FACULTY OF ENGINEERING
Scheme of Instruction & Examination
(AICTE Model Curriculum for the Academic Year 2021-2022)

And

Syllabi

Of

Four Year Degree Program

of

Bachelor of Engineering (B.E.)

Computer Science and Engineering (Data Science)

(With effect from the academic year 2021–2022)

(As approved in the faculty meeting held on XX-XX-XX)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2021- 2024

SEMESTER WISE CREDITS

S. No	Semester	Credits
1	I	16.5
2	II	20.5
3	III	21
4	IV	24
5	V	23
6	VI	20
7	VII	21
8	VIII	14
TOTAL		**160**

SEMESTER WISE CREDIT DISTRIBUTION

Semester / Course Category	I	II	III	IV	V	VI	VII	VIII	Total	AICTE
BSC	**9.5**	**9.5**		**3**					**22**	**24**
ESC	**7**	**8**	**4**	**3**					**22**	**29**
HSMC		**3**	**3**	**6**					**12**	**12**
MC	**-**	**-**							**-**	**-**
PCC			**14**	**12**	**18**	**11**	**11**		**66**	**49**
PEC					**3**	**6**	**3**	**3**	**15**	**18**
OEC						**3**	**3**	**3**	**9**	**12**
PROJ					**2**		**4**	**8**	**14**	**15**
	16.5	**20.5**	**21**	**24**	**23**	**20**	**21**	**14**	**160**	**159**

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

I – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/ D	Contact Hours/ Week	CIE	SEE	Duration in Hours	
Theory Courses										
	Three Week Induction Programme									
1	MC 802 CE	Environmental Science	2	-	-	2	30	70	-	-
2	MC 803 PY	Essence of Indian Traditional Knowledge	2	-	-	2	30	70	-	-
3	BS 201 MT	Mathematics-I	3	1	-	4	30	70	3	4
4	BS 204 CH	Chemistry	3	1	-	4	30	70	3	4
5	ES 302 CS	Programming for Problem Solving	3	-	-	4	30	70	3	3
Practical/ Laboratory Courses										
6	BS 252 CH	Chemistry Lab	-	-	3	3	25	50	3	1.5
7	ES 352 ME	Workshop Practice	-	-	2x3	6	50	50	3	3
8	ES 351 CS	Programming for Problem Solving Lab	-	-	2	2	25	50	3	1
		Total	**13**	**02**	**11**	**26**	**250**	**500**		**16.5**

BS: Basic Sciences **ES: Engineering Sciences** **MC: Mandatory Course** **L: Lectures**

T: Tutorials **P: Practicals** **D: Drawing** **CIE: Continuous Internal Evaluation**

SEE: Semester End Examination

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

II – SEMESTER

S.No	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P	Contact Hrs/Wk	CIE	SEE	Duration in Hours	
Theory Courses										
1	MC 801 PO	Indian Constitution	2	-	-	2	30	70	3	-
2	HS 101 EG	English	2	-	-	2	30	70	3	2
3	BS 202 PH	Physics	3	1	-	4	30	70	3	4
4	BS 203 MT	Mathematics-II	3	1	-	4	30	70	3	4
5	ES 301 EE	Basic Electrical Engineering	3	1	-	4	30	70	3	4
Practical/ Laboratory Courses										
6	HS 151EG	English Lab	-	-	2	2	25	50	3	1
7	BS 251PH	Physics Lab	-	-	3	3	25	50	3	1.5
8	ES 353CE	Engineering Graphics	-	-	3x2	6	50	50	3	3
9	ES 354 EE	Basic Electrical Engineering Lab	-	-	2	2	25	50	3	1
Total			**13**	3	**12**	**29**	**275**	**550**	-	**20.5**

BS: Basic Sciences **ES: Engineering Sciences** **MC: Mandatory Course** **L: Lectures**

T: Tutorials **P: Practicals** **D: Drawing** **CIE: Continuous Internal Evaluation**

SEE: Semester End Examination

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

III – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**MC 802 CE**	**Environmental Science**	**2**	**-**	**-**	**2**	**30**	**70**	**3**	**-**
2	**MC 803 PY**	**Essence of Indian TraditionalKnowledge**	**2**	**-**	**-**	**2**	**30**	**70**	**3**	**-**
3	HS103ME	Operations Research	3	1	-	4	30	70	3	3
4	ES306EC	Basic Electronics	3	-	-	3	30	70	3	3
5	PC301CD	Data Structures and Algorithms	3	1	-	4	30	70	3	3
6	PC302CD	Programming Languages	3	-	-	3	30	70	3	3
7	PC303CD	Discrete Mathematics	3	-	-	3	30	70	3	3
8	PC304CD	Python Programming	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
9	ES351EC	Basic Electronics Lab	-	-	2	2	25	50	3	1
10	PC351CD	Data Structures and Algorithms using C Lab	-	-	2	2	25	50	3	1
11	PC352CD	Python Programming Lab	-	-	2	2	25	50	3	1
			22	**02**	**06**	**30**	**315**	**710**		**21**

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L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
PY: Philosophy, BZ: Biology/ Life Sciences, CE: Civil Engineering, CS: Computer Science and Engineering
EC: Electronics and Communication Engineering, ME: Mechanical Engineering.

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.
3. All the mentioned **Mandatory Courses** should be offered either in I–Semester or II–Semester only **from the academic year 2021-2022**.
4. For those of the students admitted during the academic year 2020-2021, since the Mandatory Courses were not offered during the I–Semester or II–Semester, they should be offered either in III–Semester or IV–Semester of the **academic year 2021-2022.**

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

IV – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**MC801PO**	**Indian Constitution**	**2**	**-**	**-**	**2**	**30**	**70**	**3**	**-**
2	HS104EG	Effective Technical Communication in English	3	-	-	3	30	70	3	3
3	HS105CM	Finance and Accounting	3	-	-	3	30	70	3	3
4	BS205MT	M-III (Probability & Statistics)	3	1	-	3	30	70	3	3
5	ES305EC	Signals and Systems	3	-	-	3	30	70	3	3
6	PC401CD	OOP using JAVA	3	-	-	3	30	70	3	3
7	PC402CD	Operating systems	3	1	-	3	30	70	3	3
8	PC403CD	Database Management Systems	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
9	PC451CD	Operating Systems Lab	-	-	2	2	25	50	3	1
10	PC452CD	OOP using JAVA Lab	-	-	2	2	25	50	3	1
11	PC453CD	Database Management Systems Lab	-	-	2	2	25	50	3	1
			23	**02**	**06**	**31**	**315**	**710**		**24**

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Note:

1. Each contact hour is a clock hour
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4. For those of the students admitted during the academic year 2020-2021, since the Mandatory Courses were not offered during the I–Semester or II–Semester, they should be offered either in III–Semester or IV–Semester of the **academic year 2021-2022.**
5. The students have to undergo a Summer Internship of two-week duration after IV – Semester and credits will be awarded in V – Semester after evaluation.

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

V – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC501CD	Design and Analysis of Algorithms	3	1	-	4	30	70	3	3
2	PC502CD	Introduction To Data Science and Machine Learning	3	-	-	3	30	70	3	3
3	PC503CD	Automata Languages and Computation	3	1	-	4	30	70	3	3
4	PC504CD	Artificial Intelligence	3	-	-	3	30	70	3	3
5	PC505CD	R For Data Science	3	-	-	3	30	70	3	3
6	PE-I	Professional Elective I	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
7	PC551CD	Data Science Using ‘R’ Lab	-	-	2	2	25	50	3	1
8	PC552CD	Artificial Intelligence using Python Lab	-	-	2	2	25	50	3	1
9	PC553CD	Design and Analysis of Algorithms Lab	-	-	2	2	25	50	3	1
10	PW533CD	Mini Project	-	-	4	4	25	50	3	2
			18	**02**	**06**	**26**	**255**	**570**		**23**

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EC: Electronics and Communication Engineering, ME: Mechanical Engineering.

