UNIT-I :Introduction to Internet of Things& Python Programming**:- Introduction , Physical design of IoT, Logical design of IoT, IoT Enabling Technologies, IoT Levels &deployment Templates. Features of Python, Identifiers, variables, operators, Input/Output, Setting up python programming environment	06
2.	**UNIT-II: Fundamental IoT Mechanisms & Key Technologies** : Structural aspects of the IoT: Environment characteristics, Traffic characteristics ,scalability, Interoperability, Security and Privacy, Open architecture, Key IoT Technologies: Device Intelligence, Communication capabilities, Mobility support, Device Power, Sensor Technology, RFID technology, Satellite Technology. Evolving IoT Standards: IETF IPv6 Routing Protocol for RPL Roll, Constrained Application Protocol(CoAP), REST, 6LoWPAN, ZigBee IP(ZIP).	07
3.	**UNIT-III: IoT Systems-** Logical design using Python Introduction, Python Data Types & data structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time operations, Classes	08
4.	**UNIT-IV: IoT Physical Devices & Endpoints**: What is an IoT device, Exemplary Device: Raspberry Pi, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python	07
5.	**UNIT-V: IoT Physical Servers and Cloud Offerings** :Introduction to Cloud storage models and communication API's, WAMP –AutoBahn for IoT, Amazon web services for IoT	07
6.	**UNIT-VI: Case studies Illustrating IoT Design:** Introduction, Home automation, cities, Environment, Agriculture, Productivity applications	07

TEXT BOOKS:

1. Internet of Things: A Hands-On Approach By ArshdeepBahga, Vijay Madisetti (Unit 1,3,4,5,6) .
2. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications.

REFERENCE BOOKS: The Internet of Things: Connecting Objects to the Web, HakimaChaouchi, Wiley Publications

PEC DS3104-Elective-01

4. Automata Theory

Lectures	:3Hrs/Week	Evaluation Scheme
Credit	:3	MSE : 30Marks
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite::Basic Mathematical Concepts, Sets, graphs.

Course Objectives:

1. To introduce students to the mathematical foundations of computation, the theory of formal languages and grammars
2. To strengthen the students' ability to understand and conduct mathematical proofs for computations
3. To make the students understand the use of automata theory in Compliers & System Programming.
4. To analyze and design finite automata, pushdown automata, grammars & turing machines

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Understand basic concepts of Regular Language and Regular Expressions
2. Select appropriate abstract machine to recognize a given formal language.
3. Generate complex languages by applying Union, Intersection, Complement, Concatenation and Kleene * operations on simple languages.
4. Apply parsing concepts for syntax analysis.
5. Be familiar with thinking analytically and intuitively for problem solving situations in related areas of theory in computer science.

Unit No.	Unit Name and Contents	No. of Lectures
1.	**UNIT-I:**Regular Languages and Finite Automata Proofs, Recursive Definitions, Regular expressions and regular languages, Finite Automata, unions, intersection & complements of regular languages, Applications of FA	06
2.	**UNIT-II:** Non determinism and Kleene's Theorem Nondeterministic finite automata, NFA with null transition, Equivalence of FA's, Kleene's Theorem (Part I & Part II), Minimal Finite Automata	07
3.	**UNIT-III:** Context free Grammars Definition, Union, Concatenation and Kleene *'s of CFLs, Derivation trees and ambiguity, Simplified forms and normal forms	08
4.	**UNIT-IV :**Parsing and Pushdown Automata Definition of Pushdown Automata, Deterministic PDA, Equivalence of CFG's & PDA's, Top down parsing, bottom up parsing.	07
5.	**UNIT-V:**Context free languages CFL's and non CFL's, Pumping Lemma, intersections and complements of CFLs	07
6.	**UNIT-VI :**Turing Machines Definition, TM as language acceptors, combining Turing Machines, Computing partial function with a TM, Multi-tape TMs, and Universal TM	07

TEXT BOOKS:

1. Introduction to Languages & the Theory of Computations - John C. Martin (Tata MGH Edition)
2. Discrete Mathematical Structures with applications to Computer Science - J .P. Trembley & R. Manohar (MGH).

REFERENCE BOOKS:

1. Introduction to Automata Theory, Languages and computation - John E. Hopcraft, Raje
2. Motwani, Jeffrey D. Ullman (Pearson Edition)
3. Introduction to theory of Computations - Michael Sipser (Thomson Books/Cole)
4. Theory of Computation - Vivek Kulkarni
5. Theory of Computation A problem Solvin

MDM DS3105–Multi-disciplinary Minor–03

Programming using JAVA

Lectures	**:** 3Hrs/Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Pre-requisites: C, C++

Course Objectives

1. To introduce the concept of object-oriented programming using java.
2. To learn how to implement reliable and secure application using exception handling and package concept.
3. Have the ability to write program to perform file operations.
4. To understand how to design components with java Swing API and present mechanism of multithreading.
5. To familiarize database connectivity through JDBC and learn the collection framework.
6. To explore the concept of networking and web programming using java servlet and jsp.

Course Outcomes

1. Students will be able to articulate the principle of object-oriented problem solving & programming.
2. Students will be able to illustrate code reusability, security and abstraction using inheritance, package and interface.
3. Students will be able to develop reliable and user-friendly applications using exception handling and file handling.
4. Students will be able to create desktop apps using SWING and event handling and also illustrate multithreading concepts.
5. Students will be able to use JDBC & collection framework.
6. Students will be able to apply network programming concept & develop web applications using servlet and jsp

Unit No.	Unit Name and Contents	No. of Lectures
1	**Fundamental Programming in Java:** The Java Buzzwords, The Java Programming Environment- JVM, JIT Compiler, Byte Code Concept, Hotspot, A Simple Java Program, Source File Declaration Rules, Comments, Data Types, Variables, Operators, Strings, Input and Output, Control Flow, Big Numbers, Arrays- Jagged Array. **Objects and Classes**: Object-Oriented Programming Concepts, Declaring Classes, Declaring Member Variables, Defining Methods, Constructor, Passing Information to a Method or a Constructor, Creating and using objects, Controlling Access to Class Members, Static Fields and Methods, this keyword, Object Cloning, Class Design Hints	07
2	**Inheritance, Interface and Packaging**: Inheritance: Definition, Super classes, and Subclasses, Overriding and Hiding Methods, Polymorphism, Inheritance Hierarchies, Super keyword, Final Classes and Methods, Abstract Classes and Methods, casting, Design Hints for Inheritance, Nested classes & Inner Classes, finalization and garbage collection. **Interfaces:** Defining an Interface, Implementing an Interface, Using an Interface as a Type, Evolving Interfaces, and Default Methods. Packages: Class importing, Creating a Package, Naming a Package, Using Package Members, Managing Source and Class Files. Developing and deploying (executable) Jar File.	07
3	**Exception and I/O Streams**: Exception: Definition, Dealing with Errors, The Classification of Exceptions, Declaring Checked Exceptions, Throw an Exception, Creating Exception Classes, Catching Exceptions, Catching Multiple Exceptions, Re-throwing and Chaining Exceptions, finally clause, Advantages of Exceptions, Tips for Using Exceptions.	07

	I/O Streams: Byte Stream – Input Stream, Output Stream, Data Input Stream, Data Output Stream, File Input Stream, File Output Stream, Character Streams, Buffered Stream, Scanner, Random File Access File	
4	**Graphical User Interfaces using Swing and Multithreading** Introduction to the Swing, Swing features, Swing Top Level Containers-Creating a Frame, Positioning a Frame, Displaying Information in a Panel, The Model-View-Controller Design Pattern, The JComponent Class. Layout Management: Introduction to Layout Management, APIs for Border Layout, Flow Layout, Grid Layout Event Handling: Basics of Event Handling, The AWT Event Hierarchy, Semantic and Low-Level Events in the AWT, Low - Level Event Types User Interface Components: Text Input, Choice Components, Menus, Dialog Boxes Setting the Look and Feel of UI, Introduction to JApplet Multithreading: Processes and Threads, Runnable Interface and Thread Class , Thread Objects, Defining and Starting a Thread, Pausing Execution with Sleep, Interrupts, Thread States, Thread Properties, Joins, Synchronization	07
5	**Collection and Database Programming Collections:** Collection Interfaces, Concrete Collections- List, Queue, Set, Map, the Collections Framework Database Programming: The Design of JDBC, The Structured Query Language, JDBC Installation, Basic JDBC Programming Concepts, Query Execution, Scrollable and Updatable Result Sets, Metadata, Row Sets, Transactions	08
6	**Networking and Web:** Networking: Overview of Networking, Networking Basics, Working with URLs, Creating a URL, Parsing a URL, Reading Directly from a URL, Connecting to a URL, Reading from and Writing to a URL Connection, Sockets, Reading from and Writing to a Socket, Writing the Server Side of a Socket, Datagram, Writing a Datagram Client and Server. **Servlet and JSP**: Introduction to Servlet, The servlet Lifecycle, Retrieving Information and Sending Information, Database Connectivity using servlet, Introduction to JSP, Writing Scriplets, The jsp Lifecycle, Retrieving Information and Sending Information, Database Connectivity using jsp	06

Text Books

1 Core Java- Volume I Fundamentals Cay Horstmann and Gary Cornell Pearson, Eight edition - Unit 1 to Unit 4

2 Core Java- Volume II Advanced Features Cay Horstmann and Gary Cornell Pearson, Eight edition - Unit 5 and Unit 6

3 Java Servlet Programming Jason Hunter O'Reilly Publication, 2nd Edition - Unit 6

4 Core-Servlet and Java Server Pages Volume – 1 Marty Hall, Larry Brown Pearson Education - Unit 6

Reference Books

1 JAVA-The Complete Reference Herbert Schildt McGraw Hill, Oracle Press Ninth edition

2 Head First Java Eric Freeman Elisabeth Robson Bert Bates Kathy Sierra O'Reilly Publication 3 rd edition

3 Head First Servlets and JSP Bryan Basham, Kathy Sierra, Bert Bates O'Reilly Publication 2nd Edition

OE DS3106 –Open Elective 03

1. Optimization Techniques for AI

Lectures	**:**2Hrs/Week	**Evaluation Scheme**
Credit	**:**2	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Pre-requisites-Linear Algebra & Calculus, Data Structures & Algorithms, Probability & Statistics, Introduction to Artificial Intelligence / Machine Learning fundamentals

Course Objectives

1. Understand and apply core optimization formulations used in AI/ML
2. Formulate real-world problems as optimization tasks with constraints
3. Analyse solution methods for classical and modern optimization algorithms
4. Apply heuristic and meta-heuristic optimization for complex AI problems
5. Evaluate algorithm performance and select appropriate methods for specific AI use cases.

