IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering

Bachelor of Technology (B.Tech.) [Computer Science & Engineering (Data Science)]

V Semester

S.No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
				Theory			Practical						
				End Sem	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work / Lab Work & Sessional		L	T	P	
1.	**PCC-CSDS501**	PCC	**Database Management System**	70	20	10	60	40	**200**	2	1	2	**4**
2.	**PCC-CSDS502**	PCC	**Artificial Intelligence**	70	20	10	60	40	**200**	3	–	2	**4**
3.	**PCC-CSDS503**	PCC	**Operating System**	70	20	10	60	40	**200**	2	1	2	**4**
4.	**PCC-CSDS504**	PCC	**JAVA Programming**	–	–	–	60	40	**100**	–	–	4	**2**
5.	**PEC-CSDS501**	PEC	**Elective-I**	70	20	10	–	–	**100**	4	–	–	**4**
6.	**OEC-CSDS501**	OEC	**Open Elective-I**	70	20	10	–	–	**100**	3	–	–	**3**
7.	**PROJ-CSDS501**	PROJ	**Seminar-I**	–	–	–	–	50	**50**	–	–	2	**1**
8.	**–**	PROJ	**Internship-I**	To be completed during semester break. Its Evaluation / Credit to be added in Sixth Semester.									
		Total		**350**	**100**	**50**	**240**	**210**	**950**	**14**	**2**	**12**	**22**

Electives-I	**Open Electives-I**
PEC-CSDS501(A) Software Engineering & Project Management	OEC-CSDS501(A) Entrepreneurship
PEC-CSDS501(B) Data Warehousing and Data Mining	OEC-CSDS501(B) Intellectual Property Rights
PEC-CSDS501(C) Information Storage Management	OEC-CSDS501(C) Operation Research
PEC-CSDS501(D) Theory of Computation	OEC-CSDS501(D) Probability Theory & Statistics

1 Hr Lecture	1 Hr Tutorial	2 Hr Practical
1 Credit	1 Credit	1 Credit

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1.	**PCC-CSDS501**	PCC	**Database Management System**	70	20	10	60	40	**200**	2	1	2	**4**
2.	**PCC-CSDS502**	PCC	**Artificial Intelligence**	70	20	10	60	40	**200**	3	–	2	**4**
3.	**PCC-CSDS503**	PCC	**Operating System**	70	20	10	60	40	**200**	2	1	2	**4**
4.	**PCC-CSDS504**	PCC	**JAVA Programming**	–	–	–	60	40	**100**	–	–	4	**2**
5.	**PEC-CSDS501**	PEC	**Elective-I**	70	20	10	–	–	**100**	4	–	–	**4**
6.	**OEC-CSDS501**	OEC	**Open Elective-I**	70	20	10	–	–	**100**	3	–	–	**3**
7.	**PROJ-CSDS501**	PROJ	**Seminar-I**	–	–	–	–	50	**50**	–	–	2	**1**
8.	**–**	PROJ	**Internship-I**	To be completed during semester break. Its Evaluation / Credit to be added in Sixth Semester.									
		Total		**350**	**100**	**50**	**240**	**210**	**950**	**14**	**2**	**12**	**22**

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PEC-CSDS501(B) Data Warehousing and Data Mining	OEC-CSDS501(B) Intellectual Property Rights
PEC-CSDS501(C) Information Storage Management	OEC-CSDS501(C) Operation Research
PEC-CSDS501(D) Theory of Computation	OEC-CSDS501(D) Probability Theory & Statistics

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V-Semester

PCC-CSDS501	**Database Management System**	**2L: 1T: 2P (5 hrs.)**	**4 credits**

Course Objective:

The main objective of this course is to understand fundamental of database management system.

Course Contents: (45 hrs.)

Module 1: **(06 hrs.)**

DBMS Concepts and architecture Introduction, Database approach v/s Traditional file accessing approach, Advantages, of database systems, Data models, Schemas and instances, Data independence, Data Base Language and interfaces, Overall Database Structure, Functions of DBA and designer, ER data model: Entitles and attributes, Entity types, Defining the E-R diagram, Concept of Generalization, Aggregation and Specialization. transforming ER diagram into the tables. Various other data models object- o r i e n t e d data Model, Network data model, and Relational data model, Comparison between the three types of models.

Module 2: **(08hrs.)**

Relational Data models: Domains, Tuples, Attributes, Relations, Characteristics of relations, Keys, Key attributes of relation, Relational database, Schemas, Integrity constraints. Referential integrity, Relational Query languages: SQL-DDL, DML, integrity con straints, Complex queries, various joins, Relational algebra and relational calculus, Relational algebra operations like select, Project, Join, Division, outer union. Types of relational calculus i.e. Tuple oriented and domain oriented relational calculus and its operations.

Module 3: **(14 hrs.)**

Data Base Design: Introduction to normalization, Normal forms, Functional dependency, Decomposition, Dependency preservation and lossless join, problems with null valued and dangling tuples, multivalued dependencies. Query Optimization: Introduction, steps o f optimization, various algorithms to implement select, project and join operations of relational algebra, optimization methods: heuristic based, cost estimation based.

Module 4: **(09 hrs.)**

Transaction Processing Concepts: -Transaction s ystem , Testing of Serializability, Serializability of schedules, conflict & view serializable schedule, recoverability, Recovery from transaction failures. Log based recovery.

Control Techniques: Concurrency Control, locking Techniques for concurrency control, time stamping protocols for concurrency control.