PROFESSIONAL ELECTIVE-I		
Course Code	**Course category**	**Course Title**
PE505	PE-I	Statistical Simulation and Data Analysis
PE506		Distributed Databases
PE507		Software Engineering
PE508		Cloud Computing

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

VI – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC601CD	Compiler Design	3	1	-	4	30	70	3	3
2	PC602CD	Computer Networks	3	1	-	4	30	70	3	3
3	PC603CD	Data Mining	3	-	-	3	30	70	3	3
4	PE-II	Professional Elective-II	3	-	-	3	30	70	3	3
5	PE-III	Professional Elective-III	3	-	-	3	30	70	3	3
6	OE-1	Open Elective –I	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
7	PC651CD	Computer Networks Lab	-	-	2	2	25	50	3	1
8	PC652CD	Data Mining Lab	-	-	2	2	25	50	3	1
9	PW653CD	Summer Internship*	-	-	-	-	-	-	-	-
			18	**02**	**04**	**24**	**230**	**520**		**20**

PROFESSIONAL ELECTIVE-II		
Course Code	**Course category**	**Course Title**
PE604	PE-III	Forecasting Technique
PE605		Cognitive Science and Analytics
PE606		Software Testing Methodologies
PE607		Cyber Security

PROFESSIONAL ELECTIVE-III		
Course Code	**Course category**	**Course Title**
PE608	PE-IV	Business Intelligence and Analytics
PE609		Principles of Speech Processing
PE610		Software Project Management
PE611		Information Retrieval System

OPEN ELECTIVE-I	
Course Code	**Course Title**
OE1	Soft Skills and Interpersonal Skills
OE2	Human Resource Development and Organizational Behavior
OE3	Cyber Law and Ethics

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

VII – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC701CD	Big Data Analytics	3	1	-	4	30	70	3	3
2	PC702CD	Deep Learning	3	-	-	3	30	70	3	3
3	PC703CD	Data Handling and Visualization	3	-	-	3	30	70	3	3
4	PE-V	Professional Elective IV	3	-	-	3	30	70	3	3
5	OE-III	Open Elective –II	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
6	PC751CD	Big Data Analytics Lab	-	-	2	2	25	50	3	1
7	PC752CD	Data Handling and Visualization Lab	-	-	2	2	25	50	3	1
8	PW753CD	Project Work-1	-	-	6	6	50	-	-	3
9	SI754CD	Summer Internship	-	-	-	-	25	50	-	1
			15	**01**	**10**	**26**	**325**	**500**		**21**

PROFESSIONAL ELECTIVE-V		
Course Code	**Course category**	**Course Title**
PE703	PE- V	Web & Social Media Analytics
PE704		Natural Language Processing
PE705		Block Chain Technology
PE706		Image Processing

OPEN ELECTIVE – II	
Course Code	**Course Title**
OE4	Green Building Technologies
OE5	Fundamentals of IoT
OE6	Non-Conventional Energy Sources
OE7	Entrepreneurship

SCHEME OF INSTRUCTION & EXAMINATION

B.E. (COMPUTER SCIENCE AND ENGINEERING – DATA SCIENCE)

VIII – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PE-VI	Professional Elective V	3	-	-	3	30	70	3	3
2	OE-III	Open Elective-III	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
3	PW801CD	Project Work – II	-	-	16	16	50	100	3	8
			6	**-**	**10**	**16**	**110**	**240**		**14**

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PROFESSIONAL ELECTIVE-VI		
Course Code	**Course category**	**Course Title**
PE801	PE-VI	Internet of Things
PE802		Human Computer Interaction
PE803		Large Scale Data Processing
PE804		Quantum Computing

OPEN ELECTIVE-III	
Course Code	**Course Title**
OE13	Innovation & Entrepreneurship
OE14	Startup Management
OE15	Corrosion Science and Technology
OE16	Introduction To Philosophical Thoughts

S.No	1	2	3	4	5	6	7	8
1	Environmental Science	Indian Constitution	Environmental Science	Indian Constitution	Design and Analysis of Algorithms	Compiler Design	Big Data Analytics	Professional Elective V
2	Essence of Indian Traditional Knowledge	English	Essence of Indian Traditional Knowledge	Effective Technical Communication in English	Introduction To Data Science and Machine Learning	Computer Networks	Deep Learning	Open Elective-III
3	Mathematics-I	Physics	Operations Research	Finance and Accounting	Automata Languages and Computation	Data Mining	Data Handling and Visualization	Project Work – II
4	Chemistry	Mathematics-II	Basic Electronics	M-III (Probability & Statistics)	Artificial Intelligence	Professional Elective-III	Professional Elective V	
5	Programming for Problem Solving	Basic Electrical Engineering	Data Structures and Algorithms	Signals and Systems	R For Data Science	Professional Elective-IV	Open Elective –II	
6	Chemistry Lab	English Lab	Programming Languages	OOP using JAVA	Professional Elective I	Open Elective –I	Big Data Analytics Lab	
7	Workshop Practice	Physics Lab	Discrete Mathematics	Operating systems	Data Science Using ‘R’ Lab	Computer Networks Lab	Data Handling and Visualization Lab	
8	Programming for Problem Solving Lab	Engineering Graphics	Python Programming	Database Management Systems	Artificial Intelligence using Python Lab	Data Mining Lab	Project Work-1	Project Work – II
9		Basic Electrical Engineering Lab	Basic Electronics Lab	Operating Systems Lab	Design and Analysis of Algorithms Lab	Summer Internship*	Summer Internship	
			Data Structures and Algorithms using C Lab	OOP using JAVA Lab	Mini Project			
			Python Programming Lab	Database Management SystemsLab				

Professional Electives thread for V, VI , VII and VIII SEM

	SEM	***5th***	***6th***		***7th***	***8th***
X	***Thread***	***PE-1***	***PE-2***	***PE-3***	***PE-4***	***PE-5***
	SUBJECT CODE	***PE51X***	***PE62X***	***PE63X***	***PE74X***	***PE85X***
1	***Theory and algorithms***	Statistical Simulation and Data Analysis	Forecasting Technique	Business Intelligence and Analytics		Quantum Computing
2	***Systems (ISL)***	Distributed Databases	Cognitive Science and Analytics	Principles of Speech Processing	Image Processing	Large Scale Data Processing
3	***Multimedia***	Software Engineering	Cyber Security	Information Retrieval System	Web & Social Media Analytics	Internet of Things
4	***Software Engineering***	Cloud Computing	Software Testing Methodologies	Software Project Management		
5	***AI&ML***				Natural Language Processing	
6	***Miscellaneous/ Applications***				Block Chain Technology	Human Computer Interaction

SEMESTER V

Course Code	Course Title						Core/Elective
PC501CD	**Design And Analysis of Algorithms**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Problem Solving Skills, Data Structures,	**3**	**1**	**-**	**-**	**30**	**70**	**03**

Course Objectives

The course will introduce the students to

- Analyze the Asymptotic performance of Algorithms
- Write rigorous correctness proofs for algorithms
- Demonstrate a familiarity with major algorithms and Data structures
- Apply Important algorithmic design paradigms and methods of analysis
- Synthesize efficient algorithms in common engineering design situations

Course Outcomes

- Ability to analyze the performance of algorithms
- Ability to choose appropriate algorithm design techniques for solving problems
- Ability to Understand how the choice of data structures and the algorithm design methods impact the performance of programs

UNIT–I

Introduction & Elementary Data Structures: Introduction, Fundamentals of algorithm(Line Count, Operation Count), Analysis of algorithms(Best, Average, Worst case), Asymptotic Notations (O, Ω, Θ) Recursive Algorithms, Analysis using Recurrence Relations Heaps and Heap sort, Hashing
Sets–representation, UNION, FIND operations, **Graphs**: BFS, DFS, Bi-Connected Components

UNIT–II

Divide-and-Conquer Method: The general method, Binary search, Merge sort, Quick sort.
Brute Force: Knapsack, Traveling salesman problem, Convex-Hull

UNIT–III

Greedy Method: Knapsack problem, Minimum spanning trees, Single source shortest path, Job sequencing with deadlines, optimal storage on tapes, Optimal Merge patterns
Dynamic programming method: All pairs shortest paths, Optimal binary search tress, 0/1 Knapsack problem, Reliability design, Traveling salesman problem,

UNIT–IV

Back tracking: N-queens problem, Graph coloring, Hamiltonian cycles ,0/1 knapsack problem **Branch-and-bound**: 0/1 Knapsack problem, Traveling sales person

UNIT–V

NP-hard and NP-complete problems: Non Deterministic algorithms, The classes: P, NP, NP Complete, NP Hard, Satisfiability problem, Proofs for NP Complete Problems: Clique, Vertex Cover.