Course Outcomes (COs)

By the end of this course, students should be able to:
CO1: Formulate optimization problems from practical AI/engineering scenarios.
CO2: Classify optimization methods and choose correct approaches.
CO3: Solve constrained/unconstrained optimization problems
CO4: Implement and compare heuristic/meta-heuristic optimization such as GA/PS
CO5: Evaluate optimization performance and convergence criteria

Unit No.	Unit Name and Contents	No. of Lectures
1	Introduction to Optimization: Role in AI; objective functions; constraints; feasibility; problem formulation	5
2	Classical Optimization Methods: Linear programming, Simplex, Kuhn-Tucker conditions; convexity	4
3	Unconstrained/Constrained Optimization: Gradient methods; Conjugate gradient; Penalty & barrier methods	4
4	Heuristic & Meta-heuristic: Genetic Algorithms, Particle Swarm Optimization, Simulated Annealing, etc.	5
5	Optimization in AI/ML: Hyper parameter tuning (Bayesian optimization), loss minimization, regularization	5
6	Tools and Implementation: Python/Matlab implementation; comparison & benchmarking	5

Textbooks-

1.. Engineering Optimization: Theory and Practice – S. S. Rao (Wiley)

2. Optimization for Engineering Design: Algorithms and Examples – K. Deb (PHI)

Reference Books

1 . Introduction to Optimum Design – J. S. Arora

2. Research papers on meta-heuristic optimization such as Genetic Algorithms / PSO

OE DS3106 – Open Elective 03

2. Business Modeling and Design Thinking

Lectures	**:**2Hrs/Week	**Evaluation Scheme**
Credit	**:**2	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisites: Basic understanding of Business Concepts, Familiarity with User-Centred Design approaches, Exposure to Teamwork & Communication Skills

Course Objectives:

1. Gain a human-centred mind-set for problem framing.
2. Learn and apply Design Thinking methodologies.
3. Develop innovative business models using structured tools.
4. Execute idea validation and prototyping.
5. Integrate user feedback into business design cycles.

Course Outcomes (COs) after this course, students should be able to:

- CO1: Identify user needs and establish problem statements.
- CO2: Apply design thinking phases for real challenges.
- CO3: Construct robust business models (e.g., Business Model Canvas)
- CO4: Prototype and evaluate solutions with users.
- CO5: Reflect on design decisions and iterate improvements.

Unit No.	Unit Name and Contents	No. of Lectures
1.	**Introduction to Design Thinking & Business Modeling**-Overview, customer-centric mindset	5
2	**Empathy & User Research**-Interviewing, observations, personas	4
3	**Define & Ideate**-Problem definition, brainstorming, ideation tools	4
4	**Prototyping**-Rapid prototyping; MVP development	5
5	**Business Model Tools**-Business Model Canvas, value propositions	5
6	**Testing & Iteration-** Market testing; feedback loops; refinement	5

Text Books-

1**.** Design Your Thinking – Pavan Soni (Penguin)

2. The Design of Business – Roger L. Martin (HBR Press)

Refrance Books-

1. Articles on Design Thinking in HBR/academic sources

2. Case studies on Business Model Canvas & innovation projects

PCC DS3107- Database Engineering Lab

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : 25 Marks

Course Objectives:

1. To learn Basics of design of databases.
2. To acquire knowledge on parallel and distributed databases and its applications.
3. To study the usage and applications of SQL and NOSQL databases.
4. To Understand and perform common database administration tasks, such as database monitoring, performance tuning, data transfer, and security.
5. To understand the usage of advanced data models.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Understand and identify issues arising from parallel and distributed processing of data.
2. Select appropriate database and construct solution to real world problems of storing large data.
3. Compare and Contrast No SQL databases with each other and Relational Database Systems.
4. Make use of SQL cursors, triggers, stored procedures, and procedural SQL to write complex SQL scripts.
5. Learn database administration tasks and security measures

Minimum 12 -14 Experiments based on the following topics.

1. Installation and Demonstration of DBMS like MySql
2. Draw E-R Diagram for different applications like – Library Management Systems, College Management Systems, Hospital Management Systems etc.
3. Convert E-R Diagrams into relational tables.
4. Use DDL Statements to Crete, Alter, Drop, Rename, Truncate Tables
5. Use DML Statements to Insert, Select, Update, Delete Data
6. Use of aggregate functions, group by – having clause and order by clause.
7. Use of Joins
8. Use of Set Operations
9. Creation of Indices and Views in SQL
10. Implement PL/SQL procedure and Function
11. Implement PL/SQL Cursor.
12. Implement Triggers in PL/SQL.
13. Find Canonical Cover and Closure for set of functional dependencies.
14. Demonstration of Indexing – Dense index, Sparse index, B+ tree index
15. Demonstration of Hashing – Static hashing, Dynamic hashing
16. Demonstration of Log based recovery.
17. Study of concurrency control mechanisms

Text Books:

1. “Database System Concepts”, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, 6th edition, McGraw- Hill.
2. “Database Systems - A Practical Approach to Design, Implementation and Management”, Thomas Connolly, Carolyn Begg, 4th Edition, Addison Wesley.
3. “MySQL Cookbook”, Paul DuBois, 3rd edition, O’REILLY.

References Books:

1. “Fundamentals of Database Systems”, Ramez, Elmasri, Shamkant B. Navathe, 6th Edition, Addison Wesley.
2. “Database Systems – Design, Implementation and Management”, Rob & Coronel, 5th Edition, Thomson Course Technology.

PCC DS3108- Java Programming Lab

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : 25 Marks

Pre-requisites: C++ and html.

Course Objectives

1. To introduce the concept of object-oriented programming using java.
2. To learn how to implement reliable and secure application using exception handling and package concept.
3. Have the ability to write program to perform file operations.
4. To understand how to design components with java Swing API and present mechanism of multithreading.
5. To familiarize database connectivity through JDBC and learn the collection framework.
6. To explore the concept of networking and web programming using java servlet and jsp.

Course Outcomes

1. Students will be able to articulate the principle of object-oriented problem solving & Programming.
2. Students will be able to illustrate code reusability, security and abstraction using inheritance, package and interface.
3. Students will be able to develop reliable and user-friendly applications using exception handling and file handling.
4. Students will be able to create desktop apps using SWING and event handling and also illustrate Multithreading concepts.
5. Students will be able to use JDBC & collection framework.
6. Students will be able to apply network programming concept & develop web applications using servlet and jsp.

Minimum 15 experiments should be conducted

No.	Question
1	Create a class called Employee that includes three pieces of information as instance variables – first name, last name, and monthly salary. The class should have a constructor that initializes the three instance variables. Provide set and get methods for each instance variable. If the monthly salary is not positive, set it to 0.0. Write a test application named EmployeeTest that demonstrates class Employee's capabilities. Create two Employee objects and display each object's yearly salary. Then give each Employee a 10% raise and display each Employee's yearly salary again.
2	Create class SavingsAccount. Use a static variable annualInterestRate to store the annual interest rate for all account holders. Each object contains a private instance variable savingsBalance. Provide calculateMonthlyInterest method to calculate monthly interest and add it to savingsBalance. Provide static method modifyInterestRate. Create two objects with balances Rs.2000 and Rs.3000, apply 4% interest, then 5% interest and display balances.
3	Create Vehicle interface with name, maxPassenger, and maxSpeed. Create LandVehicle and SeaVehicle interfaces. LandVehicle has numWheels and drive(). SeaVehicle has displacement and launch(). Create Car, HoverCraft, and Ship classes. HoverCraft should support land and sea modes. Demonstrate all classes.
4	Create abstract class Shape with instance variables side, area, and perimeter. Declare abstract methods calculateArea() and calculatePerimeter(), and concrete method display(). Create subclasses Triangle, Rectangle, Circle, Cube, and Square. Use parameterized constructors and Shape reference in test class.
5	Create Stack interface with size and methods push(), pop(), display(), overflow(), and underflow(). Implement

	IntegerStack, StringStack, and DoubleStack. Interface methods use String type. Convert data types in subclasses. Create test class.
6	Develop a math package for statistical operations like Mean, Median, Average, and Standard Deviation. Create sub-package convert to convert decimal to binary, octal, hexadecimal and vice-versa. Build executable JAR file.
7	Develop an application to handle five compile-time and runtime exceptions using multiple catch blocks. Use throws and finally keywords.
8	Develop BankAccount class with balanceEnquiry(), withdraw(), transfer(), and deposit() methods. Create two objects using array. Generate LowBalanceException, NegativeNumberException, and PasswordMismatchException.
9	Take file name from command line. If file exists, display contents. Ask user to append or replace data. Modify file accordingly. If file does not exist, create it. Use Character Streams.
10	Take Student details and store using DataOutputStream and FileOutputStream. Retrieve using DataInputStream and FileInputStream. Use Serialization and Byte Streams.
11	Develop Swing GUI based calculator using event handling and layout managers.
12	Create Stop Watch using Swing GUI and Multithreading with Lap Counting.
13	Read a text file line by line, store lines in LinkedList, and print them in reverse order.
14	Fill HashMap with key-value pairs. Sort by key and store in LinkedHashMap to show insertion order.
15	Develop GUI based Student Registration and Login system using Database.
16	Create GUI based Chat Application using TCP or UDP.
17	Design Student Registration, Login, Home, and Logout pages using Servlets.
18	Store registration data in Database. Validate login and provide search functionality using Servlet and JSP using MVC

.

Text Books

1 Core Java- Volume I Fundamentals Cay Horstmann and Gary Cornell Pearson, Eight edition

2 Core Java- Volume II Advanced Features Cay Horstmann and Gary Cornell Pearson, Eight edition

3 Java Servlet Programming Jason Hunter O'Reilly Publication, 2nd Edition

4 Core-Servlet and Java Server Pages Volume – 1 Marty Hall, Larry Brown Pearson Education

Reference Books

1 JAVA-The Complete Reference Herbert Schildt McGraw Hill, Oracle Press Ninth edition

2 Head First Java Eric Freeman Elisabeth Robson Bert Bates Kathy Sierra O'Reilly Publication 3 rd edition

3 Head First Servlets and JSP Bryan Basham, Kathy Sierra, Bert Bates O'Reilly Publication 2nd Edition

PEC DS3109- Elective Lab 1
1. Machine Learning Lab

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : --

Course Prerequisites:
Python Programming Language

Course Description:
Study and implement Machine Learning Concepts.