Module 5: **(08 hrs.)**

Study of Relational Database Management Systems through Oracle/PL SQL

QL/MySQL: Architecture, physical files, memory structures, background process. Concept of table spaces, segments, extents and block. Dedicated server, multi threaded server. SQL queries, Data extraction from single, multiple tables equi- join, non equi-join, self - join, outer join. Usage of like, any, all, exists, in Special operators. Cursor management: nested and parameterized cursors, Oracle exception handling mechanism. Stored procedures, in, out, in out type parameters, usage of parameters in procedures. User defined functions their limitations. Triggers, mutating errors, instead of triggers.

Course Outcomes:

1. Describe basic concepts of DBMS and Explain ER model.
2. Solve queries using Relational Algebra, Relational Calculus and SQL.
3. Explain database schema and discuss the Query optimization methods.
4. Describe transaction processing, concurrency control and recovery technique.
5. Analyze the Various DBMS software like Oracle, SQL/PL SQL etc.

List of Text / Reference Books:

1. Date C J, “An Introduction to Database System”, Pearson Educations, 8th Edition,2003.
2. Korth, Silbertz,Sudarshan, “Fundamental of Database System”, McGraw Hill,5th Edition,2006.
3. Peter Rob, “ Data Base System:Design Implementation & Management”, CengageLearninig 4th Edition,2000.
4. Elmasri, Navathe, “Fundamentals of Database Systems”, Pearson Educations,7th Edition 2017.
5. Atul Kahate ,“ Introduction to Database Management System”, Pearson Educations,2004.
6. Oracle 9i Database Administration Fundamental-I, Volume I, Oracle Press, TMH.
7. Paneerselvam,”DataBase Management System”, PHI Learning,3rd Edition,2018.
8. J. D. Ullman, “Principles of Database and Knowledge – Base Systems”, Computer Science Press,2nd Edition 1988.
9. Serge Abiteboul, Richard Hull, Victor Vianu,“Foundations ofDatabases”, Addison-Wesley,1995.

List of Experiments

1. Introduction to Oracle and SQL
2. Write the queries for Data Definition language (DDL)
3. Write the queries for Data manipulation language (DML)
4. Use of various types of Integrity Constraints
5. Write the queries for Data Control language (DCL)
6. Use of SELECT command with different clauses.
7. Write SQL queries using logical operation (AND, OR, NOT)
8. Write SQL queries for aggregate functions (Max, Min, Sum, Avg, and Count)
9. Write SQL queries for group by and having
10. Write SQL queries for sub queries and nested queries
11. Write an SQL query to implement JOINS
12. Write SQL queries to create views
13. Write program by the use of PL/SQL
14. Design and implementation of any Data base system (like Banking, University etc).

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V-Semester

PCC-CSDS502	**Artificial Intelligence**	**3L: 0T: 2P (5 hrs.)**	**4 credits**

Course Objective:

The main objective of this course is to understand concepts of Artificial Intelligence.

Course Contents: (42 hrs.)

Module 1: **(09 hrs.)**

Meaning and definition of artificial intelligence, Physical Symbol System Hypothesis, production systems, Characteristics of production systems; Breadth first search and depth first search techniques. Heuristic search Techniques: Hill Climbing, Iterative deepening DFS, bidirectional search. Analysis of search methods. A* algorithm, and their analysis. Introduction to Genetic Algorithms.

Module 2: **(09hrs.)**

Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau. Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, in ferencing, monotonic and non monotonic reasoning. Introduction to prolog.

Module 3: **(08 hrs.)**

Network-based representation and reasoning, Semantic networks, Conceptual Graphs, frames. Description logic (DL), concept language, reasoning using DL. Conceptual dependencies (CD), scripts, reasoning using CD. Introduction to natural language processing.

Module 4: **(08 hrs.)**

Adversarial search and Game theory, classification of games, game playing strategies, prisoner's Dilemma. Game playing techniques, minimax procedure, alpha-beta cut-offs. Complexity of alpha-beta search. Automated planning, classical planning problem, forward planning, partial order planning, planning with proposal logic, hierarchical task planning, multi- agent planning

Module 5: **(08 hrs.)**

Reasoning in uncertain environments, Fuzzy logic, fuzzy composition relation, operations on fuzzy sets. Probabilistic reasoning, Bayes theorem, construction of Bayesian networks, belief propagation. Markov processes and Hidden Markov models

Course Outcomes:

1. Describe basic concepts of AI and Heuristic search Techniques.
2. Explain Knowledge Representation, Forward and backward reasoning.
3. Explain Network-based representation and reasoning.
4. Apply Adversarial search and Game theory.
5. Analyze the Various Probabilistic Graphical Models

List of Text / Reference Books:

1. Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-GrawHill.
2. Introduction to AI & Expert System: Dan W.Patterson, PHI.
3. Artificial Intelligence by Luger (Pearson Education)
4. Russel&Norvig, Artificial Intelligence: A Modern Approach, Pearson Education

List of Experiments

1. Installation of gnu-prolog, Study of Prolog (gnu-prolog), its facts, and rules.
2. Write simple facts for the statements and querying it.
3. Write a program for Family-tree.
4. Write Program for Monkey-banana Problem.
5. Write a program which behaves a small expert for medical Diagnosis.
6. Write programs for computation of recursive functions like factorial Fibonacci numbers, etc.
7. Write program to solve 5-queens problem.
8. Write a Program for water jug problem.
9. Write a program for travelling salesman program.
10. Case study of standard AI programs like Mycin and AI Shell

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V-Semester

PCC-CSDS503	**Operating System**	**2L: 1T: 2P (5 hrs.)**	**4 credits**

Prerequisite: Computer Organization & Architecture

Course Objective:
This Course provides a comprehensive introduction of Operating System, Process Management, Memory Management, File Management and I/O management.