Text Book:

1. HorowitzE, Sahni S,FundamentalsofComputer Algorithms,2nd Edition,UniversitiesPress,2007

Reference Books:

1. Thomas H.Cormen, Charles E.Lei**serson, Ronald L. Rivest and Clifford Stein,** "Introduction to Algorithms", Third Edition, PHI Learning Private Limited, 2012
2. MichaelT.Goodrich,RobertoTamassia,AlgorithmDesign:Foundations,AnalysisandInternetExamples,JohnWiley&Sons,2002

Course Code	Course Title						Core/Elective
PC502CD	**Introduction To Data Science and Machine Learning**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**03**

Course Objectives

The course will introduce the students to

- Provide basics knowledge of Data Science qualitative and quantitative data
- Provide mathematics knowledge for Data science like statistics and probability
- Provide Basic knowledge of Machine Learning
- **Course Outcomes**

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

1. Understand the basic concepts in data science, including real world applications
2. Understand statistical and Probability analysis for Given data Set.
3. Understand the essential of machine learning for Data Science
4. Choose linear, non-linear regression models and classification techniques for data analysis
5. Make use of clustering method as K-means for develop a data science application

UNIT-I

Introduction to Data Science: What is Data Science- the Data Science Venn Diagram Terminology- Types of Data: - Flavors of Data- Structured and Unstructured Data-Quantitative versus qualitative Data- Four Levels of Data- Case study

UNIT-II

Five Steps of Data Science: - Introduction to Data Science- Overview of Five Steps- Explore the Data- Dataset 1 Yelp- Dataset2 – Titanic

Communication Data: Why Does Communication matter- Identifying effective and ineffective visualizations- When graphs and statistics Be- Verbal Communication

UNIT-III

Basics and Advanced Mathematics: Basic Symbols and Terminology- Linear Algebra – Introduction to Probability- Advanced Probability- Basics Statistics- Advanced Statistics

UNIT-IV

Machine Learning Essentials: What is Machine Learning- How does Machine Learning works- Types of Machine Learning work- Statistical model fit- Linear Regression- Logistic Regression – Probability odds, and log odds

UNIT-V

Predictions: Navie Bayes Classification- Decision Tree- Unsupervised Learning- K means Clustering- The Bias Variance Trade off - K folds cross- validation- Grid Searching- Ensembling Techniques- Neural Networks Structure

Text Book:

1.Principles of Data Science , Sinon Ozdemir, Packt Publishing Ltd,2016

Reference Books:

1. Rafael A Irizarry, Introduction to Data Science, Lean Publishing, 2016
2. Uma N. Dulhare, Khaleel Ahmed, Khairol Amali Bin Ahamad, Machine Learning and Big Data: Concepts, Algorithms, Tools and Applivations, Scrivener Publishing Wiley 2020
3. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017.

Course Code	Course Title						Core/Elective
PC503CD	**Automata Languages and Computation**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Data structures (graphs), Basics of probability	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives

The course will introduce the students to

- Develop a formal notation for strings, languages and machines.
- Design finite automata to accept a set of strings of a language.
- Design context free grammars to generate strings from a context free language and Convert them into normal forms.
- Identify the hierarchy of formal languages, grammars and machines.
- Distinguish between computability and non-computability and Decidability and undecidability.

Course Outcomes

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

1. Write a formal notation for strings, languages and machines, Design finite automata to accept a set of strings of a language.
2. Design context free grammars to generate strings of context free languages.
3. Determine equivalence of languages accepted by Pushdown Automata and languages generated by context free grammars
4. Write the hierarchy of formal languages, grammars and machines.
5. Distinguish between computability and non-computability and Decidability and undecidability.

UNIT-I

Introduction: Finite state automata, Non-deterministic finite state automata, FA with €-transitions, Regular expressions, Applications of FA, Properties of regular sets, Pumping Lemma, Closure properties, Myhill-Nerode Theorem, , Minimization of FA,

UNIT-II

Context Free Grammars and Languages: Derivations, Parse-trees, Ambiguity in Grammars and Languages. Pushdown Automata–Definitions, The languages of PDA, Equivalence of PDAs and CFGs, Deterministic Pushdown Automata.

UNIT-III

Properties of CFLs: Normal forms for CFGs, Pumping Lemma, Closure properties, Deterministic Context Free Languages, Decision properties

UNIT-IV

Turing Machines: Introduction, Computational Languages and Functions, Techniques for construction of Turing machines. Modifications of TM, TM as enumerator, Restricted TM.

UNIT-V

Undecidability: Recursive and Recursively enumerable languages, UTM and undecidable problem, Rice Theorem, Post's correspondence problem. Chomsky's Hierarchy–Regular grammars, Unrestricted grammar, CSL, Relationship between classes of languages.

Suggested Books:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman,

Suggested Reference Books:

1. Zvi Kohavi, Switching and Finite Automata Theory, TMH, 1976
2. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.
3. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
4. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
5. John Martin, Introduction to Languages and The Theory of Computation, Tata McGraw Hill.

Course Code	Course Title						Core/Elective
PC504CD	**ARTIFICIAL INTELLIGENCE**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Data structures (graphs), Basics of probability	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives

The course will introduce the students to

- Understand the importance of the field of AI by discussing its history and various applications.
- Learn about one of the basic applications of A.I, search state formulations.
- Learn methods of expressing knowledge by a machine with appropriate reasoning and different mathematics involved behind it
- Learn how to reason when an agent has only uncertain information about its task.
- Know various supervised and unsupervised learning algorithms

Course Outcomes

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

1. Formalize a problem in the language/framework of different AI methods
2. Illustrate basic principles of AI in solutions that require problem solving, search, inference
3. Represent natural language/English using Predicate Logic to build knowledge through various representation mechanisms
4. Demonstrate understanding of steps involved in building of intelligent agents, expert systems, Bayesian networks
5. Differentiate between learning paradigms to be applied for an application

UNIT-I: Problem Solving & Search

Introduction- Definition of Artificial intelligence- Foundations of artificial intelligence (AI). History of AI, Structure of Agents.

Problem Solving - Formulating problems, problem types, states and operators, state space.
Search strategies. - Informed Search Strategies- Best first search, A* algorithm, heuristic functions, Iterative deepening A*.
Adversarial Search/ Game playing - Perfect decision game, imperfect decision game, evaluation function, alpha-beta pruning.

UNIT-II: Knowledge, Reasoning & Planning
Reasoning - Knowledge based agent, Propositional Logic, Inference, Predicate logic (first order logic), Resolution
Structured Knowledge Representation – Frames, Semantic Nets
Planning - A Simple Planning Agent, Form Problem Solving to Planning, Basic representation of plans, partial order planning, hierarchical planning

UNIT-III: Expert Systems, Reasoning with Uncertainty
Expert System and Applications: Introduction, Phases in Building Expert Systems, Expert System Architecture, Applications.
Uncertainty - Basic probability, Bayes rule, Belief networks, Inference in Bayesian Networks**,** Fuzzy sets, and fuzzy logic: Fuzzy logic system architecture, membership function, Fuzzy Inferences

UNIT-IV: Learning
Machine-Learning Paradigms: Introduction, Machine Learning Systems, Supervised and Unsupervised Learning, Inductive Learning, Learning Decision Trees
Artificial Neural Networks: Introduction, Artificial Neural Networks, Single-Layer Feed-Forward Networks, Multi-Layer Feed-Forward Networks
Genetic Algorithms: Genetic Representations, (Encoding) Initialization and Selection, Different Operators of GA

UNIT-V: Communicating & Perceiving
Introduction to NLP- Progress & applications of NLP, Components of NLP, Grammars, Parsing
Automatic Speech Recognition (ASR) – Speech Processing, Ex: DRAGON, HARPY (from Ch 17 of book 3)
Machine Vision – Applications, Basic Principles of Vision, Machine vision techniques: Low, Middle, and High-level vision

Suggested Readings:
1. Stuart Russell and Peter Norvig. Artificial Intelligence – A Modern Approach, Third edition, Pearson Education Press,.
2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence, McGraw Hill, 3rd ed, 2009.
3. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009

References:
1. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2011
2. K.R.Chowdhary, Fundamentals of AI, Springer, 2020

Course Code	Course Title						Core/Elective
PC505CD	**R- For Data Science**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Statistics	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

- To introduce the Tool R to Execute the Data Science Programs
- To learn R built in functions
- To learn to plot graphs using R language.