Course Objectives:

1. To familiarize students with Python programming environment and libraries required for implementing data science and machine learning algorithms.
2. To design and implement fundamental machine learning models, including regression, classification, clustering, neural networks, and association rule mining techniques using real datasets.
3. To analyze data-driven problems and develop intelligent solutions, such as time series forecasting, text classification, and recommendation systems using appropriate algorithms.

Course Outcomes:

1. Demonstrate, visualize, analyze and preprocess the dataset from a real-time source.
2. Apply appropriate Machine learning algorithms to the data.
3. Analyze the results of algorithm and convert to appropriate information required for the real – time application

Practical List
Minimum of 10 to 12 experiments should be carried out based on the following experiments.

1. Study and installation of python
2. Study and implementation of Simple Linear Regression
3. Write a program to implement Multiple Linear Regression
4. Write a program to implement Logistic Regression.
5. Write a program to implement Multi-class Classification
6. Write a program to implement Neural Network
7. Write a program to implement Backpropagation algorithm of Neural Network
8. Write a program to implement K-means Clustering
9. Write a program to implement association rule mining
10. Write a simple program to identify next point of time series analysis
11. Write a program to build naïve bay's classifier for text data
12. Demonstrate simple recommendation system

Text Books:
1. Machine Learning with Python- an approach to applied ML, by Abhishek Vijayvargia, BPB publications
2. Practical Machine Learning by Sunila Gollapudi Packt Publishing Ltd.
3. Machine Learning by Tom M. Mitchell, McGraw Hill Education; First edition

References Books:
1. Machine Learning for dummies John Paul Muller, Willey Publication
2. EthemAlpaydin : Introduction to Machine Learning, PHI 2nd Edition-2013

PEC DS3109- Elective Lab 1
2. Advance Computer Network

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : --

Prerequisites:
Must have basic knowledge of computers and Computer Network

Course Objectives:

1. To provide in-depth understanding of computer network architecture, Internet structure, networking models (OSI, TCP/IP), networking devices, and packet-switched network performance parameters.
2. To analyze link-layer and network-layer protocols**,** including error control, multiple access mechanisms, routing algorithms, congestion control, and internetworking techniques.
3. To explain Internet addressing, transport, and application-layer protocols, enabling the design and implementation of end-to-end communication and network applications.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1: Explain the structure and functioning of the Internet, networking models, protocols, and networking devices, and analyze performance issues such as delay, loss, and throughput.

2: Analyze and compare link-layer and network-layer mechanisms including error detection, multiple access protocols, routing algorithms, congestion control, and LAN technologies.

3: Design and implement network-based applications using transport and application-layer protocols such as TCP, UDP, HTTP, FTP, DNS, and socket programming.

Practical List -

Experiments based on the following topics.

1. Design and simulation of sample network
2. Demonstration of network testing tools
3. Implementation of framing techniques A) Character count B) Bit stuffing
4. Implementation of Error control mechanisms A) CRC B) Hamming Code
5. Implementation of Flow control mechanisms A) Stop and wait ARQ B) Go Back N C) Selective repeat
6. Design and simulate working of Virtual LAN
7. Implementation of Routing algorithm A) Shortest path routing B) Distance vector routing
8. Implementation of Client-Server model A) Simple client-server model B) Iterative client-server model C) Concurrent client-server model
9. Simulation of application layer protocol
10. Installation and Configuration of FOSS server

Text Books:

1. Data Communications and Networking – Behrouz A Forouzan (The McGraw Hill) (Unit 1,2,3)
2. Computer Networks – Andrew S. Tanenbaum- (Prentice Hall) 5th Edition (Unit 3, 4)
3. TCP/IP Protocol Suite- Behrouz Forouzan-(The McGraw Hill) (4,5,6)

Reference Books:

1. Computer Networking with Internet Protocols and Technology, William Stallings (Prentice Hall)

PEC DS3109- Elective Lab 1
3. Internet of Things

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : --

Pre-requisites:
Fundamentals of Computer Network and Internet, basics of C / C++ programming language.

Course Objectives
9. To learn Internet of Things Technology
10. To know the basics of RFID, Sensor technologies.
11. To know the basics of IoT systems like Raspberry Pi, Arduino, and Banana Pi.
12. To aware students about wireless communication technologies and IoT applications.

Course Outcome
1. Students will understand basic concepts of IoT
2. students will be able to learn and implement RFID technology in various applications.
3. Students will be able to write programs for basic applications
4. Student will understand and implement different communication technologies in IoT systems

Practical List •
Minimum 10 experiments should be conducted based on above topics and covering following list.
At least two experiments should be conducted on each unit in the syllabus.

1. Introduction of Arduino IDE
2. Write an arduino program to demonstrate setup () and loop () functions
3. Write an arduino program to demonstrate data types.
4. Write an arduino program to demonstrate if statements
5.Write an arduino program to demonstrate strings
6. Write an arduino program to demonstrate digital I/O functions
7. Write an arduino program to demonstrate the 7-segment display.
8. Write an arduino program to demonstrate interrupts
9. Write an arduino program to demonstrate I2C communication protocol
10. Write an arduino program for interfacing with potentiometer.
11. Write an arduino program for interfacing with potentiometer.
12. Write an arduino program for interfacing with PIR sensor
13. Write an arduino program to demonstrate SPI communication protocol
14. Write an arduino program for interfacing with infrared and ultrasonic sensor
15. Write an arduino program for interfacing with servo motor

TEXT BOOKS:
1. Internet of Things: A Hands-On Approach By ArshdeepBahga, Vijay Madisetti (Unit 1,3,4,5,6) .
2. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications.

REFERENCE BOOKS: The Internet of Things: Connecting Objects to the Web, HakimaChaouchi, Wiley Publications

PEC DS3109- Elective Lab 1
4. Automata Theory

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : --

Course Prerequisites:
Python Programming Language

Course Objectives:
1. To introduce students to the mathematical foundations of computation, the theory of formal languages and grammars
2. To strengthen the students' ability to understand and conduct mathematical proofs for computations
3. To make the students understand the use of automata theory in Compliers & System Programming.
4. To analyze and design finite automata, pushdown automata, grammars & turing machines

Course Outcomes:
Upon successful completion of this course, the student will be able to –
1. Understand basic concepts of Regular Language and Regular Expressions
2. Select appropriate abstract machine to recognize a given formal language.
3. Generate complex languages by applying Union, Intersection, Complement, Concatenation and Kleene * operations on simple languages.
4. Apply parsing concepts for syntax analysis.
5. Be familiar with thinking analytically and intuitively for problem solving situations in related areas of theory in computer science.

Minimum 12 experiments should completed

No.	Experiment Name	Experiment Details
1	Regular Languages & Proof Techniques	Write and prove closure properties of regular languages under union, intersection, and complement. Solve textbook problems using set-theoretic and inductive proofs.
2	Regular Expressions	Construct regular expressions for given languages. Convert regular expressions into Finite Automata (FA).
3	Deterministic Finite Automata (DFA)	Design DFA for strings ending with specific patterns and for binary strings with even and odd number of 0s and 1s. Explain applications of DFA in pattern matching.
4	Operations on Finite Automata	Construct Finite Automata for union of two regular languages, intersection of two regular languages, and complement of a regular language.
5	Nondeterministic Finite Automata (NFA)	Design NFA for given languages. Convert NFA to DFA using subset construction.
6	NFA with ε (Null) Transitions	Construct ε-NFA for a given regular expression. Convert ε-NFA to DFA.
7	Kleene's Theorem	Verify Kleene's Theorem – Part I (Regular Expression → FA). Verify Kleene's Theorem – Part II (FA → Regular Expression).
8	Minimization of Finite Automata	Minimize a given DFA using partitioning method. Compare original DFA and minimized DFA.
9	Context-Free Grammars (CFG)	Construct CFGs for palindromes, balanced parentheses, and a^nb^n type languages. Demonstrate union, concatenation, and Kleene star of CFLs.
10	Derivation Trees & Ambiguity	Generate leftmost and rightmost derivations. Identify ambiguous grammars and remove ambiguity if possible.
11	Simplified & Normal Forms	Convert CFG into Chomsky Normal Form (CNF) and Greibach Normal Form (GNF).
12	Pushdown Automata (PDA)	Design PDA for a^nb^n and balanced parentheses. Prove equivalence of CFG and PDA.
13	Parsing Techniques	Perform top-down parsing (LL parsing) and bottom-up parsing (LR parsing).

		Construct parse tables and explain conflicts.
14	Context-Free Languages & Pumping Lemma	Apply Pumping Lemma for CFL to prove a given language is CFL or not CFL. Discuss closure properties of CFLs.
15	Turing Machines	Design Turing Machines for string reversal, palindrome checking, and unary addition. Study multi-tape TM, Universal Turing Machine, and TM as language acceptors.

TEXT BOOKS:

1. Introduction to Languages & the Theory of Computations - John C. Martin (Tata MGH Edition)
2. Discrete Mathematical Structures with applications to Computer Science - J .P. Trembley & R. Manohar (MGH).

REFERENCE BOOKS:

1. Introduction to Automata Theory, Languages and computation - John E. Hopcraft, Raje
2. Motwani, Jeffrey D. Ullman (Pearson Edition)
3. Introduction to theory of Computations - Michael Sipser (Thomson Books/Cole)
4. Theory of Computation - Vivek Kulkarni
5. Theory of Computation A problem Solvin

MDM DS3110- Multi-Disciplinary Minor 03 Lab
Programming using Java

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 50 Marks
		ESE : --

Pre-requisites: C++ and html.

Course Objectives

1. To introduce the concept of object-oriented programming using java.
2. To learn how to implement reliable and secure application using exception handling and package concept.
3. Have the ability to write program to perform file operations.
4. To understand how to design components with java Swing API and present mechanism of multithreading.
5. To familiarize database connectivity through JDBC and learn the collection framework.
6. To explore the concept of networking and web programming using java servlet and jsp.