Course Contents: (40 hrs.)

Module 1: **(06 hrs.)**
Introduction to Operating Systems: Function, Evolution, Different Types, Desirable Characteristics and features of an O/S, Operating Systems Services: Types of Services, Different ways of providing these Services – Utility Programs, System Calls, Operating System Structure, and Spooling & Buffering.

Module 2: **(11 hrs.)**
CPU Scheduling : Process Concept, Scheduling Concepts, Types of Schedulers, Scheduling Criteria, Process State Diagram, Scheduling Algorithms, Operation on Process, Algorithms Evaluation, System calls for Process Management; Multiple Processor Scheduling; Concept of Threads. Concurrent Processes : Real and Virtual Concurrency, Mutual Exclusion, Synchronization, Inter- Process Communication, Critical Section Problem, Solution to Critical Section Problem : Semaphores – Binary and Counting Semaphores, WAIT & SIGNAL Operations and their implementation. Deadlocks: Deadlock Problems, Characterization, Prevention, Avoidance, Recovery.

Module 3: **(11 hrs.)**
Memory Management: Different Memory Management Techniques – Partitioning, Swapping, Segmentation, Paging, Paged Segmentation, Comparison of these techniques, Techniques for supporting the execution of large programs: Overlay, Dynamic Linking and Loading, Virtual Memory – Concept, Implementation by Demand Paging etc., Page replacement algorithms.

Module 4: **(06 hrs.)**
File Systems: File Concept, User's and System Programmer's view of File System, Disk Organization, Tape Organization, Different Modules of a File System, Disk Space Allocation Methods – Contiguous, Linked and Indexed. Directory Structures, File Protection, System Calls for File Management, Disk Scheduling Algorithms.

Module 5: **(06 hrs.)**

Introduction to Network, Distributed and Multiprocessor Operating Systems. Case Studies: Unix/Linux, WINDOWS and other Contemporary Operating Systems.

Course Outcomes:

1. State the core concepts of operating system, evolution and types of operatingsystem.
2. Illustrate various input output concepts, interprocess communication and deadlock
3. Illustrate process scheduling and memory management techniques.
4. Describe the concept of file and disk management.
5. State the core concepts of network, distributed and multiprocessor operating system.

List of Text / Reference Books:

1. Avi Silberschatz, Peter Galvin, Greg Gagne, "Operating System Concepts Essentials", Wiley Asia Student Edition, 10th Edition, 2018.
2. William Stallings, "Operating Systems: Internals and Design Principles", Prentice Hallof India, 5th Edition, 2005.
3. Charles Crowley, "Operating System: A Design-oriented Approach", Irwin Publishing, 1st Edition.
4. Gary J. Nutt, "Operating Systems: A Modern Perspective", Addison-Wesley, 2nd Edition.
5. Maurice Bach, "Design of the Unix Operating Systems", Prentice-Hall of India, 8th Edition.
6. Daniel P. Bovet, Marco Cesati, "Understanding the Linux Kernel", O'Reillyand Associates, 3rd Edition.
7. Andrew S. Tanenbaum, "Modern Operating Systems", Prentice Hall, 3rd Edition,2007.
8. Bovet & Cesati, "Understanding the Linux Kernel", O'Reily, 3rd Edition.

List of Experiment:

Write a program:

1. To implement FCFS CPU scheduling algorithm.
2. To implement SJF CPU scheduling algorithm.
3. To implement Priority CPU Scheduling algorithm.
4. To implement Round Robin CPU scheduling algorithm.
5. To compare various CPU Scheduling Algorithms over different Scheduling Criteria.
6. To implement classical inter process communication problem (producer consumer).
7. To implement classical inter process communication problem (Reader Writers).
8. To implement classical inter process communication problem (Dining Philosophers).
9. To implement & Compare various page replacement algorithms.
10. To implement & Compare various Disk & Drum scheduling Algorithms
11. To implement Banker's algorithms.
12. To implement Remote Procedure Call (RPC).
13. Write a Devices Drivers for any Device or peripheral.

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V-Semester

PCC-CSDS504	**JAVA Programming**	**0L: 0T: 4P (4 hrs.)**	**2 credits**

Course Objective:

The objective is to impart programming skills used in this object oriented language java. The course explores all the basic concepts of core java programming.

Course Contents: (20 hrs.)

Module 1: **(04 hrs.)**

Java Basics: Concepts of OOP, Features of Java, How Java is different from C++, Environmental setup, Basic syntax, Objects and classes, Basic Data Types, Variable Types, Modifier Types, Basic operators, Loop Control, Decision Making, Strings and Arrays, Methods, I/O.

Module 2: **(04hrs.)**

Java Object Oriented: Inheritance, Overriding, Polymorphism, Abstraction, Encapsulation, Interfaces, Packages, Exploring java.util package.

Module 3: **(04 hrs.)**

Exception Handling and Threading: Exception Hierarchy, Exception Methods, Catching Exceptions, Multiple catch Clauses, Uncaught Exceptions Java¨s Built-in Exception. Creating, Implementing and Extending thread, thread priorities, synchronization suspending, resuming and stopping Threads, Multi-threading.