Course Outcomes:

Student will be able to:

- Identify and execute basic syntax and programs in R.
- Perform the Matrix operations using R built in functions
- Apply non numeric values in vectors
- Create the list and data frames
- Exploit the graph using ggplot2.

Unit 1: **Overview of R**

History and Overview of R- Basic Features of R-Design of the R System- Installation of R- Console and Editor Panes- Comments- Installing and Loading R Packages- Help Files and Function Documentation- Saving Work and Exiting R- Conventions- R for Basic Math- Arithmetic- Logarithms and Exponentials- E-Notation- Assigning Objects- Vectors- Creating a Vector- Sequences, Repetition, Sorting, and Lengths- Subsetting and Element Extraction- Vector-Oriented Behaviour

Unit 2: MATRICES AND ARRAYS

Defining a Matrix – Defining a Matrix- Filling Direction- Row and Column Bindings- Matrix Dimensions- Subsetting- Row, Column, and Diagonal Extractions- Omitting and Overwriting- Matrix Operations and Algebra- Matrix Transpose- Identity Matrix- Matrix Addition and Subtraction- Matrix Multiplication- Matrix Inversion-Multidimensional Arrays- Subsets, Extractions, and Replacements

Unit 3: NON-NUMERIC VALUES

Logical Values- Relational Operators- Characters- Creating a String- Concatenation- Escape Sequences- Substrings and Matching- Factors- Identifying Categories- Defining and Ordering Levels- Combining and Cutting

Unit 4: LISTS AND DATA FRAMES

Lists of Objects-Component Access-Naming-Nesting-Data Frames-Adding Data Columns and Combining Data Frames-Logical Record Subsets-Some Special Values-Infinity-NaN-NA-NULLAttributes- Object-Class-Is-Dot Object-Checking Functions-As-Dot Coercion Functions

Unit 5: BASIC PLOTTING

Using plot with Coordinate Vectors-Graphical Parameters-Automatic Plot Types-Title and Axis Labels-Color-Line and Point Appearances-Plotting Region Limits-Adding Points, Lines, and Text to an Existing Plot-ggplot2 Package-Quick Plot with qplot-Setting Appearance Constants with Geoms-- READING AND WRITING FILES- R-Ready Data Sets- Contributed Data Sets- Reading in External Data Files- Writing Out Data Files and Plots- Ad Hoc Object Read/Write Operations

Text Book:

1. Tilman M.Davies,"THE BOOK OF R - A FIRST PROGRAMMING AND STATISTICS" Library of Congress Cataloging-in-Publication Data,2016.

Reference Book:

1. Roger D. Peng,"R Programming for Data Science"Lean Publishing, 2016.
2. Hadley Wickham, Garrett Grolemund," R for Data Science",OREILLY Publication,2017
3. Steven Keller, "R Programming for Beginners", CreateSpace Independent Publishing Platform 2016.
4. Kun Ren ,"Learning R Programming", Packt Publishing,2016

Course Code	Course Title						Core/Elective
PC551CD	**Data Science Using R lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
			-	**-**	**30**	**70**	**01**

Course Objectives

- Understand the R Programming Language.
- Exposure on solving of data science problems.
- Understand the classification and Regression Model.

Course Outcomes

- ✓ After completing this course, the student will be able to:
- ✓ Work with Data Science using R Programming environment
- ✓ Implement various statistical concept like linear and logistic regression
- ✓ Perform Classification and Clustering using appropriate dataset

1. CALCULATOR APPLICATION

a. Using with and without R objects on console
b. Using mathematical functions on console
c. Write an R script, to create R objects for calculator application and save in a specified location in disk

2. DESCRIPTIVE STATISTICS IN R

a. Write an R script to find basic descriptive statistics using summary
b. Write an R script to find subset of dataset by using subset ()

3. READING AND WRITING DIFFERENT TYPES OF DATASETS

a. Reading different types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location.
b. Reading Excel data sheet in R.
c. Reading XML dataset in R.

4. VISUALIZATIONS

a. Find the data distributions using box and scatter plot.
b. Find the outliers using gplot.
c. Plot the histogram, bar chart and pie chart on sample data

5. CORRELATION AND COVARIANCE

a. Find the correlation matrix.
b. Plot the correlation plot on dataset and visualize giving an overview of relationships among data on iris data.
c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data

6. REGRESSION MODEL

Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in a institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS).

7. Build CLASSIFICATION MODEL using KNN algorithm

a. Install relevant package for classification.
b. Choose classifier for classification problem.
c. Evaluate the performance of classifier.

8. Build CLUSTERING MODEL using K-mean algorithm

a. Clustering algorithms for unsupervised classification.
b. Plot the cluster data using R visualizations.

Course Code	Course Title						Core/Elective
PC552CD	**Artificial Intelligence Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Basics of programming in Python			**-**	**2**	**30**	**70**	**01**

Course Objectives: The objective of this lab is to get an overview of the various Artificial Intelligence techniques and can able to demonstrate them using python.

- To introduce students to the basic concepts of AI and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.
- To gain experience of doing independent study and research.

Course Outcomes:

After the completion of the course the student can able to:

- After learning the AI concepts the student must be able to design and implement AI solutions searching techniques using AI.
- Able to know about facts of querying.
- Be capable of confidently applying tree mechanism using AI with nueral network
- Be capable of performing experiments in Machine Learning using real-world data.·
- Able to Text processing.

1. Write a program to implement Uninformed search techniques: a. BFS
b. DFS

2. Write a program to implement Informed search techniques a. Greedy Best first search
b. A* algorithm

3. Study of Prolog, its facts, and rules. a. Write simple facts for the statements and querying it.
b. Write a program for Family-tree.

4. Write a program to train and validate the following classifiers for given data (scikit-learn): a. Decision Tree

b. Multi-layer Feed Forward neural network

5. Text processing using NLTK a. Remove stop words

b. Implement stemming

c. POS (Parts of Speech) tagging

• Game bot (Tic Tac toe, 7 puzzle)

• Expert system (Simple Medical Diagnosis)

• Text classification

• Chat bot

In addition to the above programs, students should be encouraged to study implementations of one of the following

Game bot (Tic Tac toe, 7 puzzle)

Expert system (Simple Medical Diagnosis)

Text classification

Chat bot

Course Code	Course Title						Core/Elective
PC553CD	**Design and Analysis of Algorithms Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Problem Solving Skills, Data Structures			**-**	**2**	**30**	**70**	**01**

Course Objectives

- To learn the importance of designing an algorithm in an effective way by considering space and Time complexity
- To learn graph search algorithms
- To study network flow and linear programming problems
- To learn the dynamic programming design techniques.
- To develop recursive backtracking algorithms.

Course Outcomes

After completing the course, the student will be able to

- Design an algorithm in an effective manner
- Apply iterative and recursive algorithms
- Design iterative and recursive algorithms
- Implement optimization algorithms for specific applications
- Design optimization algorithms for specific applications

S.No	Description of the program
1	Print all the nodes reachable from a given starting node in a digraph using BFS method and Check whether a given graph is connected or not using DFS method.
2	Sort a given set of elements and determine the time required to sort

	the elements using following algorithms: • Merge Sort • Quick Sort
3	Implement Knapsack problem using • Brute Force Approach • Greedy Method • Dynamic Programming
4	Find Minimum Cost Spanning Tree of a given undirected graph using • Kruskal's algorithm • Prim's algorithm
5	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm
6	Implement Travelling Salesperson Problem using • Brute Force Approach • Dynamic Programming
7	Implement All-Pairs Shortest Paths Problem using Floyd's algorithm
8	Implement the following using Back Tracking • N Queen's problem • Hamiltonian Cycle • Graph Coloring

Course Code	Course Title						Core/Elective
PW533CD	**Mini Project**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Problem Solving Skills, Data Structures			**-**	**2**	**50**	**70**	**02**

Course Objectives

To enhance practical and professional skills.
To familiarize tools and techniques of systematic literature survey and documentation
To expose the students to industry practices and team work.
To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes

After completing the course, the student will be able to

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective coding, written, presentation and oral communication skills

The students are required to carry out mini projects in any of the areas such as Data Structures, principles of Data Science, Artificial Intelligence, Database Management Systems, Operating Systems, Design and Analysis of Algorithms, Software Engineering, Data Communications, Computer Networks, Compiler Construction, and Object Oriented System Development.