Course Outcomes

1. Students will be able to articulate the principle of object-oriented problem solving & Programming.
2. Students will be able to illustrate code reusability, security and abstraction using inheritance, package and interface.
3. Students will be able to develop reliable and user-friendly applications using exception handling and file handling.
4. Students will be able to create desktop apps using SWING and event handling and also illustrate Multithreading concepts.
5. Students will be able to use JDBC & collection framework.
6. Students will be able to apply network programming concept & develop web applications using servlet and jsp.

Minimum 12-15 experiments should be conducted

No.	Question
1	Create a class called Employee that includes three pieces of information as instance variables – first name, last name, and monthly salary. The class should have a constructor that initializes the three instance variables. Provide a set and a get method for each instance variable. If the monthly salary is not positive, set it to 0.0. Write a test application named Employee Test that demonstrates class Employee's capabilities. Create two Employee objects and display each object's yearly salary. Then give each Employee a 10% raise and display each Employee's yearly salary again.
2	Create class Savings Account. Use a static variable annual Interest Rate to store the annual interest rate for all account holders. Each object of the class contains a private instance variable savings Balance indicating the amount the saver currently has on deposit. Provide method calculate Monthly Interest to calculate the monthly interest by multiplying the savings Balance by annual Interest Rate divided by 12. This interest should be added to savings Balance. Provide a static method modify Interest Rate that sets the annual Interest Rate to a new value. Write a program to test class Savings Account. Instantiate two Savings Account objects, saver1 and saver2, with balances of Rs. 2000.00 and Rs. 3000.00 respectively. Set annual Interest Rate to 4%, calculate the monthly interest, and print the new balances. Then set annual Interest Rate to 5%, calculate the next month's interest, and print the balances again.
3	Create Vehicle interface with name, max Passenger, and max Speed variables. Create LandVehicle and SeaVehicle interfaces from Vehicle interface. Land Vehicle has numWheels variable and drive method.

	SeaVehicle has displacement variable and launch method. Create Car class from Land Vehicle, Hover Craft from Land Vehicle and Sea Vehicle interfaces, and Ship from Sea Vehicle. Provide additional methods in Hover Craft such as enter Land and enter Sea. Provide other methods for Car and Ship. Demonstrate all classes in an application.
4	Create abstract class Shape which has instance variables side, area, and perimeter. Declare calculate Area() and calculate Perimeter() as abstract methods and display() as a concrete method. Write subclasses extending Shape such as Triangle, Rectangle, Circle, Cube, and Square. Override abstract methods and display method. Use parameterized constructors with this reference. Write a test class using Shape reference to calculate area, perimeter, and display results.
5	Create the interface Stack which has variable size and abstract methods push(), pop(), display(), overflow(), and underflow(). Implement Integer Stack, String Stack, and Double Stack classes. All interface methods are declared using String type. In Integer Stack convert String to Integer, and similarly for other stacks. Create one test class to check all classes.
6	Develop a mathematical package for statistical operations like Mean, Median, Average, and Standard Deviation. Create a sub-package convert in the math package. In convert package provide classes to convert decimal to octal, binary, hexadecimal, and vice-versa. Develop an application program to use this package and build an executable JAR file.
7	Develop an application which can handle any five combinations of predefined compile-time and runtime exceptions using multiple catch blocks. Use throws and finally keywords as well.
8	Develop a Bank Account class which contains methods balance Enquiry(), withdraw(), transfer(), and deposit(). Create at least two Bank Account objects using an array and perform all operations. Generate user-defined exceptions Low Balance Exception, Negative Number Exception, and Password Mismatch Exception whenever required. Use two Bank Account objects to transfer amount from one account to another.
9	Take file name as input through command line. If file exists, open and display contents of the file. After displaying contents ask user whether to add data at the end of file or replace specified text. Based on user response, accept data and modify the file. If file does not exist, create a new file and store user data. User should type exit on a new line to stop the program. Use Character Stream classes.
10	Take Student information such as name, age, weight, height, city, and phone from user and store it in a file using Data Output Stream and File Output Stream. Retrieve data using Data Input Stream and File Input Stream and display the result. Use Serialization concept and Byte Stream classes.
11	Develop a Swing GUI based standard calculator program using event handling and layout managers of Swing package.
12	Create Stop Watch with Swing GUI and Multithreading. Provide facility for Lap Counting.
13	Write a program to read a text file one line at a time. Read each line as a String and place it into a Linked List. Print all lines in the Linked List in reverse order.
14	Fill a HashMap with key-value pairs. Print the results to show ordering by hash code. Extract the pairs, sort by key, and place the result into a Linked Hash Map. Show that insertion order is maintained.
15	Write a GUI based program to create student registration and login. Store registration data in database and take login information from database.
16	Create GUI based chat application using TCP or UDP.
17	Design a student registration form containing all registration details. After registration display success page showing entered details. Design login form, home page, and logout form using servlet.
18	Write a program to store registration form information in database. During login validate from database. Display all student names on home page. Provide search field to search particular student record and display complete information using Servlet and JSP following MVC architecture.

Text Books

1 Core Java- Volume I Fundamentals Cay Horstmann and Gary Cornell Pearson, Eight edition

2 Core Java- Volume II Advanced Features Cay Horstmann and Gary Cornell Pearson, Eight edition

3 Java Servlet Programming Jason Hunter O'Reilly Publication, 2nd Edition

4 Core-Servlet and Java Server Pages Volume – 1 Marty Hall, Larry Brown Pearson Education

Reference Books

1 JAVA-The Complete Reference Herbert Schildt McGraw Hill, Oracle Press Ninth edition

2 Head First Java Eric Freeman Elisabeth Robson Bert Bates Kathy Sierra O'Reilly Publication 3 rd edition

3 Head First Servlets and JSP Bryan Basham, Kathy Sierra, Bert Bates O'Reilly Publication 2nd Edition

EL DS3111–Business English

Practical	**:** 2Hrs/Week	**Evaluation Scheme**
Credit	**:** 1	**MSE : --**
		ISE/CA : 25 Marks
		ESE : --

Prerequisite::
1) Knowledge of functional grammar and vocabulary in English
2) Knowledge of the importance of business English in their career path
3) Knowledge of linguistic competence and understand intricacies involved in technical Communication

Course Objectives:
1. Develop basic skills to deal with people in business situations
2. Increase their knowledge of key business concepts worldwide
3. Write and read basic business reports, letters, e-mails etc
4. Expand vocabulary related to general business situations
5. Develop confidence to deal with people and basic issues in the business world

Course Outcomes:
1. Learn to communicate with others in practical, business oriented situations
2. Learn to express themselves in English with greater fluency, accuracy and confidence
3. Learn to handle themselves in English in a variety of business contexts, from negotiating, to using the telephone, to making presentations, to socialising
4. Enhance the skills of listening, speaking, pronunciation skills, as well as business vocabulary
5. Acquire the communicative competencies crucial for appropriate workplace behavior

Experiment List

1. Case study of organizational hierarchy
2. Match the following on antonyms & synonyms
3. Irregular verb list (like choose, chose, chosen)
4. Word building by using prefixes suffixes (eg. ir-regular, im-possible)
5. Minutes of Meeting – writing
6. Report writing (any report)
7. Comprehension/paragraph writing
8. Business letter / resume writing / email writing
9. PPT presentation on any non-technical topic. PPT handout should be attached
10. Do's & Dont's of group discussion & Business etiquettes

TEXT BOOKS:
1Technical Communication- Ashraf Rizvi BY Tata McGraw
2. Effective Business Communication - M. V Rodriques BY Concept Publishing Company Pvt. Ltd. 2013

PCC DS3201 –Advanced Database Systems

Lectures	**:**3Hrs/Week	**Evaluation Scheme**
Credit	**:**3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Database Systems

Course Objectives:

1.To learn Basics of design of databases.
2. To acquire knowledge on parallel and distributed databases and its applications.
3.To study the usage and applications of SQL and NOSQL databases.
4. To Understand and perform common database administration tasks, such as database monitoring, performance tuning, data transfer, and security.
5. To understand the usage of advanced data models.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Understand and identify issues arising from parallel and distributed processing of data.
2. Select appropriate database and construct solution to real world problems of storing large data.
3. Compare and Contrast NoSQL databases with each other and Relational Database Systems.
4. Make use of SQL cursors, triggers, stored procedures, and procedural SQL to write complex SQL scripts.
5. Learn database administration tasks and security measures.

Unit No.	Unit Name and Contents	No. of Lectures
1.	**Parallel and Distributed Databases** : Database System Architectures: Centralized and Client – Server Architectures, Server System Architectures, Parallel Systems, Parallel Database Architectures, Parallel Databases --I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism, Design of Parallel Systems, Distributed Systems, Distributed Database Concepts, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control, Distributed Query Processing, Case Studies- Distributed Databases in Oracle.	07
2.	**Advanced SQL:** Relational Set Operators, SQL Join Operators, Sub queries and Correlated Queries, SQL Functions, Oracle Sequences, Synonyms, Database Links, Updatable Views, Procedural SQL, Triggers, Stored Procedures, PL/SQL Processing with Cursors, PL/SQL Stored Functions, Embedded SQL, Dynamic SQL. Case study Postgrey SQL	07
3.	**NoSQL Database Management: NOSQL: Definition and Introduction**, Features and Types of NOSQL databases, Sorted Ordered Column-Oriented Stores, Key/Value Stores, Document Databases, Graph Databases. **NOSQL: Getting Initial Hands-On Experience**, Storing and Accessing Data, Storing Data in and Accessing Data from MongoDB, Querying MongoDB**, Interfacing and Interacting with NOSQL**, Case Study-CouchDB, CouchDB vs. MongoDB, Compass / Atlas GUI Tools for MongoDB. .	08
4.	**Database Administration and Security:** The Need for and Role of a Database in an Organization, The Evolution of the Database Administration Function, The Database Environment's Human Component Security, Database Administration Tools: The Data Dictionary, CASE Tools, developing a Data Administration Strategy, The DBA at Work: Using Oracle for Database Administration.	07

5.	**Business Intelligence and Data Warehouses:** The Need for Data Analysis, Business Intelligence, Business Intelligence Architecture, Decision Support Data, The Data Warehouse, Online Analytical Processing, Star Schemas, Implementing a Warehouse, Data Mining, SQL Extensions for OLAP, Materialized Views, Case Study- FireBase-Google.	07
6.	**Data analysis and exploration:** Mathematical models for decision making, data mining, data preparation, data exploration. Data mining tasks - association rules	06

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TEXTBOOKS:

Sr.No.	Title	Author(s) Name	Publication & Edition	Units Covered
1	Database System Concepts	Silberschatz, Korth, Sudarshan	MGH, 6th Edition (International edition) 2010	Unit 1
2	Database Systems, Design, Implementation andManagement	Coronel-MorrisRob		Unit No.2, 4
3	Professional NOSQL	Shashank Tiwari	John Wiley & Sons, Inc. 2011	Unit No.3
4	Business Intelligence- Data Mining and optimization for Decision Making	Carlo Vercellis	Wiley Publications.	Unit No.5, 6

REFERENCE BOOKS:

Sr. No.	Title	Author(s) Name	Publication & Edition
1	Database Management System	Raghu Ramkrishnan, Johannes Gehrke,	MGH, [4e], 2015
2	Fundamentals of Database Systems	R. Elmasri S. B. Navathe	Addison Wesley
3	NoSQL Distilled: A brief guide to merging world of Polyglot persistence	Pramod J. Sadalage and Marin Fowler	Addison Wesley, 2012.
4	Advanced Database Management System	Rini Chakrabarti Shilbhadra Dasgupta	
5	Database Systems: A Practical Approach to Design, Implementation and Management,	Thomas Connolly, Carolyn Begg	6th Edition,2012.