Module 4: **(04 hrs.)**

Event Handling and AWT: Event handling Mechanism, Event Model, Event Classes, Sources of Events, Event Listener Interfaces AWT: Working with Windows, AWT Controls, Layout Managers.

Module 5: **(04 hrs.)**

Java Advanced: Applet Class, Architecture, Skeleton, Display Methods. Swings: Japplet, Icons, labels, Text Fields, Buttons, Combo Boxes. Socket Programming: Socket methods, Server Socket methods, Socket Client and Socket Server examples.

Course Outcome:

1. Understand basic JAVA concepts and basics of Java programming.
2. Understand JAVA Object oriented concepts
3. Apply Exception Handling and Threading in Java programming.
4. Apply Event Handling and AWT in Java programming.
5. Understand Java Advanced concepts

List of Text / Reference Books:

1. "JAVA The Complete Reference" by Patrick Naughton & Herbert Schild, TMH
2. "Introduction to JAVA Programming a primar", Balaguruswamy.
3. "Introduction to JAVA Programming" Daniel/Young PH
4. "Java Script", Jeff Frentzen and Sobotka, Tata McGraw Hill,1999

List of Experiments:

1. WAP to find the average and sum of the N numbers Using Command line argument.
2. WAP to Demonstrate Type Casting.
3. WAP to find the number of arguments provide at runtime.
4. WAP to Test the Prime number.
5. WAP to calculate the Simple Interest and Input by the user.
6. WAP to create a Simple class to find out the Area and perimeter of rectangle and box using super and this keyword.
7. WAP to design a class account using the inheritance and static that show all function of bank (withrowal, deposite).
8. WAP to find the factorial of a given number using Recursion.
9. WAP to design a class using abstract Methods and Classes.
10. WAP to design a String class that perform String Method (Equal,Reverse the string,change case).
11. WAP to handle the Exception using try and multiple catch blocks.
12. WAP that Implement the Nested try Statements.
13. WAP to create a package that access the member of external class as well as same package.
14. WAP that import the user define package and access the Member variable of classes that Contained by Package.
15. WAP that show the partial implementation of Interface.
16. WAP to Handle the user defined Exception using throw keyword.
17. WAP to demonstrate System clock.

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V-Semester **Elective -I**

PEC-CSDS501 (A)	**Software Engineering & Project Management**	**4L: 0T: 0P (4 hrs.)**	**4 credits**

Course Objective:
The purpose of this subject is to cover the underlying concepts and techniques used in Software Engineering & Project Management.

Course Contents: (40 hrs.)
Module 1: **(08 hrs.)**

The Software Product and Software Process: Software Product and Process Characteristics, Software Process Models: Linear Sequential Model, Prototyping Model, RAD Model, Evolutionary Process Models like Incremental Model,Spiral Model, Component Assembly Model, RUP and Agile processes. Software Processcustomization and improvement, CMM, Product and Process Metrics, Feasibility Analysis, CostEstimation Model.

Module 2: **(08 hrs.)**

Requirement Elicitation, Analysis, and Specification: Functional and Non-functional requirements, Requirement Sources and Elicitation Techniques, Use case Modeling, System and Software Requirement Specifications, Requirement Validation, Traceability.

Module 3: **(08 hrs.)**

Software Design: The Software Design Process, Design Concepts and Principles, Software Modeling and UML, Architectural Design, Architectural Views and Styles, User Interface Design, Function- oriented Design, SA/SD Component Based Design and Design Metrics.

Module 4: **(08 hrs.)**

Software Analysis and Testing: Software Static and Dynamic analysis, Code inspections, Software Testing, Fundamentals, Software Test Process, Testing Levels, Test Criteria, Test Case Design, Test Oracles, Test Techniques, Black-Box Testing, White-Box Unit Testing and Unit, Testing Frameworks, Integration Testing, System Testing and other Specialized, Testing, Test Plan, Test Metrics, Testing Tools.

Module 5: **(08 hrs.)**

Software Maintenance & Software Project Measurement: Need and Types of Maintenance, Software Configuration Management (SCM), Software Change Management, Version Control, Change control and Reporting, Program Comprehension Techniques, Re-engineering, Reverse Engineering, Tool Support. Project Management Concepts, Project and Process Planning, Resources Allocations, Project Scheduling and Tracking, Risk Assessment and Mitigation, Software Quality Assurance (SQA). Project Plan, Project Metrics.

Course Outcomes:

1. Decompose the given project in various phases of a lifecycle.
2. Choose appropriate process model depending on the user requirements.
3. Perform various life cycle activities like Analysis, Design, Implementation, Testing & Maintenance.
4. Know various processes used in all the phases of the product.
5. Apply the knowledge, techniques, and skills in the development of a software product

List of Text / Reference Books:

1. Pankaj Jalote ,"An Integrated Approach to Software Engineering", Narosa Pub, 2005
2. Rajib Mall, "Fundamentals of Software Engineering" Second Edition, PHILearning,Fouth Edition, 2014.
3. P, S. Pressman "Software Engineering. A Practitioner's Approach" New edition, McGraw Hills,7th edition,2010.
4. Sommerville,"Software Enginerring",Pearson Education, 9th Edition,2011.
5. Richard H.Thayer,"Software Enginerring & Project Managements", WileyIndia
6. Waman S.Jawadekar,"Software Enginerring", TMH,2004.
7. Bob Hughes, M.Cotterell, Rajib Mall "Software Project Management", McGrawHill,Sixth Edition,2017
8. Schwalbe, Kathy "Information Technology Project Management" 8th Edition, 2016.
9. Kieron Conway "Software project Management from concept to development Black Book" Dreamtech Press.
10. Deepak Jain, "Software Engineering principle and practices" Oxford University Press,2008.
11. Bell Douglas "Software Engineering for students" ,Pearson Education.,4th Edition,2005.
12. Kelkar "Software Project Management," PHI Learning,3rd edition 2012.