Problems Statements are suggested to be taken from Smart India Hackathon (SIH) Portal invited from the Ministries *I* PSUs *I* MNCs *I* NGOs to be worked out through.

The project could be classified as hardware, software, modeling, simulation etc. The project should involve one or many elements of techniques such as analysis, design, and synthesis.

The department will appoint a project coordinator who will coordinate the following:

1. Grouping of students (maximum of3 students in a group)
2. Allotment of projects and project guides.
3. All projects allotment is to be completed by the 4th week of the semester so that the students get sufficient time for completion of the project.

4. Disseminate guidelines given by monitoring committee comprising of senior faculty members to the students and their guides. Session marks are to be awarded by the monitoring committee. Common norms will be established for the final presentation and documentation of the project report by the respective departments.

Students are required to submit a presentation and report on the mini project at the end of the semester.

Course Code	Course Title						Core/Elective
PE505	**Statistical Simulation and Data Science**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	
	L	T	D	P			**Elective**
Basic Knowledge of Integral and Calculus	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives

The course will introduce the students to

1. To learn Basics of Regression and Classification
2. Students know about single variable analysis and Multi variable analysis
3. Students know about Gradient for Data Analysis

Course Outcomes

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

1. Able to know about the regression.
2. Solve numerical issues based on regression with classification
3. Able to do sampling of data.
4. Able to know about Tree based methods
5. Able to know about unsupervised learning

Unit 1: Course intro: Regression, classification, survival, unsupervised learning, empirical applications, General techniques: K-nearest neighbour, Bias-variance trade off, overfitting.

Unit 2: Linear regression- Multiple linear regression, dummy variable, interactions, hypothesis testing. Linear models for classification- logistic regression, LDA, QDA, ROC curve.

Unit 3: Resampling techniques: Cross validation, Bootstrap. Model selection: AIC, BIC, Regularisation (lasso +ridge), Stepwise regression.

Unit 4: Tree-based methods: Trees, random forest, boosting. Bayesian inference: prior, posterior, map, regularisation in Bayesian setup, intro to mcmc.

Unit 5: Unsupervised learning: PCA, k-means clustering, hierarchical clustering, Gaussian mixture model Survival analysis: Kaplan Maier plot, Cox proportional hazard model, log rank test.

Text Book:

1."Simulation" by Sheldon M. Ross (Academic Press, Fourth Edition), 2006.
Bootstrap from "An Introduction to the Bootstrap" by B. Efron and R.J. Tibshirani (Chapman and Hall), 1994, Chapters 1-6, 12, 13.

2."Markov Chain Monte Carlo in Practice" by W.R. Gilks, S. Richardson, D.J. Spiegelhalter (Chapman and Hall).

Reference Book:

1. Cluster Analysis from "Cluster Analysis" by B.S. Everitt, S. Landau, M. Leese, D. Stahl, (Wiley), 2011.

2. "Simulation and the Monte Carlo Method" by R.Y. Rubinston and D.P Kroese (Wiley).

Course Code	Course Title						Core/Elective
PE506	**Distributed Databases**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Database Management System	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives

The course will introduce the students to

1. Introduce basic principles and implementation techniques of distributed database systems.
2. Equip students with principles and knowledge of parallel and object-oriented databases
3. To learn distributed DBMS architecture and design; query processing and optimization; distributed transaction management and reliability; parallel and object database management systems.

Course Outcomes

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

1. Understand theoretical and practical aspects of distributed database systems.

2. Study and identify various issues related to the development of distributed database system.

3. Understand the design aspects of object-oriented database system and related development.

UNIT – I

Introduction; Distributed Data Processing, Distributed Database System, Promises of DDBSs, Problem areas. Distributed DBMS Architecture: Architectural Models for Distributed DBMS, DDMBS Architecture. Distributed Database Design: Alternative Design Strategies, Distribution Design issues, Fragmentation, Allocation.

UNIT – II

Query processing and decomposition: Query processing objectives, characterization of query processors, layers of query processing, query decomposition, localization of distributed data. Distributed query Optimization: Query optimization, centralized query optimization, distributed query optimization algorithms.

UNIT – III

Transaction Management: Definition, properties of transaction, types of transactions, distributed concurrency control: serializability, concurrency control mechanisms & algorithms, time – stamped & optimistic concurrency control Algorithms, deadlock Management.

UNIT – IV

Distributed DBMS Reliability: Reliability concepts and measures, fault-tolerance in distributed systems, failures in Distributed DBMS, local & distributed reliability protocols, site failures and network partitioning. Parallel Database Systems: Parallel database system architectures, parallel data placement, parallel query processing, load balancing, database clusters.

UNIT – V

Distributed object Database Management Systems: Fundamental object concepts and models, object distributed design, architectural issues, object management, distributed object storage, object query Processing.

Object Oriented Data Model: Inheritance, object identity, persistent programming languages, persistence of objects, comparison OODBMS and ORDBMS

TEXT BOOKS:

1. M. Tamer OZSU and Patuck Valduriez: Principles of Distributed Database Systems, Pearson Edn. Asia, 2001.

2. Stefano Ceri and Giuseppe Pelagatti: Distributed Databases, McGraw Hill.

REFERENCE BOOKS:

1. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom: “Database Systems: The Complete Book”, Second Edition, Pearson International Edition

Course Code	Course Title						Core/Elective
PE507	**Software Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3		**-**	**-**	**30**	**70**	**03**

Course Objectives:

1. To introduce the basic concepts of software development processes from defming a
2. product to shipping and maintaining
3. To impart knowledge on various phases, methodologies and practices of software
4. development
5. To understand the importance of testing in software development, study various testing strategies along with its relationship with software quality and metrics

Course Outcomes:

Student will be able to:

1. Acquired working knowledge of alternative approaches and techniques for each phase of software development
2. Judge an appropriate process model(s) assessing software project attributes and analyze necessary requirements for project development eventually composing SRS
3. Creation of visual models to describe (non-) algorithmic solutions for projects using various design principles.
4. Acquire skills necessary as an independent or as part of a team for architecting a complete software project by identifying solutions for recurring problems exerting knowledge on patterns.
5. Concede product quality through testing techniques employing appropriate metrics by understanding the practical challenges associated with the development of a significant software system.

UNIT – I

Introduction to Software Engineering: Software and Software Engineering: The Nature of Software
The Software Process: Process Framework, Software Engineering Practice
Process Models: A Generic Process Model, Process Assessment and Improvement, Prescriptive Process Models, Waterfall Model, Prototyping Process Model, Evolutionary Process Model, The Unified Process Model, Product and Process.
Agility and Process: Introduction to Agility and Agile Process, Scrum, Other Agile Frameworks.

UNIT – II

Recommended Process Model: Requirements Definition, Preliminary Architectural Design, Resource Estimation, First Prototype Construction, Prototype Evaluation, Go, No-Go Decision, Prototype Evolution, Prototype Release, Maintain Release Software.
Human Aspects of Software Engineering: Characteristics of a Software Engineer, The Psychology of Software Engineering, The Software Team, Team Structures, The Impact of Social Media, Global Teams
MODELING:Principles That Guide Practice: Core Principles, Principles That Guide Each Framework Activity

Understanding Requirements: Requirements Engineering, Establishing the Groundwork, Requirements Gathering, Developing Use Cases, Building the Analysis Model, Negotiating Requirements, Requirements Monitoring, Validating Requirements

UNIT – III

Requirements Modeling: Requirements Analysis, Scenario-Based Modeling, Class-Based Modeling, Functional Modeling, Behavioral Modeling

Design Concepts: Design within the Context of Software Engineering, The Design Process, Design Concepts, The Design Model

UNIT – IV

Architectural Design: Software Architecture, Agility and Architecture, Architectural Styles, Architectural Considerations, Architectural Decisions, Architectural Design, Assessing Alternative Architectural Designs,

Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-Level Design, Specialized Component-Level Design, Component Refactoring.