PCC DS3202 - Data Mining & Data Warehousing

Lectures	**:**3Hrs/Week	**Evaluation Scheme**
Tutorial-	: 1Hr/Week	**MSE : 30Marks**
Credit	**:** 4	**ISE/CA : 10Marks**
		ESE : 60Marks

Prerequisite: Basic Knowledge of Databases, basics of C / C++ programming language.

Course Objectives:

1. Define Data warehousing Architecture and Implementation
2. Explain Data mining principles and techniques and Introduce DM as a cutting-edge business intelligence
3. Interpret association rule mining for handling large data
4. Classification for the retrieval purposes
5. Explain clustering techniques in details for better organization and retrieval of data.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Demonstrate storing voluminous data for online processing, Preprocess the data for mining applications
2. Apply the association rules for mining the data.
3. Design and deploy appropriate classification techniques
4. Cluster the high dimensional data for better organization of the data.
5. Discover the knowledge imbibed in the high dimensional system.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction:** Introduction and Data Pre-processing: Why data mining, what is data mining, What kinds of data can be mined, what kinds of patterns can be mined, Which Technologies Are used, which kinds of Applications are targeted, Major issues in data mining.	07
2	**Data Pre-processing:** An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization.	06
3	**Data warehousing and online analytical processing:** Data warehousing: Basic concepts, Data warehouse modeling: Data cube and OLAP, Data warehouse design and usage, Data warehouse implementation.	07
4	**Classification:** Basic Concepts, Decision tree induction, Bayes Classification Methods, Rule-Based classification, Model evaluation and selection, Techniques to improve classification accuracy.	07
5	**Cluster Analysis:** Basic concepts and methods: Cluster Analysis, Partitioning methods, Hierarchical Methods, Density-based methods, Grid-Based Methods, Evaluation of clustering.	07
6	**Data Mining Trends and Research Frontiers:** Mining Complex Data Types, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining Trends.	06

Text Books:

1. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining Concepts and Techniques, ELSEVIER(MK) 3rd edition 2012.

Reference Books:

1. The Data Warehouse Toolkit, 3rd Edition, Ralph Kimball
2. Data Mining: Concepts and Techniques (The Morgan Kaufmann Series in Data Management Systems) 3rd Edition, Jiawei Han , Micheline Kamber, Jian Pei Professor.

Tutorial list: Tutorials should be conducted based on following topics:

Tutorial 1 – Introduction to Data Mining: Why Data Mining, What is Data Mining, Types of Data and Patterns
Tutorial 2 – Data Mining Technologies, Applications, and Major Issues
Tutorial 3 – Data Preprocessing Overview and Data Cleaning Techniques
Tutorial 4 – Data Integration, Data Reduction, Transformation, and Discretization
Tutorial 5 – Basics of Data Warehousing: Concepts, Design, and Architecture
Tutorial 6 – Data Cube, OLAP Operations, and Data Warehouse Implementation
Tutorial 7 – Classification Basics, Decision Tree Induction, and Bayesian Methods
Tutorial 8 – Rule-Based Classification, Model Evaluation, and Accuracy Improvement
Tutorial 9 – Cluster Analysis: Concepts, Partitioning, Hierarchical, Density-based, and Grid-based Methods
Tutorial 10 –Case Study

PCC DS3203-Feature Engineering

Lectures	**:**3Hrs./Week	**Evaluation Scheme**
Credit	**:**3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Fundamentals of Mathematical Statistics, Basics of Python Programming.

Course Objectives:

1. To know basics of feature engineering.
2. To know basics of feature representation.
3. To understand feature selection transformation process.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Explain basics of feature engineering used for representing and generating process.
2. Describe features of different types of data with feature selection process.
3. Describe feature transformations process for converting high dimensional features to low dimensional features.
4. Explain feature learning process from the given input.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction to Feature Engineering:** Motivating example – AI-powered communications, importance of feature engineering, introduction of feature engineering, Evaluation of machine learning algorithms and feature engineering procedures, Feature understanding, Feature improvement – cleaning datasets, Feature selection – removing bad attributes, Feature construction, Feature transformation, Feature learning.	6
2	**Basics of Feature Representation:** Scalars, Vectors, and Spaces, Dealing with Counts, Binarization, Quantization or Binning, Log Transformation, Feature Scaling or Normalization, Min-Max Scaling, Standardization (Variance Scaling), ℓ2 Normalization, Interaction Features, Feature Selection.	7
3	**Features of Text and Categorical Data**: Bag-of-X: Turning Natural Text into Flat Vectors, Filtering for Cleaner Features, Atoms of **Meaning**: From Words to n-Grams to Phrases, Tf-Idf : A Simple Twist on Bag-of-Words, Putting It to the Test, Deep Dive, Encoding Categorical Variables, Dealing with Large Categorical Variables.	8
4	**Feature Selection:** Importance of Feature Selection in Machine Learning, Goals of Feature Selection, Classes of Feature Selection Methodologies, Effect of Irrelevant Feature, Overfitting to Predictors and External Validation, Greedy Search Methods- Simple Filters, Recursive Feature Elimination, Stepwise Selection	7
5	**Feature Transformations:** Intuition, Derivation, Linear Projection, Variance and Empirical Variance -Vector Formulation, General Solution of the Principal Components, Transforming Features, Implementing PCA, PCA in Action, Whitening and ZCA, Considerations and Limitations of PCA, Use Cases	8
6	**Feature Learning:** Parametric assumptions of data, Non-parametric fallacy, feature learning algorithms, Reconstructing the data, The Bernoulli RBM, Extracting PCA components from MNIST, Extracting RBM components from MNIST, Using RBMs in a	6

	machine learning pipeline, Learning text features – word vectorizations, Word embeddings, Application of word embeddings – information Retrieval	

Text Books:

1. Sinan Ozdemir, Divya Susarla, “Feature Engineering Made Easy”, Packt Publishing, ISBN 978-1-78728-760-0
2. Alice Zheng & Amanda Casari, “Feature Engineering for Machine Learning: Principles and Techniques for data scientist”, Oreilly.

Reference Books:

1. Max Kuhn , Kjell Johnson, “Feature Engineering and Selection: A Practical Approach for Predictive Models” 1st Edition, Chapman & Hall/CRC Data Science Series, ISBN 13 978-1-138-07922-9.

PEC DS3204-Elective –II

1. Research Methodology

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Pre- requisites: Mathematics Proficiency, Communication Skills

Course Objectives:

1. Effectively impart the fundamental steps for the literature review to identify gaps in the research.
2. Make students familiar with the research process keeping in view testable hypotheses.
3. Make students to realize the concepts of reliability and validity of a data collection, measurement and scaling techniques.
4. Make students to understand the techniques of interpretations, characteristics of a good research report and importance of IPRs.

Course Outcomes:

After the completion of this course, a successful student will be able to do the following:

1. Define a good research problem, hypothesis and objectives.
2. Identify alternative research methodologies and analytical techniques for a chosen research question.
3. Analyze basic techniques of quantitative and qualitative data gathering.
4. Summarize the purpose, process, methods and results in preparation of a research report and various forms of IPRs.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction to Research Methodology:** Meaning and Concept of Research, Research Process, Objectives, Motivation, Ethics in Research, Types of Research – Basic, Applied, Descriptive, Analytical, Conceptual, Empirical, Qualitative and Quantitative.	7
2	**Problem Identification & Formulation** – Introduction, Concept and Need of Research Problem, Literature Survey, hypothesis, characteristics of hypothesis, Steps of Defining a Research Problem, Characteristics of a Good Research Problem, Identifying and Formulating Research Problem.	7
3	**Measurement and Scaling Techniques** – Concept of Measurement, Measurement Scale, Developing Measurement Tools, Basic Criteria of Good Measurement Tools, Errors in Measurement, Concept of Scaling and Types of Scales.	7
4	**Methods of Data Collection** – Concept of Data Collection, Types of Data, Methods of Primary Data Collection, Methods of Secondary Data Collection, Selecting an Appropriate Method of Data Collection.	7
5	**Test of Significance**: Basic concepts, procedure of hypothesis testing, Tests for Hypotheses I and II, Important parameters, Limitations of the tests of Hypotheses, Parametric tests-chi square, t – Test, F Test, Z Test. Introduction to ANOVA.	7

6	**Intellectual Property Rights (IPRs)** - Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs, Geographical Indications**. Interpretation and Report Writing** - Techniques of interpretation, Structure and components of scientific reports, Layout, structure and language of the report, Illustrations and tables, References and Citations.	7

Textbooks:

1. Books: C. R. Kothari, "Research Methodology", New Age international, 2004.
2. Deepak Chopra and Neena Sondhi, "Research Methodology: Concepts and cases", Vikas Publishing House, New Delhi, 2008. 3. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", 2nd Edition, Sage Publisher, 2011.

References:

1. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
2.Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
4.Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 2000.
5.Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi.
6.Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
7. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.