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V-Semester **Elective -I**

PEC-CSDS501 (B)	**Data Warehousing and Data Mining**	**4L: 0T: 0P (4 hrs.)**	**4 credits**

Prerequisite: NIL

Course Objective:

The main objective of this course is to understand fundamental of Data Warehousing and Data Mining.

Course Contents: (40 hrs.)

Module 1: **(08 hrs.)**

Data warehouse: Introduction to Data warehouse, Difference between operational database systems and data warehouses, Data warehouse Characteristics, Data warehouse Architecture and its Components, Extraction- Transformation-Loading, Logical(Multi-Dimensional), Data Modeling, Schema Design, Star and Snow-Flake Schema, Fact Constellation, Fact Table, Fully Addictive, Semi Addictive, Non Addictive Measures; Fact-Less-Facts, Dimension Table Characteristics; OLAP Cube, OLAP Operations, OLAP Server Architecture-ROLAP, MOLAP and HOLAP.

Module 2: **(08 hrs.)**

Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Data Mining Task Primitives, Integration of a Data Mining System with a Database or Data Warehouse System, Major issues in Data Mining.

Data Preprocessing: Need for Preprocessing the Data, Data Cleaning, Data Integration & Transformation, Data Reduction, Discretization and Concept Hierarchy Generation

Module 3: **(08 hrs.)**

Association Rules: Problem Definition, Frequent Item Set Generation, The APRIORI Principle, Support and Confidence Measures, Association Rule Generation; APRIOIRI Algorithm, The Partition Algorithms, FP-Growth Algorithms, Compact Representation of Frequent Item Set-Maximal Frequent Item Set, Closed Frequent Item Set.

Module 4: **(08 hrs.)**

Classification: Problem Definition, General Approaches to solving a classification problem, Evaluation of Classifiers , Classification techniques, Decision Trees-Decision tree Construction, Methods for Expressing attribute test conditions, Measures for Selecting the Best Split, Algorithm for Decision tree Induction ; Naive-Bayes Classifier, Bayesian Belief Networks; K- Nearest neighbor classification Algorithm and Characteristics, prediction: Accuracy and Error measures, Evaluating the accuracy of a classifier or a predictor, Ensemble methods.

Module 5: **(08 hrs.)**

Clustering: Clustering Overview, A Categorization of Major Clustering Methods, partitioning methods, hierarchical methods, , partitioning clustering-k-means algorithm, pam algorithm; hierarchical clustering-agglomerative methods and divisive methods, Basic Agglomerative Hierarchical Clustering Algorithm, Key Issues in Hierarchical Clustering, Strengths and Weakness, Outlier Detection.

Course Outcomes

1. Understand why the data warehouse in addition to database systems.
2. Understand data mining and Pre-processing of data
3. Identify the association rules,
4. Understand different classification in large data sets
5. Understand different clustering in large data sets

List of Text / Reference Books:

1. Data Mining- Concepts and -1.chniques- Jiawei Han, Micheline Kamber, Morgan Kaufmann Publishers, Elsevier, 2 Edition, 2006
2. Introduction to Data Mining, Psng-Ning Tan, Vipin Kumar, Michael Steinbanch, Pearson
3. Data Mining Techniques, Arun KPujari, 3rd Edition, Universities Press.
4. Data Warehousing Fundament's, Pualraj Ponnaiah, Wiley Student Edition.
5. The Data Warehouse Life CycleToolkit — Ralph Kimball, Wiley StudentEdition
6. Data Mining, Vikaram Pudi,P Rddha Krishna, Oxford University Press.

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V-Semester **Elective -I**

PEC-CSDS501 (C)	**Information Storage Management**	**4L: 0T: 0P (4 hrs.)**	**4 credits**

Prerequisite: None

Course Objective:
To introduce solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities

Course Contents :(40 hrs)

Module 1: **(06hrs.)**
Introduction to Storage Technology: Data proliferation, evolution of various storage technologies, Overview of storage infrastructure components, Information Lifecycle Management, Datacategorization.

Module 2: **(12 hrs.)**
Storage Systems Architecture: Intelligent disk subsystems overview, Contrast of integratedvs. modular arrays, Component architecture of intelligent disk subsystems, Disk physical structure components, properties, performance, and specifications, RAIDlevels & parity algorithms, hot sparing, Front end to host storage provisioning, mapping andoperation.

Module 3: **(06 hrs.)**
Introduction to Networked Storage: JBOD, DAS, NAS, SAN & CAS evolution and comparison. Applications, Elements, connectivity, standards, management, security and limitations of DAS, NAS, CAS & SAN.

Module 4: **(06 hrs.)**
Hybrid Storage solutions; Virtualization: Memory, network, server, storage & appliances. Data center concepts & requirements, Backup & Disaster Recovery: Principles Managing & Monitoring: Industry management standards (SNMP, SMI-S, CIM), standard framework applications, Key management metrics (Thresholds, availability, capacity, security, performance).