User Experience Design: User Experience Design Elements, The Golden Rules, User Interface Analysis and Design, User Experience Analysis, User Experience Design, User Interface Design, Design Evaluation, Usability and Accessibility, Conventional Software UX and Mobility

Pattern-Based Design: Design Patterns, Pattern-Based Software Design, Architectural Patterns, Component-Level Design Patterns, Anti-Patterns, User Interface Design Patterns, Mobility Design Patterns

UNIT – V

Quality Concepts: Software Quality, The Software Quality Dilemma, Achieving Software Quality

Software Quality Assurance: Elements of Software Quality Assurance, SQA Processes and Product Characteristics, SQA Tasks, Goals, and Metrics, Formal Approaches to SQA, Statistical Software Quality Assurance, Software Reliability, The ISO 9000 Quality Standards, The SQA Plan

Software Testing: Component Level:A Strategic Approach to Software Testing, Planning and Recordkeeping, Test-Case Design, White-Box Testing, Black-Box Testing, Object-Oriented Testing.**Integration Level:**Software Testing Fundamentals, Integration Testing, Artificial Intelligence and Regression Testing, Integration Testing in the OO Context, Validation Testing, Testing Patterns.

Specialized Testing For Mobility: Mobile Testing Guidelines, The Testing Strategies, User Experience Testing Issues, Web Application Testing, Web Testing Strategies, Internationalization, Security Testing, Performance Testing, Real-Time Testing, Testing AI Systems, Testing Virtual Environments, Testing Documentation and Help Facilities

Software Metrics and Analytics: Software Measurement, Software Analytics, Product Metrics, Metrics for Testing, Metrics for Maintenance, Process and Project Metrics, Software Measurement, Metrics for Software Quality, Establishing Software Metrics Programs.

Suggested Readings:

1. Roger S. Pressman and Bruce R. Maxim, “Software Engineering: A Practitioner’s Approach”, 9th Edition , Tata McGrawHill,2020.
2. Ian Sommerville, “Software Engineering”, 10th Edition, Pearson,2016
3. Shari Lawrence Pfleeger &Joanne M. Atlee, “Software Engineering: Theory and Practice”, 4th Edition, Pearson, 2010
4. Rajib Mall, “Fundamentals of Software Engineering”, 5th Edition, PHI, 2018

Pankaj Jalote, “An Integrated Approach to Software Engineering”,3rd Edition, Narosa Publishing House,2005

Course Code	Course Title						Core/Elective
PE508	**Cloud Computing**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3		**-**	**-**	**30**	**70**	**03**

Course Objectives

- To understand the concept of cloud computing
- To understand the various issues in cloud computing.
- To familiarize themselves with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

Course Outcomes

After completing this course, the student will be able to

- Define Cloud Computing and related concepts and describe the characteristics, advantages, risks and challenges associated with cloud computing.
- Explore virtualization technique.
- Explore characterize various cloud service models, cloud deployment models

Illustrate the use of various cloud services available online

Unit - I:

Introduction - Historical Development -System Models for Distributed and Cloud Computing; Cloud Computing Architecture – The Cloud Reference Model – Cloud Characteristics – Cloud Deployment Models: Public, Private, Community, Hybrid Clouds, Challenges and Risks,Cloud Delivery Models: IaaS, PaaS, SaaS.

Unit - II: Virtual Machines& Cloud Computing Mechanism: Levels of Virtualization, Virtualization Structures//Tools and Mechanisms, Virtualization of CPU, Memory and I/O Devices, Virtual Clusters and Resource Management, Cloud Infrastructure Mechanism: Cloud Storage, Cloud Usage Monitor

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UNIT – III:

State Management Database – Cloud Management Mechanism: Remote Administration System, Resource Management System, SLA Management System, State Management Database – Cloud Management Mechanism: Remote Administration System, Resource Management System, SLA Management System,

.**UNIT- IV:**

Cloud Security and Trust Management, Data Security in the Cloud: An Introduction to the Idea of Data Security, The Current State of Data Security in the Cloud, CryptDb: Onion Encryption layersDET, RND, OPE, JOIN, SEARCH, HOM, and Homomorphic Encryption.

Unit –V:

CaseStudies: Google App Engine (GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services (AWS) – GAE Applications – Cloud Software Environments – Eucalyptus – Open Nebula – Open Stack

Suggested Reading:

1. Thomas Erl, ZaighamMahood, Ricardo Puttini, ―Cloud Computing, Concept, Technology and Architecture‖, Prentice Hall, 2013.
2. Essentials of cloud Computing: K. Chandrasekhran, CRC press, 2014
3. John W. Rittinghouse, "Cloud Computing: Implementation, Management, and Security ". James F. Ransome, CRC Press 2009

Reference Books

1. Raluca Ada Popa, Catherine M.S. Redfield, NickolaiZeldovich, and Hari Balakrishnan, "CryptDB: Protecting Confidentiality with encrypted Query Processing", 23rd ACM Symposium on Operating Systems Principles (SOSP 2011), Cascais, Portugal October 2011.
2. A Fully Homomorhic Encryption Scheme, Craig Gentry, September 2009.

David Marshall, Wade A. Reynolds, "Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center", Auerbach Publications, 2006.

SEMESTER VI

Course Code	Course Title						Core/Elective
PC601CD	**Compiler Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	**1**	**-**	**-**	**30**	**70**	**03**

Course Objectives:

- To understand and list the different stages in the process of compilation. Identify different methods of lexical analysis
- Design top-down and bottom-up parsers
- Identify synthesized and inherited attributes
- Develop syntax directed translation schemes
- Develop algorithms to generate code for a target machine

Course Outcomes:

Student will be able to:

1. Upon completion of the course, the students will be able to:
2. For a given grammar specification, develop the lexical analyzer.
3. For a given parser specification, design top-down and bottom-up parsers. Develop syntax directed translation schemes.
4. Develop algorithms to generate code for target machine.

UNIT-I

Introduction: The Structure of a Compiler, Phases of Compilation, The Translation Process, Major Data Structures in a Compiler, Bootstrapping and Porting.

Lexical Analysis (Scanner): The Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recoguition of Tokens, The Lexical Analyzer Generator Lex.

UNIT-II

Syntax Analysis (Parser): The Role of the Parser, Syntax Error Handling and Recovery, Top-Down Parsing, Bottom-Up Parsing, Simple LR Parsing, More Powerful LR Parsing, Using Ambiguous Grammars, Parser Generator Yaac.

UNIT-III

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD's Applications of Syntax-Directed Translation.

Symbol Table: Structure, Operations, Implementation and Management.

UNIT-IV

Intermediate Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Translation of Expressions, Type Checking, Control Flow, Backpatching, Switch-statements, Intermediate Code for Procedures.

Run-time environment: Storage Orgauization, Stack Allocation of Space, Access to Nonlocal Data on the Stack, Parameter passing, Heap Management and Garbage Collection.

UNIT-V

Code Generation: Issues in the Design of a Code Generator, The Target Language, Addresses in the Target Code, Basic Blocks and Flow graphs, Optimization of Basic Blocks, Peephole Optimization, Register Allocation and Assignment.

Machine-Independent Optimizations: The Principal Sources of Optimizations, Introduction to Data-Flow Analysis.

Suggested Books:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, & Jeffrey D. Ullman , *Compilers :Principler, Techniques and Fools,* ⅇ Edition, Pearson Education, 2006.
2. Kenneth C. Louden. *Compiler Conslnlction: Principles and Practice, .77Jomson Leaming Inc., fgg7.*

Course Code	Course Title						Core/Elective
PC602CD	**Computer Networks**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	**1**	**-**	**-**	**30**	**70**	**03**

Course Objectives:

- To develop an understanding of communication in modem network architectures from a design and performance perspective.
- To understand Data Transmission standards and MAC protocols.
- To introduce the protocols functionalities in Network Layer and Transport Layer. To understand DNS and supportive application protocols.
- To provide basic concepts of Cryptography.

Course Outcomes:

Student will be able to:

1. Explain the functions of the different layer of the OSI and TCPIIP Protocol.
2. Understand wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) describe the function of each block.
3. Able to illustrate network layer and transport layer protocols. For a given problem related
4. TCPIIP protocol developed the network programming.
5. Configure DNS , EMAIL, SNMP, Bluetooth, Firewalls using open source available software and tools.
6. Able to Identify the types of encryption techniques.

UNIT-I

Data communication Components: Representation of data communication, flow of Networks, Layered architecture, OSI and TCP/IP model, Transmission Media. (William stalling)

Techniques for Bandwidth utilization: Line configuration, Multiplexing - Frequency division, Time division and Wave division, Asynchronous and Synchronous transmission, XDSL , Introduction to Wired and Wireless LAN

UNIT-II

Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction Fundamentals,

Block coding, Hamming Distance, CRC;

Flow Control and Error control protocols: Stop and Wait, Go back-N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking.