PEC DS3204-Elective –II
2. Soft Computing

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Pre- requisites: Basics of problem solving

Course Objectives:

1. To learn soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world and engineering problems.
2. To develop an understanding of fundamental soft computing tools such as Fuzzy Logic, Neural Networks
3. To build a strong foundation in Artificial Neural Networks and Genetic Algorithms, focusing on architectures, learning mechanisms, optimization strategies, and their practical applications.
4. To explore hybrid systems and multi-objective optimization techniques, integrating fuzzy, neural, and evolutionary methods to solve complex real-world problems effectively.

Course Outcomes:

After successful completion of the course, students will be able to,

1. Explain the necessity of Soft Computing techniques in addressing complex, uncertain and imprecise problems encountered in various domains.
2. Analyze and apply Fuzzy Logic concepts such as fuzzy sets, membership functions, fuzzy inference systems.
3. Evaluate different search methods for problem-solving, including state space search, heuristic search and evolutionary algorithms for finding optimal solutions.
4. Design and implement Genetic Algorithms for solving single-objective optimization problems, utilizing various genetic operators such as encoding, crossover, selection, and mutation.
5. Design different ANN models for solving real-life problems.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction to Soft Computing:** What is Soft Computing, Requirement of Soft computing, Characteristics of Soft computing, Applications of Soft Computing, Basic tools: Fuzzy logic, Neural Networks, and Evolutionary Computing.	5
2	**Fuzzy Systems:** Introduction to Fuzzy Logic, fuzzy sets, membership functions, fuzzy relations, defuzzification, fuzzy arithmetic and fuzzy measures, fuzzy rule base, and approximate reasoning, introduction to fuzzy decision making, Fuzzy logic controller design, applications of Fuzzy logic.	8
3	**Artificial Neural Networks:** What is Neural Network, Learning rules and various activation functions, Single layer Perceptrons , Back Propagation networks, Architecture of Back propagation(BP) Networks, Back propagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.	8
4	**Genetic Algorithms:** History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization, Applications.	7

5	**Hybrid Systems:** Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.	7
6	**Multi-objective Optimization Problem Solving:** Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs.	6

TEXT BOOKS:

1. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
2. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd Ed, Pearson Education, 1999.
3. G. Chen and T. T. Pham, Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems, CRC Press, 2001.

REFERENCE BOOKS:

1. P. M. Dixit, U. S. Dixit, Modeling of metal forming and machining processes: by finite element and soft computing methods, 1st Ed, Springer-Verlag, 2008.
2. K. Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2006.
3. R. A. Aliev, R. R. Aliev, Soft Computing and its Applications, World Scientific Publishing Co. Pte. Ltd., 2001
4. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
5. Genetic Algorithms: Search and Optimization, E. Goldberg.

PEC DS3204-Elective –II

3. Cyber Security

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Fundamental knowledge of Data Communication, Networking and Information Security.

Course Objectives:

1. To gain knowledge about securing both clean and corrupted systems, protect personal data, and secure computer networks
2. To examine secure software development practice
3. To understand key terms and concepts in I.T. ACT
4. To incorporate approaches for incident analysis and response

Course Outcomes:

On completion of the course, student will be able to

1. Explain the cyber security concepts.
2. Describe the cyber security vulnerabilities and prevention techniques.
3. Explain the different rules and regulations under I.T. ACT.
4. Explain the concepts of digital forensics & incident managemen

Unit No.	Unit Name and Contents	No. of Lectures
1	**Computer and Network Security** Introduction to Computer Security - Introduction, How Seriously Should You Take Threats to Network Security?, Identifying Types of Threats, Basic Security Terminology, Concepts and Approaches, Online Security Resources Networks and the Internet : Introduction, Network Basics, How the Internet Works, Basic Network Utilities , Advanced Network Communications Topics.	7
2	**Cyber Frauds, DoS, Viruses:** Cyber Stalking, Fraud, and Abuse: Introduction, How Internet Fraud Works, Identity Theft, Cyber Stalking, Protecting Yourself Against Cyber Crime. Denial of Service Attacks: Introduction, DoS, Illustrating an Attack, Malware: Introduction, Viruses, Trojan Horses, The Buffer-Overflow Attack. The Sassier Virus/Buffer Overflow, Spyware, Other Forms of Malware, Detecting and Eliminating Viruses and Spyware	8
3	**Techniques Used by Hackers :** Introduction, Basic Terminology, The Reconnaissance Phase, Actual Attacks, Malware Creation, Penetration Testing	7
4	**Computer Security Technology**: Introduction, Virus Scanners, Firewalls, Antispyware, IDS, Digital Certificates, SSL/TLS, Virtual Private Networks, Wi-Fi Security	6
5	**I.T. ACT:** Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, I.T. Act	6

6	**Introduction to Forensics:** Introduction, General Guidelines, Finding Evidence on the PC, Finding Evidence in System Logs , Getting Back Deleted Files, Operating System Utilities, Operating System Utilities, Mobile Forensics: Cell Phone Concepts	7

TEXT BOOKS:

1. Computer Security Fundamentals - Chuck Easttom, Pearson, third edition.

REFERENCE BOOKS:

1. Jason Luttgens, Matthew Pepe, Kevin Mandia, Incident Response & Computer Forensics, McGraw-Hill Osborne Media, 3 rdedition , 2014.
2. Keith J. Jones, Richard Bejtlich, Curtis W. Rose, Real Digital Forensics: Computer Security and Incident Response, Paperback – Import, 2005.
3. John Sammons, the Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics Paperback, February 24, 2012.
4. Hacking Exposed: Network Security Secrets & Solutions, Stuart McClure, Joel Scambray and George.Kurtz, McGraw-Hill, 2005.
5. Ethical Hacking, Thomas Mathew, OSB Publisher, 2003.
6. Dave Shackleford, Virtualization Security: Protecting Virtualized Environments, John Wiley & Sons, 2012.
7. BRAGG, Network Security: The Complete Reference, McGraw Hill Professional, 2012

PEC DS3204-Elective –II

4. Computer Algorithms

Lectures	**:**3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Data Structures, Discrete Mathematics, Engineering Mathematics, Programming Concepts.

Course Objectives:
1. To introduce algorithm design methods / techniques with analysis
2. To devise algorithm for given problem statement
3. To introduce complex computational problems
4. Introducing parallel algorithms

Course Outcomes:
On completion of the course, student will be able to
1. Understand and demonstrate algorithm design methods with analysis
2. Devise algorithm for given problem statement and analyze its space and time complexity by using recurrence relation
3. Categorize the problem to determine polynomial and non-polynomial based on its nature
4. Understand and demonstrate basic concepts of parallel algorithms

Unit No.	Unit Name and Contents	No. of Lectures
1	**Unit 1 : Divide and Conquer:** What is algorithm, Algorithm Specification, Flow chart, Algorithm Design techniques. Recurrence relations, Performance Analysis, Asymptotic Notations. **Divide and Conquer:** The general method, Binary search, Finding the maximum and minimum, Merge sort, Quick sort, analysis of Divide and Conquer algorithms.	6
2	**The Greedy Method:** The general method, Fractinal Knapsack problem, Job sequencing with deadlines, minimum-cost spanning trees – Prim's and Kruskal's Algorithms, Optimal storage on tapes, Optimal merge Patterns, Huffman Codes, Single Source shortest Path.	7
3	**Dynamic Programming:** The general method, Comparison of Divide and Conquer and Dynamic Programming, Multistage graphs, All pair shortest paths, 0/1 knapsack, Traveling Sales person problem.	8
4	**Basic Traversal and Search Techniques :** Techniques for Binary Trees, Game Tree; Techniques for Graphs – Breadth First Search & Traversal, Depth First Search & Traversal, AND/OR graphs; Connected components and Spanning Trees; Bi-connected components and depth first search.	7
5	**Backtracking -** The general method,4- queen problem, 8-queen problem, sum of subsets, Knapsack Problem, Hamiltonian Cycle, and Graph Coloring, **Branch and bound** : Introduction, Job sequencing with deadline.	7

6	**NP Hard and NP Complete Problems:** Basic Concepts, Introduction to NP Hard Graph Problems. **Introduction to Parallel Algorithm:** Computational Model and Fundamental Techniques and Algorithms – PRAM, MESH and HYPERCUBE.	7

TEXT BOOKS:

1. Fundamentals of Computer Algorithms Ellis Horowitz, Satraj Sahani, SaguthevarRajasejaran Universities Press, Second Edition

REFERENCE BOOKS:

1. Fundamentals of Algorithmics Gilles Brassard, Paul Bratley Pearson Education
2. Mastering Algorithms with C Kyle Loudon SPD O'Reilly
3. Computer Algorithms- Introduction to Design and Analysis Sara Baase, Allen Van Gelder Pearson Education

PEC DS3205-Elective –III

1. Data Acquisition

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Course Objectives:

- To understand the fundamentals of data acquisition and its role in the data science lifecycle.
- To explore various data sources and formats including files, databases, web, sensors, and streaming platforms.
- To develop skills for acquiring data using programming tools, APIs, and big data ingestion frameworks.
- To create awareness about data quality, governance, security, and ethical issues during data collection.

Course Outcomes:

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

- Identify and classify data sources, data types, and formats suitable for data science applications.
- Acquire data from heterogeneous sources such as files, databases, web APIs, and real-time streams.
- Implement scalable data ingestion pipelines using modern tools and cloud platforms.
- Apply data quality checks, governance policies, and ethical practices during data acquisition.