Module 5: **(10 hrs.)**

Information storage on cloud :Concept of Cloud, Cloud Computing, storage on Cloud, Cloud Vocabulary, Architectural Framework, Cloud benefits, Cloud computing Evolution, Applications & services on cloud, Cloud service providers and Models, Essential characteristics of cloud computing, Cloud Security and integration.

Course Outcome:

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

1. To Understand the Concept of Information Storage and Data centre Environment.
2. To understand about Data Protection.
3. To Understand Fiber ChannelSAN.
4. To describe the different backup and recovery topologies and their role in providing disaster recovery and business continuity capabilities.
5. To Understand Cloud Computing.

List of Text / Reference Books:

1. G. Somasundaram & Alok Shrivastava (EMC Education Services) editors, "Information Storage and Management: Storing, Managing, and Protecting Digital Information",Wiley India,2009.
2. Ulf Troppens, Wolfgang Mueller-Friedt, Rainer Erkens, Rainer Wolafka, Nils Haustein, "Storage Network explained : Basic and application of fiber channels, SAN, NAS, iSESI, INFINIBAND and FCOE", WileyIndia.
3. John W. Rittinghouse and James F. Ransome, "Cloud Computing:Implementation, Management and Security", CRC Press, Taylor Frances Pub.1st Edition,2017
4. Nick Antonopoulos, Lee Gillam, "Cloud Computing : Principles, System &Application", Springer.
5. Anthony T. Velete, Toby J.Velk, and Robert Eltenpeter, "Cloud Computing: A practical Approach", McGraw-Hill Education (India) PvtLimited,2009
6. Dr. Kumar Saurabh , "Cloud Computing : Insight into New Era I", Wiley India Pvt. Limited, 2011.

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V-Semester **Elective -I**

PEC-CSDS501 (D)	**Theory of Computation**	**4L: 0T: 0P (4 hrs.)**	**4 credits**

Prerequisite: Nil

Course Objective:
The main objective of this course is to understand fundamental of Theory of Computation.

Course Contents: (40 hrs.)

Module 1: **(08 hrs.)**

Introduction of Automata Theory: Examples of automata machines, Finite Automata as a language acceptor and translator, Moore machines and mealy machines, composite machine, Conversion from Mealy to Moore and vice versa.

Module 2: **(08 hrs.)**

Types of Finite Automata: Non-Deterministic Finite Automata (NDFA), Deterministic finite automata machines, conversion of NDFA to DFA, minimization of automata machines, regular expression, Arden's theorem. Meaning of union, intersection, concatenation and closure, 2- way DFA.

Module 3: **(08 hrs.)**

Grammars: Types of grammar, context sensitive grammar, and context free grammar, regular grammar. Derivation trees, ambiguity in grammar, simplification of context free grammar, conversion of grammar to automata machine and vice versa, Chomsky hierarchy of grammar, killing null and unit productions. Chomsky normal form and Greibach normal form.

Module 4: **(08 hrs.)**

Push down Automata: example of PDA, deterministic and non-deterministic PDA, conversion of PDA into context free grammar and vice versa, CFG equivalent to PDA, Petrinet model.

Module 5: **(08 hrs.)**

Turing Machine: Techniques for construction. Universal Turing machine Multitap, multihead and multidimensional Turing machine, N-P complete problems. Decidability and Recursively Enumerable Languages, decidability, decidable languages, undecidable languages, Halting problem of Turing machine & the post correspondence problem.

Course Outcomes

1. Explain the basic concepts of switching and finite automata theory & languages.
2. Relate practical problems to languages, automata, computability and complexity.
3. Construct abstract models of computing, check their power to recognize the languages and analyze the grammar, its types, simplification and normal form.
4. Interpret rigorously formal mathematical methods to prove properties of languages, grammars and automata.
5. Develop an overview of how automata theory, languages and computation are applicable in engineering application.

List of Text / Reference Books:

1. Daniel I.A. Cohen,"Introduction to Computer Theory",Wiley India, 2nd Edition,2003.
2. John E Hopcroft, Jeffrey D. Ullman and Rajeev Motwani, "Introduction to Automata Theory, Languages and Computation", Pearson Education, 2nd Edition,2001.
3. K.L.P Mishra & N.Chandrasekaran,"Theory of Computer Science", PHI Learning, 3rdEdition,2006.
4. Peter Linz, "Introduction to Automata Theory and Formal Languages", Narosa Publishing. 3rdEdition,2007.
5. John C Martin, "Introduction to languages and the theory of computation", TATA McGraw Hill, 3rd Edition 2013.
6. Harry R. Lewis and Christos H. Papadimitriou, "Elements of the Theory ofComputation", Pearson Education Asia,2nd edition, 1998.
7. Dexter C. Kozen, "Automata and Computability", Undergraduate Texts in ComputerScience, Springer,1st edition,2012.
8. Michael Sipser, "Introduction to the Theory of Computation", PWS Publishing., 3rd edition,2012.

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V-Semester **Open Elective-I**

OEC-CSDS501(A)	**Entrepreneurship**	**3L:0T:0P (3hrs)**	**3 Credits**

Prerequisite(s): NA

Course Objectives:

- To develop conceptual understanding of the concept of Entrepreneurship
- To learn the government's policy.
- To Learn about **t**ypes of Enterprises
- To Learn about E-commerce and its Technological Aspects
- To Learn about Digital Marketing

Course Content:

Module 1 **(08Hrs)**

Entrepreneurship: Definition, requirements to be an entrepreneur, entrepreneur and entrepreneur, entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship, rural and urban entrepreneurship

Module 2 **(10Hrs)**

Entrepreneurial Motivation

Motivating factors, motivation theories-Maslow's Need Hierarchy Theory, McClelland's Acquired Need Theory, government's policy actions towards entrepreneurial motivation, entrepreneurship development programme.