Multiple access protocols: Pure *ALOHA*, Slotted *ALOHA*, CSMA/CD,CDMA/CA

UNIT-III

Network Layer: Switching techniques (Circuit and Packet) concept ,Logical addressing: IPV4(Header), IPV6(Header), NAT, Sub-Netting concepts.

Inter-Networking:Tunnelling , Fragmentation , congestion control (Leaky Bucket and Token Bucket algorithm), Internet control protocols: ARP, RARP, BOOTP and DHCP.

Network Routing Algorithms: Delivery, Forwarding and Unicast Routing protocol, Multi-cast routing protocolsGateway protocols.

UNIT-IV

Transport Layer: Process to Process Communication, Elements of transport protocol , Internet Transport

Protocols: UDP, TCP. Congestion and Quality of Service, QoS improving techniques.

UNIT-V

Application Layer: Domain Name Space (DNS), EMAIL, SNMP, Bluetooth.

Basic concepts of Cryptography: Network Security Attacks, firewalls, symmetric encryption, Data encryption Standards, public key Encryption (RSA), Hash function, Message authentication, Digital Signature.

Suggested Books:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGrawHill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
3. W. Richard Stevens, Unix Network Programming, Prentice Hall *I* Pearson Education, 2009

Course Code	Course Title						Core/Elective
PC603CD	**Data Mining**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Database Management System	**3**	**1**	**-**	**-**	**30**	**70**	**03**

Course Objectives:

To introduce the basic concepts of data Mining and its applications
To understand different data mining like classification, clustering and Frequent Pattern mining
To introduce current trends in data mining
To understand, pre-process and analyze the basic concepts of Data Attributes
To explore the various data mining techniques (Association Analysis, Classification, Clustering) adapted on data as per the requirement

Course Outcomes:

Student will be able to:

1. Organize and Prepare the data needed for data mining using preprocessing techniques Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on a given data set
2. Define and apply metrics to measure the performance of various data mining algorithms
3. Understanding the importance of data mining application and using the most appropriate approach or trend for the realistic strategy

UNIT-I

INTRODUCTION: What is Data Mining? The process of knowledge discovery in databases, predictive and descriptive data mining techniques, supervised and unsupervised learning techniques. Major issues in Data Mining. Getting to know your data: Data objects and attributed types. Basic statistical descriptions of data. Data visualization, Measuring data similarity and dissimilarity.

UNIT-II

MINING FREQUENT PATTERNS, ASSOCIATIONS AND CORRELATIONS: Basic concepts and methods, Frequent Item set Mining Methods, Sequential Pattern Mining concepts and Pattern evaluation methods.

UNIT-III

CLASSIFICATION: Basic concepts, Decision tree, Decision rules, Bayes classification methods, Advance methods, Bayesian Belief Network, K-Nearest Neighbor (KNN) classifier, Classification by back propagation, Support vector machine.

UNIT-IV

CLUSTER ANALYSIS: Concepts and Methods: Type of data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of clustering.

UNIT-V

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.

Suggested Reading:

1. Jiawei Han, MichelineKamber, Jin Pei, Data Mining: Concepts & Techniques, 3nt Edition., MorgonKoffman,2011
2. VikramPudi, P. Radha Krishna, Data Mining, Oxford University Press, 1'1 Edition,2009.
3. Pang-Ning Tan, Michael Steinbach, AKarpatne, and Vipin Kumar, Introduction to Data Mining, znd Ed., Pearson Education, 2018.
4. J Zaki Mohammed and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algoritbms,Cambridge University Press,2014

Course Code	Course Title						Core/Elective
PC651CD	**Computer Networks Lab**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
			-	**2**	**30**	**70**	**01**

Course Objectives:

- Learn to communicate between two desktop computers.
- Learn to implement the different protocols
- Be familiar with socket programming.
- Be familiar with the various routing algorithms
- Be familiar with simulation tools.
- To use simulation tools to analyze the performance of various network protocols

Course Outcomes:

Student will be able to:

1. Implement various protocols using TCP and UDP.
2. Program using sockets.
3. Use simulation tools to analyze the performance of various network protocols.
4. Implement and Analyze various routing algorithms.

1. Running and using services/commands like tcpdump, netstat, ifconfig, nslookup, FTP, TELNET and traceroute. Capture ping and trace route PDUs using a network protocol analyzer and examine.

2. Configuration of router, switch. (using real devices or simulators)

3. Socket programming using UDP and TCP (e.g., simple DNS, data & time client/server, echo client/server, iterative & concurrent servers)

4. Network packet analysis using tools like Wireshark, tcpdump, etc.

5. Network simulation using tools like Cisco Packet Tracer, NetSim, OMNeT++, NS2, NS3, etc.

6. Study of Network simulator (NS) and Simulation of Congestion Control Algorithms using NS. Performance evaluation of Routing protocols using Simulation tools.

7. Programming using raw sockets

8. Progrmming using RPC

SOFTWARE:

1. C / C++ / Java / Python / Equivalent Compiler
2. Network simulator like NS2/NS3/0PNET/ CISCO Packet Tracer / Equivalent

Course Code	Course Title						Core/Elective
PC652CD	**Data Mining Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
			-	**2**	**30**	**70**	**01**

Course Objectives:

The student should be made to:

- Be familiar with the algorithms of data mining,
- Be acquainted with the tools and techniques used for Knowledge Discovery in Databases.
- Be exposed to web mining and text mining

Course Outcomes:

Student will be able to:

- Apply data mining techniques and methods to large data sets.
- Use data mining tools.
- Compare and contrast the various classifiers.

LIST OF EXPERIMENTS:

- Creation of a Data Warehouse.
- Apriori Algorithm.
- FP-Growth Algorithm.
- K-means clustering.
- One Hierarchical clustering algorithm.
- Bayesian Classification.
- Decision Tree.
- Support Vector Machines.
- Applications of classification for web mining.
- Case Study on Text Mining or any commercial application.

SOFTWARE: WEKA, RapidMiner, DB Miner or Equivalent

Course Code	Course Title						Core/Elective
PW653CD	**Summer Internship**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
			-	**2**	**50**		**--**

Course Objectives:

The student should be made to:

- To give an experience to the students in solving real life practical problems with all its constraints.
- To give an opportunity to integrate different aspects of learning with reference to real life problems.
- To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry.

Course Outcomes:

Student will be able to:

1. Able to design/develop a small and simple product in hardware or software.
2. Able to complete the task or realize a pre-specified target, with limited scope, rather than taking up a complex task and leave it.
3. Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre-specified criteria.
4. Able to implement the selected solution and document the same.

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Industry / R & D Organization / National Laboratory for a period of 4 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be orgauized by the department. Award of session marks are based on the performance of the student at the work place and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will coordinate the overall activity of Summer Internship.

Course Code	Course Title						Core/Elective
PE604	**Forecasting Technique**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Knowledge of Statistics	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

- To Learn Basics concepts of Time series Analysis and Forecasting
- To learn about Regression Models based on Time Series
- To learn Non-Stationary and multivariate time series

Course Outcomes:

Student will be able to:

1. Knowledge of basic concepts in time series analysis and forecasting
2. Understanding the use of time series models for forecasting and the limitations of the methods.
3. Ability to criticize and judge time series regression models.
4. Distinguish the ARIMA modelling of stationary and non-stationary time series
5. Compare with multivariate times series and other methods of applications

Unit 1: **INTRODUCTION OF TIMESERIES ANALYSIS**

Introduction to Time Series and Forecasting -Different types of data-Internal structures of time series-Models for time series analysis-Autocorrelation and Partial autocorrelation.

Examples of Time series Nature and uses of forecasting-Forecasting Process-Data for forecasting – Resources for forecasting.

Unit 2: **STATISTICS BACKGROUND FOR FORECASTING**

Graphical Displays -Time Series Plots - Plotting Smoothed Data - Numerical Description of Time Series Data - Use of Data Transformations and Adjustments- General Approach to Time Series Modeling and Forecasting- Evaluating and Monitoring Forecasting Model Performance.