Unit No.	Unit Name and Contents	No. of Lectures
1	**UNIT I: Introduction to Data Acquisition** • Data acquisition in the data science lifecycle • Types of data: structured, semi-structured, unstructured • Sources of data: internal vs external data • Data formats: CSV, JSON, XML, Parquet, Avro • Data collection challenges and quality issues • Ethical, legal, and privacy considerations (GDPR, data consent)	7

2	**UNIT II: Data Acquisition from Files and Databases**
	• File-based data acquisition
	  ○ Text files, CSV, Excel
	  ○ Log files and system-generated data
	• Relational databases
	  ○ SQL basics for data extraction
	  ○ Joins, subqueries, views
	• NoSQL databases
	  ○ Key-value, document, column-family, graph databases
	• Data ingestion using Python (Pandas, SQLAlchemy)
		8

3	**UNIT III: Web-Based Data Acquisition** • Web data sources and APIs • RESTful APIs and HTTP methods • Data acquisition using public APIs (JSON/XML) • Web scraping concepts	7

	◦ HTML structure and DOM ◦ Scraping using BeautifulSoup and Scrapy • Handling pagination, authentication, rate limits • Legal and ethical issues in web data extraction	
4	**UNIT IV: Sensor, Streaming, and Real-Time Data Acquisition** • Sensor data and IoT-based data sources • Data acquisition from devices and embedded systems • Streaming data concepts • Message brokers and streaming platforms ◦ Apache Kafka ◦ Apache Flume ◦ MQTT • Real-time data ingestion pipelines • Use cases: smart cities, healthcare monitoring, industrial IoT	7
5	**UNIT V: Big Data and Cloud-Based Data Acquisition** • Data acquisition in big data ecosystems • HDFS data ingestion • Tools for large-scale data acquisition ◦ Apache Sqoop ◦ Apache NiFi • Cloud-based data sources ◦ AWS (S3, Kinesis) ◦ Google Cloud (BigQuery, Pub/Sub) ◦ Azure (Data Factory, Event Hubs) • Data versioning and metadata management	7
6	**UNIT VI: Data Quality, Preprocessing, and Governance** • Data validation and cleansing during acquisition • Handling missing, noisy, and inconsistent data • Data provenance and lineage • Data governance frameworks • Security in data acquisition pipelines • Case studies in healthcare, finance, and social media data acquisition	6

Text Books

1. O'Neil, Cathy & Schutt, Rachel, Doing Data Science: Straight Talk from the Frontline, O'Reilly Media, 2013.
2. Müller, Andreas C. & Guido, Sarah, Introduction to Machine Learning with Python, O'Reilly Media – (Data handling and acquisition chapters).
3. Karau, Holden et al., Learning Spark: Lightning-Fast Big Data Analysis, O'Reilly Media, 2015.
4. Leskovec, Rajaraman & Ullman, Mining of Massive Datasets, Cambridge University Press, 2014.

Reference Books

1. Provost, Foster & Fawcett, Tom, Data Science for Business, O'Reilly Media, 2013.
2. White, Tom, Hadoop: The Definitive Guide, O'Reilly Media, 4th Edition.
3. Kleppmann, Martin, Designing Data-Intensive Applications, O'Reilly Media, 2017.

PEC DS3205-Elective –III

2. Object Oriented Modeling and Design

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Software Engineering &Object Oriented Concepts.

Course Objectives:

1. To Understand the Object Based View of the System
2. To design Problems using Object Oriented Analysis and Design Techniques
3. To Understand UML notations and compare with OMT
4. To inculcate necessary skills to handle complexities in Software Design

Course Outcomes:

1. Ability to analyze and model software systems
2. Ability to construct OO view of the system
3. Ability to design a Software System using OMT design techniques.
4. Ability to design a Software System using UML design techniques.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction:** Ability to analyze and model software systems Object oriented themes, modeling as a design technique. **Object Modeling:** Object, classes, Link & association, advanced link & Association concepts, generalization & Inheritance, grouping constructs, aggregation, abstract classes, generalization as extension & restriction, multiple inheritance, metadata, candidate key & constraints.	8
2	**Dynamic & Functional Modeling:** Dynamic modeling: Events & states, operations, nested state diagrams, concurrency, advanced dynamic modeling concepts &simple dynamic model, relation of object dynamic models. **Functional Modeling:** functional model, data flow diagrams, specifying operations, constriction, a simple functional model, relation of functional to object & dynamic model.	8
3	**Design Methodology:** OMT methodology, Impact of an object-oriented approach, analysis, system design with examples, combining models, design algorithms, design optimization, implementation of controls, design association & physical packaging.	6
4	**Introducing the UML:** An overview of the UML, Conceptual Model of UML, Architecture of UML Structure modeling Using UML: Classes, Relationship, Diagrams, Class Diagrams.	7
5	**Behavioral Modeling:** Interactions, Use Cases, Use Case Diagram, Interaction diagrams, Activity diagrams, Events & Signals, State Machines, Process & Threads, Time & Space, State chart diagrams.	6

6	**Architectural Modeling**: Components, Deployment, Collaboration, Patterns & frameworks, component diagrams, Deployment diagrams.	6

TEXT BOOKS:

4. Object-orientated Modeling & Design: (Unit 1 to 3) James Rambaugh, Michael Blaha, William Premerlani, Frederick Eddy, William Lorensen PHI (Unit 1 to 3)
5. The Unified Modeling Language User Guide Grady Booch, James Rambaugh, Lvar Jacobson Addison Wesley (Unit 4 to 6)

REFERENCE BOOKS:

1. Object oriented analysis & design using UML H. Srimathi, H. Sriram, A. Krishnamoorthy SCITECH PUBLICATION 2nd Edition
2. Object Oriented analysis& Design Andrew High TMG
3. Practical Object Oriented Design with UML Mark Priestley McGraw-Hill Education
4. Threat first Object oriented analysis & design BreetMclaughline, Garry Police &Devide West OREILLY

PECDS3205-Elective –III

3. Image Processing

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Basic knowledge of Linear Algebra and programming language

Course Objectives:

1. To understand the fundamentals of digital image processing, including components of image processing systems, image formation, digitization, and different image types such as binary, grayscale, and color images.
2. To apply image enhancement and filtering techniques using gray-level transformation functions, histogram equalization, and spatial domain filtering for improving image quality and visual interpretation.
3. To analyze and implement advanced image processing techniques, including morphological operations, image segmentation methods, and shape representation for effective extraction of meaningful image features.
4. To design and evaluate image-based classification and recognition systems using supervised and unsupervised techniques, and apply digital image processing concepts to real-life applications such as face recognition, object detection, and classification through case studies.

Course Outcomes:

After completion of this course, students will be able to:

1. Explain different concepts and processes in digital image processing.
2. Apply different image processing operations on an image.
3. Analyze various operations on image using different tools.
4. Compare various filtering, enhancement, segmentation and classification techniques used in image processing.
5. Design various applications in Image Processing.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Digital Image Fundamentals:**Components of image processing system, human and computer vision, hierarchy of image processing system, applications, image formation and digitization, binary, gray scale and color images.	7
2	**Image Enhancement & Image Filtering Gray level transformation function:** Image Negatives, Log Transformations, Power Law Transformation, Piecewise Linear Transformation Functions, Histogram equalization, Basics of spatial filtering, smoothening and sharpening spatial filter..	7
3	**Morphological Image Processing** :Dilation and erosion, opening and closing operation, Hit or miss transformation, Edge Detection, Applications of Morphological Image Processing.	6

4	**Image Segmentation:** Thresholding, Role of illumination, global and adaptive thresholding, pixel-based segmentation, region-based segmentation and edge-based segmentation.	7
5	**Image Shape and Classification:** Shape representation, Feature space, Clusters and classification techniques, Supervised and Unsupervised classification, Basic algorithms: Boundary extraction, region filling, thinning and thickening, skeletons.	7
6	**Real Life Applications and Case Studies**: Face recognition, Object detection, Object Classification, various case studies and applications of Digital Image Processing.	6

TEXT BOOKS:

1. R.C. Gonzalez & R.E. Woods, Digital Image Processing, Pearson.
2. Pratt W.K, Digital Image Processing, John Wiley & Sons.

REFERENCE BOOKS:

1. R.C. Gonzalez & R.E. Woods, Digital Image Processing using MATLAB, Pearson.
2. Georgy Gimel' farb, Patrice Delmas, Image Processing and Analysis: A Primer, World Scientific.

PECDS3205-Elective –III

4. Exploratory Data Analysis

Lectures	**:** 3Hrs./Week	**Evaluation Scheme**
Credit	**:** 3	**MSE : 30Marks**
		ISE/CA : 10Marks
		ESE : 60Marks

Prerequisite: Statistics and Linear Algebra, Python Programming

Course Objectives:

1. To understand datasets, variable types, and relationships using statistical measures like correlation, covariance, and normal distribution.
2. To handle missing values effectively and apply suitable data encoding techniques.
3. To perform variable discretization and manage outliers for improving data quality.
4. To apply feature scaling and transformation methods for better model performance.
5. To implement feature engineering and data balancing techniques for building robust analytical models.

Course Outcomes:

6. Explain the fundamental concepts in exploratory data analytics.
7. Interpret various data preprocessing techniques in exploratory data analytics.
8. Apply different techniques in EDA on real life data.
9. Analyze different application dataset using EDA techniques

Unit No.	Unit Name and Contents	No. of Lectures
1	**UNIT 1: Introduction to EDA** EDA :- Definition, need, steps. Introduction to Dataset :- Definition, Variables and their types, Identify numerical and categorical variables, Cardinality in categorical variables, Relationship between variables, Covariance and Correlation, concept of multi co-linearity, Normal Distribution.	7
2	**UNIT 2 Handling Missing Data and Data Encoding** Impute missing data: - Interpretation of missing data, handling missing data - mean, mode, median, min, max, forward fill, backward fill, remove missing data. Data Encoding: - Significance of data encoding, Types of encoding techniques - one hot encoding, ordinal encoding, label encoding, mean encoding.	7
3	**UNIT 3 Variable Discretization and Working with Outliers** Variable Discretization:- divide the variables into equal intervals, perform discretization followed by categorical encoding. Working with outliers:- Interpretation of outliers , trimming outliers, capping the variables at arbitrary max and min values, performing zero coding.	7
4	**UNIT 4 Feature Scaling** Significance of Feature Scaling, Related terms in feature scaling, Normalization, Standardization, difference between normalization and standardization, Types of Scalers - Max Abs scaler, Robust scaler, Quantile Transformer scaler, Power Transformer scaler	7
5	**UNIT 5 Feature Engineering** Curse of Dimentionality, Feature Elimination Techniques - PCA, LDA, Feature Selection - Wrapper, Embedded Techniques, Concept of Multicolinearity, VIF.	6

6	**UNIT 6 Data BalancingComponents** Interpretation of classification dataset, Impact of imbalanced dataset, Techniques to handle imbalanced dataset - undersampling, over-sampling, K-fold Cross-Validation, SMOTE, Balanced Bagging Classifier, Threshold moving.	6

TEXT BOOKS:

1. "Python Feature Engineering Cookbook" by Soledad Galli - Packt Publication

REFERENCE BOOKS:

1. “Python for data analysis “ by Wes Mckinney - O'Reilly Publication.
2. "Hands-On Exploratory Data Analysis with Python" by Suresh Kumar Mukhiya, Usman Ahmed - Packt Publishing March 2020

MDM DS3206-Multidsciplinary Minor-04
(Database Concepts and Design)

Lecture	**:** 2 Hrs./Week	**Evaluation Scheme**
Credit	**:** 2	**MSE:**30 Marks
		ISE/CA:10Marks
		ESE :60 Marks

Prerequisite:

Course Objectives:

1. **To explain the fundamental concepts of database systems**,
2. To apply relational database design principles
3. To develop proficiency in Structured Query Language (SQL)
4. To understand transaction management, concurrency control, indexing, and NoSQL concepts

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Explain the fundamental database concepts
2. Apply the normalization techniques and SQL queries on database
3. Interpret various indexing and concurrency control techniques.
4. Develop a database application using database design principles.