Module 3 **(10Hrs)**

Types of Enterprises and Ownership Structure: Small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance

Module 4 **(12Hrs)**

E-commerce and its Technological Aspects: Overview of developments in Information Technology and Defining E-Commerce: The scope of E commerce, Electronic Market, Electronic Data Interchange, Internet Commerce, Benefits and limitations of E-Commerce, Produce a generic framework for E-Commerce, Architectural framework of Electronic Commerce, Web based E Commerce Architecture.

Module5 **(10Hrs)**

Introduction to Digital Marketing:. Evolution of Digital Marketing from traditional to modern era, Role of Internet, Search Engine Advertising, Display marketing, Social Media Marketing.

Course outcomes:

1. To inculcate entrepreneurship skills to students.
2. To aware about industry structure and how to start up a company.
3. To aware about types of Enterprises.
4. To understand E-commerce practices.
5. To understand and practice Digital Marketing.

Text Books:

1. Koontz &O' Donnel¸ Essentials of Management, Tata McGraw Hill,NewDelhi,2009
2. Peter F Drucker, The Practice of Management, McGraw Hill, NewYork,1960
3. Peter F.Drucker, Innovation and Development, McGraw Hill, NewYork,2000.

Reference Books:

1. Mohanty SK; Fundamental of Entrepreneurship; PHI, 2005.
2. Davis & Olson; Management Information System; TMH,1985.

Perspective:

Entrepreneurship education cultivates innovative talents, which are an important driving force for future development. At present, innovation-driven development strategies place new demands on entrepreneurship education

Recommendation:

Entrepreneurship is not just about start-ups. It is a problem-solving frame of mind that requires technical expertise, a business sense, an ability to anticipate the future, and an appreciation of social context

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V-Semester **Open Elective-I**

OEC-CSDS501(B)	**Intellectual Property Rights**	**3L:0T:0P (3hrs)**	**3 Credits**

Prerequisite(s): NA

Course Objective:

- To be familiar with the concept of intellectual property.
- To be familiar with Purpose and function of trademarks
- To be familiar with Fundamental of copy right law
- To clear idea of the trade Secrete
- To be familiar with latest development in the field of intellectual property.

Module 1 (08 Hrs)

Introduction to Intellectual Property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

Module 2 (08 Hrs)

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Module 3 (10 Hrs)

Law Of Copyrights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

Module 4 (08 Hrs)

Trade-Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Module 5 (08 Hrs)

New Development In Intellectual Property: new developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

Course Outcome:

After completion of the course student will be able to:

1. Understand the concept of intellectual property.
2. Understand what is trademark and its importance.
3. Understand the law of copyright.
4. Understand how trade secrete help in competitive market
5. Understand the latest trends in intellectual property.

Text Books & References:

1.Intellectual property right, Deborah.E.Bouchoux, Cengagelearning.

2.Intellectual property right –Unleashing the knowledge economy, Prabuddha Ganguli, Tata McGraw Hill Publishing company ltd.

Perspective:

The subject of IPR includes patents (granted to inventions that are new, no obvious, and useful, for a period of 20 years) designs, trademarks, Copyright etc. Students possess an understanding on IPR so that they can add more value when they join industries because they can apply these concepts in day to day scenarios protecting the assets of both the organization and as well as their customers.

Recommendation:

Each industry should evolve its own IPR policies, management style, strategies, and so on depending on its area of specialty. Pharmaceutical industry currently has an evolving IPR strategy requiring a better focus and approach in the coming era.

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V-Semester **Open Elective-I**

OEC-CSDS501(C)	**Operation Research**	**3L:0T:0P (3hrs)**	**3Credits**

Pre requisite(s): M-II, M-III

Course Objective:

1. To be familiar with all the OR Techniques and optimization methods.
2. To be familiar with various inventory control techniques.
3. To be familiar with waiting line models and Competitive strategy.
4. To clear idea of the decision making and meta-heuristic algorithm.
5. To understand project network analysis.

Course Content:

Module 1 (12 Hrs)

Linear system and distribution models: Mathematical formulation of linear systems by LP, solution of LP for two variables, Simplex method, special cases of LP- transportation and assignment model and their graphical solution, Vogels Approximation Method (VAM) or penalty method, cell evaluation degeneracy.

Module 2 (10 Hrs)

Inventory Models: Necessity of inventory in process and safety stock, problem of excess inventory and cycle time, JIT/ Lean Mfg; basics of inventory models with deterministic demand, Classical EOQ Model, ABC, VED and other analysis based on shelf life, movement, size, MRP technique and calculations, lot sizing in MRP, linking MRP with JIT; evolution of MRP to ERP to SCM and e-business.

Module 3 (10 Hrs)

Waiting Line Models: Introduction, Input process, service mechanism, Queue discipline, single server (M/M/1), average length and average time calculations, optimum service rate; basic multiple server models (M/M/s)

Competitive strategy: concept and terminology, assumptions, pure and mixed strategies, two person zero sum games, saddle point, dominance, graphical, algebraic and LP methods for solving game theory problems.

Module 4 (10 Hrs)

Decision Analysis: Decision under certainty, risk Probability and uncertainty, Hurwitz criterion AHP assigning weight and consistency test of AHP. **Metaheuristics:** definition of heuristic and metaheuristic algorithms.