Unit No.	Unit Name and Contents	No. of Lectures
1	**Introduction to Database Concepts:** Purpose of Database Systems, View of Data, Data Models, Database Architecture, Roles in Database Environment, The Entity-Relationship Model, Entity-Relationship Diagrams, Reduction to Relational Schemas, Introduction to Relational Model, Relational Query Languages- The Relational Algebra.	05
2	**Relational Database Design :** The purpose of Normalization, Data Redundancies and Update Anomalies, Functional Dependencies, The Process of Normalization, First Normal Form, Second Normal Form, Third Normal Form, Boyce-Codd Normal Form, Fourth Normal Form, Fifth Normal Form.	05
3	**Relational Model and Structured query Language:**. Structure of Relational Databases, SQL Data Definition Language, Basic Structure of SQLQueries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database, Join Expressions, Views.	05
4	**Transactions and Concurrency Control:** Simple Transaction Model, Serializability, Concurrency Control- Lock-Based Protocols, Two phase locking protocols, Graph-based protocols, Multiple Granularity, Timestamp-Based Protocols, Validation-Based Protocols.	05
5	**File Structure, Indexing and Hashing**: Overview of Physical Storage Media, File Organization, Organization of Records in Files, Data-Dictionary Storage, Database Buffer. Basic Concepts of Indexing and Hashing, Ordered Indices.	04

6	**Overview of NoSQL:**Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, The Value of Relational Databases	04

TEXT BOOKS :

1. Fundamentals of Database Systems – by Ramez Elmasri and Shamkant Navathe Publisher -Pearson Education, 5th Edition.
2. Database Systems: Design, Implementation and Management.-PeterRof, Carlos Coronel (7th Edition), Cengage Learning.

REFERENCE BOOKS:

1. DataBase System Concept by Henry F. Korth, Abraham Silberschatz, Sudarshan (McGraw Hill Inc.) Sixth Edition
2. Database Systems- A practical approach to Design, Implementation and Management by Thomos Connolly, Carolyn Begg, 3rd Edition, Pearson Education

PCC DS3207-Advanced Database Systems Lab

Practical	**:** 2Hrs./Week	**Evaluation Scheme**
Credit	**:** 1	**MSE:--**
		ISE/CA:50Marks
		ESE :25Marks

Prerequisite: Database Systems

Course Objectives:

1.To learn Basics of design of databases.
2. To acquire knowledge on parallel and distributed databases and its applications.
3.To study the usage and applications of SQL and NOSQL databases.
4. To Understand and perform common database administration tasks, such as database monitoring, performance tuning, data transfer, and security.
5. To understand the usage of advanced data models.

Course Outcomes:

Upon successful completion of this course, the student will be able to –

1. Understand and identify issues arising from parallel and distributed processing of data.
2. Select appropriate database and construct solution to real world problems of storing large data.
3. Compare and Contrast NoSQL databases with each other and Relational Database Systems.
4. Make use of SQL cursors, triggers, stored procedures, and procedural SQL to write complexSQL scripts.
5. Learn database administration tasks and security measures.

Minimum 12 to 14 experiments should be completed

Experiment List

1.	Installation of Oracle / MySQL and practicing DDL & DML commands. Execute basic utilities used to interact with Oracle DBMS / MySQL.
2.	Design and implement the Fragmentation schema & the Replication schema for the social networking websites / online e shopping / e-learning websites.
3.	Implementation of 2 Phase Commit protocol for distributed databases.
4.	Execute partitioning queries on parallel databases.
5.	Implementation of Relational Set Operators, SQL Join queries, Subqueries and Correlated Queries, Oracle Synonyms and Sequence.
6.	Demonstrate SQL Functions, Procedures, Cursors, and triggers using PL/SQL, Views.
7.	Installation of MongoDB and Apache Cassandra.
8.	Exploring MongoDB, and Apache Cassandra basics, Identify the schema design and data modeling techniques in MongoDB.
9.	Accessing MongoDB and Apache Cassandra from some of the popular high-level programming languages. Perform Create, Retrieve, Update and Delete or CRUD operations in MongoDB.
10.	Install CouchDB on Windows.
11.	Create and delete CouchDB database. Run CouchDB query with Mongo.
12.	Case study of Oracle Database Administration and Security. Study of database administrator's responsibilities like – • Installing and upgrading the database server and/or application tools. • Creating user's profiles and ensuring system security by careful allocation of user permissions. • Monitoring technical support for both database systems and related applications.

13. Study of CASE concept and tools.
14. Demonstrate all OLAP operations and cube operator in OLAP.
15. Consider a case study of any Big Data system of your choice and design the distributed database architecture and analyze the probable solutions available in the market.
16. Demonstrate data analysis and visualization using any BI Tool.

TEXTBOOKS:

Sr.No.	Title	Author(s) Name	Publication & Edition	Units Covered
1	Database System Concepts	Silberschatz, Korth, Sudarshan	MGH, 6th Edition (International edition) 2010	Unit 1
2	Database Systems, Design, Implementation andManagement	Coronel-MorrisRob		Unit No.2, 4
3	Professional NOSQL	Shashank Tiwari	John Wiley & Sons, Inc. 2011	Unit No.3
4	Business Intelligence- Data Mining and optimization for Decision Making	Carlo Vercellis	Wiley Publications.	Unit No.5, 6

REFERENCE BOOKS:

Sr. No.	Title	Author(s) Name	Publication & Edition
1	Database Management System	Raghu Ramkrishnan, Johannes Gehrke,	MGH, [4e], 2015
2	Fundamentals of Database Systems	R. Elmasri S. B. Navathe	Addison Wesley
3	NoSQL Distilled: A brief guide to merging world of Polyglot persistence	Pramod J. Sadalage and Marin Fowler	Addison Wesley, 2012.
4	Advanced Database Management System	Rini Chakrabarti Shilbhadra Dasgupta	
5	Database Systems: A Practical Approach to Design, Implementation and Management,	Thomas Connolly, Carolyn Begg	6th Edition,2012.

PCC DS3208-R Programming Lab

Practical	**:** 2Hrs./Week	**Evaluation Scheme**
Credit	**:** 1	**MSE: --**
		ISE/CA:50 Marks
		ESE :25Marks

Prerequisite: Data visualization with Graphs

Course Objectives

1. To introduce the fundamentals of R programming and data structures
2. To develop proficiency in R programming constructs
3. To apply mathematical, statistical, and simulation techniques using R
4. To enable students to perform data analysis and visualization

Course Outcomes

At the end of this course, students will be able to:

1. Demonstration and implement of basic R programming framework and data structures
2. Explain critical R programming language concepts such as control structures and recursion
3. Applying mathematical and statistical operations data structures in R
4. Examine data-sets to create testable hypotheses and identify appropriate statistical tests

Experiment List:

1. Download and install R-Programming environment and install basic packages using install.packages() command in R.
2. Learn all the basics of R-Programming (Data types, Variables, Operators etc,.)
3. Write a program to find list of even numbers from 1 to n using R-Loops.
4. Create a function to print squares of numbers in sequence.
5. Write a program to join columns and rows in a data frame using cbind() and rbind() in R.
6. Implement different String Manipulation functions in R.
7. Implement different data structures in R (Vectors, Lists, Data Frames)
8. Write a program to read a csv file and analyze the data in the file in R.
9. Create pie chart and bar chart using R.
10. Create a data set and do statistical analysis on the data using R.

Text Books:

1. R Programming for Data Science Roger D. Peng , 2012
2. The Art of R Programming- A Tour of Statistical Software Design Norman Matloff , 2011

Reference Books

1. Hands-On Programming with R: Write Your Own Functions and Simulations Garrett Grolemund, Hadley Wickham 1st Edition, 2014

EL-DS3209-Software Testing Tools

Practical	**:** 4 Hrs./Week	**Evaluation Scheme**
Credit	**:** 2	**MSE: --**
		ISE/CA:50 Marks
		ESE :---

Perquisite: Basic knowledge of programming and software development concepts.

Course Objectives:

1. Introduce software testing fundamentals and automation concepts**.**
2. Develop skills in manual testing
3. Provide hands-on experience in automated testing using Selenium
4. Enable students to perform performance testing and defect tracking

Course Outcomes:

1. Understand software testing concepts, STLC, and bug life cycle.
2. Design and execute manual test cases for software applications.
3. Automate functional test cases using Selenium tools.
4. Apply advanced automation techniques such as data-driven testing and TestNG.
5. Perform performance testing and defect tracking using testing tools.
6. Develop and automate a complete web application testing project.

Minimum 10 to 12 experiments should be completed

Experiment List

1. Introduction to software testing tools and automation concepts
2. Study of **Software Testing Life Cycle (STLC)**and **Bug Life Cycle**
3. Manual testing – writing **test cases** for a given application
4. Selenium IDE – Installation ,record, play, and export test cases
5. Selenium WebDriver – basic test scripts, automation using locators
6. Selenium WebDriver – automation with XPath & CSS selectors
7. Data-driven testing using Selenium
8. Automation of **login and form validation**
9. Web element handling and validations
10. Use of **Assertions and TestNG** framework
11. Regression testing using Selenium
12. Introduction to **JMeter** and test plan creation
13. Defect reporting and tracking (**JIRA / Bugzilla** – demo)
14. Mini project – complete automation of a web module

Textbooks:

1.SoftwareTesting: Principles and Practices **by** Naresh Chauhan
2**.**Software Testing: A Craftsman's Approach **by** Paul C. Jorgensen

Reference Books

1. Software Testing: Principles, Techniques and Tools by M.G. Limaye
2. Selenium WebDriver: Practicals and Automation by Satya Avasarala / Navneesh Garg
3. Performance Testing with JMeter 3 – Third Editionby Bayo Erinle
4. Software Testing Tools: Test Management, Automation Tools by K.V.K.K. Prasad