Module 5 (10 Hrs)

Network Analysis: Project Planning, Scheduling and Controlling; Project management; Network Techniques and its role in project management, Network logics, Fulkerson's Law, Merits and Demerits of AON Diagrams; Progr amme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Determination of critical path, Float/Slack.

Course Outcome:

After completion of the course student will be able to:

1. Understand the concept of optimization and its application.
2. Understand the concept of various inventory control techniques used in industries.
3. Understand the concept of Queuing and Game Theory.
4. Understand the idea of the decision making and application of meta-heuristic algorithm
5. Implement project management concepts, tools and techniques in order to achieve project success

Text Books :

1. Hillier FS and Liberman GJ; Introduction to Operations Research concept and cases; TMH , 8th Ed. 2008.
2. Heera and Gupta,Operation Research, S Chand Pub.reprint with corrections ,2017
3. Sharma JK; Operations Research; Macmillan 3rd Ed. 2006.
4. Heera and Gupta ,Problems in Operations Research Principles and Solutions, S Chand Pub, 4th Ed. 2015.

Reference Books:

1. Taha H; Operations research; PHI, 10th Ed.2019.
2. Jain, pandey & shrivastava; Quantitative techniques for management, New Age publishers.2019
3. Srinivasan G; Quantitative Models In Operations and SCM; PHI Learning, 2017
4. Sen RP; Operations Research-Algorithms and Applications; PHI Learning, 2009
5. Bronson R ;Theory and problems of OR; Schaum Series; TMH, 2016.

Perspective:

Operations Research is interdisciplinary field, intermixing theories and methodologies from mathematics, management science, computer science, operations management, economics, engineering, decision support, soft computing and many more.

Recommendation:

Operations research and computers interact in many scientific fields of vital importance to our society. These include, among others, transportation, economics, investment strategy, inventory control, logistics. Computers & Operations Research (COR) provides an forum for the application of computers and operations research techniques to problems in these and related fields.

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V-Semester **Open Elective-I**

OEC-CSDS501(D)	**Probability Theory & Statistics**	**3L:0T:0P (3hrs)**	**4 Credits**

Course Objective: To understand the basic concept of probability, LPP, Index number and perform the data analysis with suitable forecasting in research and project phases.

Module-1: Probability (9 Hours)

Probability, Types of probability, Random variable, Probability function, Sampling: purpose and principle of sampling, Methods of sampling, Size of sample, Merits and limitations of sampling, Sampling distribution, Conditional probability, Baye's theorem.

Module-2: Correlation and Regression Analysis (9 Hours)

Correlation analysis: Significance, Correlation & Causation, Types of correlation, Methods of studying correlation, Multiple correlation, Regression analysis: Difference between correlation and regression, Bivariate linear regression model, Regression lines, Equations, Coefficients.

Module-3: Hypothesis Testing (8 Hours)

Concept of hypothesis, Types of error in testing, Level of significance, Null and alternative hypothesis, Special tests of significance: The Chi ($\chi 2$) test, The Z-Score test, The T-test, Test for proportion.

Module-4: Linear Programming (9 Hours)

Linear programming: General linear programming problem (LPP), Standard and canonical form of LPP, Formulation of LPP, Graphical solution, Simplex method, Artificial variable techniques: Two phase method, Big-M method, Duality: definition of the dual problem, Dual simplex method.

Module-5: Index Numbers, Forecasting and Time Series Analysis (10 Hours)

Index numbers: Use of index numbers, Unweighted index numbers, Weighted index numbers, Quantity index numbers, Volume index numbers, Time reversal test, Factor reversal test, Forecasting: Introduction, Steps in forecasting, Methods of forecasting, Time series analysis: Components of time series, Straight line trends, Non-linear trend.

Course Outcomes:

CO1: Apply fundamental concepts of probability to Computer Science & Engineering problem.
CO2: Apply and explain the Correlation & Regression to Computer Science & Engineering project.
CO3: Apply the various test of significance to structure engineering decision-making problems.
CO4: Apply various linear programming methods to Computer Science & Engineering.
CO5: Apply and analyze the index numbers, forecasting analysis and time series analysis on suitable classified data.

Textbooks/References:

1. Connor, L R and Morreu, A J H, Statistics in Theory and Practice, Pitman, London, 1964.
2. Wannacott and Wannacott, Introductory Statistics, John Wiley & Sons, New York,5th Edition, 1990.
3. Willams, Ken (ed), Statistics and Urban Planning, Charles Knight & Co. Ltd, London, 1975.
4. Yamane, Taro, Statistics – An Introductory Analysis, Harper, New York, 1973.
5. D. C. Montgomery and G. C. Runjer, Applied Statistics & Probability for Engineers, Wiley Publication, 6thEdition, 2014.
5. A. Ravindran, D. T. Phillips and James J. Solberg, Operations Research- Principles and Practice, John Wiley & Sons, 2nd Edition 2007.
6. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 10th Edition, 2019.
7. F.S. Hillier, G.J. Lieberman, Introduction to Operations Research- Concepts and Cases, Tata McGraw Hill, 10th Edition, 2017.
8. C. Chatfield, The Analysis of Time Series - An Introduction, Chapman and Hall, 7th edition 2019.
9. Peter J. Brockwell and Richard A. Davis, Introduction to Time Series and Forecasting, Springer, 3rd Edition 2016.
10. S. Ross, A first course in probability, Pearson education India, 6th edit