Unit 3: TIME SERIES REGRESSION MODEL

Introduction - Least Squares Estimation in Linear Regression Models - Statistical Inference in Linear Regression- Prediction of New Observations - Model Adequacy Checking -Variable Selection Methods in Regression - Generalized and Weighted Least Squares- Regression Models for General Time Series Data- Exponential Smoothing-First order and Second order.

Unit 4: **AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELS**

Autoregressive Moving Average (ARMA) Models - Stationarity and Invertibility of ARMA Models - Checking for Stationarity using Variogram- Detecting Nonstationarity - Autoregressive Integrated Moving Average (ARIMA) Models - Forecasting using ARIMA - Seasonal Data - Seasonal ARIMA Models- Forecasting using Seasonal ARIMA Models Introduction - Finding the "BEST" Model -Example: Internet Users Data- Model Selection Criteria - Impulse Response Function to Study the Differences in Models - Comparing Impulse Response Functions for Competing Models .

Unit 5: MULTIVARIATE TIME SERIES MODELS AND FORECASTING

Multivariate Time Series Models and Forecasting - Multivariate Stationary Process- Vector ARIMA Models - Vector AR (VAR) Models - Neural Networks and Forecasting -Spectral Analysis - Bayesian Methods in Forecasting.

TEXT BOOKS

1.**Introduction To Time Series Analysis And Forecasting**, 2nd Edition, Wiley Series In Probability And Statistics, By Douglas C. Montgomery, Cheryl L. Jen(2015) https://b-ok.cc/book/2542456/2fa941

2. **Master Time Series Data Processing, Visualization, And Modeling Using Python** Dr. Avishek Pal Dr. Pks Prakash (2017) https://b-ok.cc/book/3413340/2eb247

3. **Time Series Analysis And Forecasting By Example**SorenBisgaardMurat Kulahci Technical University Of Denmark Copyright c 2011 By John Wiley & Sons, Inc. All Rights Reserved. https://b-ok.cc/book/1183901/9be7ed

REFERENCE BOOKS

1. **Peter J. Brockwell Richard A. Davis Introduction To Time Series And Forecasting** Third Edition.(2016). https://b-ok.cc/book/2802612/149485

2. **Multivariate Time Series Analysis and Applications**William W.S. Wei Department of Statistical Science Temple University, Philadelphia, PA, SA This edition first published 2019 John Wiley & Sons Ltd. https://b-ok.cc/book/3704316/872fbf

3. **Time Series Analysis by James D Hamilton** Copyright c 1994 by prince town university press. https://b-ok.cc/book/3685042/275c71

E BOOKS

1.https://www.stat.ipb.ac.id/en/uploads/KS/S2%20-%20ADW/3%20Montgomery%20-%20Introduction%20to%20Time%20Series%20Analysis%20and%20Forecasting.pdf
2. https://ru.b-ok2.org/terms/?q=forecasting
3. https://otexts.com/fpp2/
4. http://home.iitj.ac.in/~parmod/document/introduction%20time%20series.pdf

MOOC

1. https://www.coursera.org/learn/practical-time-series-analysis
2. https://ocw.mit.edu/courses/economics/14-384-time-series-analysis-fall-2013/downloadcourse-materials/
2. https://swayam.gov.in/nd1_noc19_mg46/preview

Course Code	Course Title						Core/Elective
PE605	**Cognitive Science and Analytics**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Knowledge of Statistics	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

1. To study the basic concepts and approaches in the field of cognitive science
2. To apply the concepts of planning, reasoning and learning models in cognitive applications

To analyze language and semantic models of cognitive process

Course Outcomes:

Student will be able to:

1. Students will be able to understand the basic concept of cognitive science
2. Learn and understand the learning model and apply the same to appropriate real world applications
3. Apply reasoning methodology to real world applications
4. Students will understand and apply declarativeand logic models
5. Envisage the concept of cognitive learning
6. Acquire knowledge in language processing and understanding

Unit 1: **Introduction to Cognitive Science**

Fundamental Concepts of cognitive science – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation, semantic networks, frames, conceptual dependency, scripts, Ontology-Understanding, Common Sense Reasoning.

Unit 2: **Planning and Learning Methods**

Planning – Situation Logic- Learning in Cognitive Systems- Rote Learning – Learning by Examples - Incremental Concept Learning – Inductive Learning - Classification Techniques – Statistical Reasoning- Bayesian Classification- Bayesian Networks- Concept Learning- Version,Spaces - Discrimination Trees.

Unit 3: **Reasoning methods**

Reasoning by analogy – Explanation based reasoning – Case based reasoning- Constraint Satisfaction- Constraint Propagation- Temporal reasoning – Temporal Constraint Networks- Spatial reasoning- Visual Spatial reasoning- Meta reasoning – Learning by correcting mistakes-AI ethics

Unit 4: Cognitive Modeling

Declarative/ logic-based computational cognitive modelling - connectionist models of cognition – Bayesian models of cognition - Cognitive Models of Memory and Language - Computational models ofepisodic andsemantic memory - modelling psycholinguistics (with emphasis on lexical semantics) - towards deep understanding - modelling the interaction of language, memory and learning.

Unit 5: Modeling Paradigm

Modelling Select Aspects of Cognition Classical models of rationality - symbolic reasoning and decision making under uncertainty - Formal models of inductive generalization causality - Categorization and similarity analysis.

Text Book(s)	
1.	José Luis Bermúdez, “Cognitive Science: An Introduction to the Science of the Mind”, Cambridge University Press, New York, 2014.
2.	Mallick, Pradeep Kumar, Borah, Samarjeet," Emerging Trends and Applications in Cognitive Computing”, IGI Global Publishers, 2019.
3.	Elaine Rich, Kevin Knight, Shivashankar B. Nair, “Artificial Intelligence”, Third Edition, Tata McGraw-Hill Education, 2012.
Reference Books	
1.	Stuart J. Russell, Peter Norvig, “Artificial Intelligence - A Modern Approach”, Third Edition, Pearson Publishers, 2015.
2.	Paul Miller, “An Introductory Course in Computational Neuroscience”, MIT Press, 2018.
3.	Jerome R. Busemeyer, Zheng Wang, James T. Townsend, Ami Eidels(Ed), “The Oxford Handbook of Computational and Mathematical Psychology”,Oxford University Press (2015).
4.	Neil Stillings, Steven E. Weisler, Christopher H. Chase and Mark H. Feinstein, “Cognitive Science: An Introduction”, Second Edition, MIT press ,1995.

Course Code	Course Title						Core/Elective
PE606	**Software Testing Methodologies**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Knowledge of Statistics	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

To understand the software testing methodologies such as flow graphs and path testing, transaction flows testing, data flow testing, domain testing and logic base testing

Course Outcomes:

Student will be able to:

- Ability to apply the process of testing and various methodologies in testing for developed software.
- Ability to write test cases for given software to test it before delivery to the customer.

UNIT – I: Introduction:-Purpose of testing, Dichotomies, model for testing, consequences of bugs, taxonomy of bugs. Flow graphs and Path testing:- Basics concepts of path testing, predicates, path predicates and achievable paths, path sensitizing, path instrumentation, application of path testing.

UNIT – II: Transaction Flow Testing:-transaction flows, transaction flow testing techniques. Dataflow testing:- Basics of dataflow testing, strategies in dataflow testing, application of dataflow testing.

UNIT – III: Domain Testing:-domains and paths, Nice & ugly domains, domain testing, domains and interfaces testing, domain and interface testing, domains and testability.

UNIT - IV Paths, Path products and Regular expressions:- path products & path expression, reduction procedure, applications, regular expressions & flow anomaly detection. Logic Based Testing:- overview, decision tables, path expressions,

UNIT - V State, State Graphs and Transition testing:- state graphs, good & bad state graphs, state testing, Testability tips. Graph Matrices and Application:-Motivational overview, matrix of graph, relations, power of a matrix, node reduction algorithm, building tools. (Student should be given an exposure to a tool like JMeter or Win-runner).

TEXT BOOKS:

1. Software Testing techniques – Boris Beizer, Dreamtech, second edition.
2. Software Testing Tools – Dr. K. V. K. K. Prasad, Dreamtech

REFERENCE BOOKS:

1. The craft of software testing - Brian Marick, Pearson Education.
2. Software Testing, 3 rd edition, P.C. Jorgensen, Aurbach Publications (Dist. by SPD).
3. Software Testing, N. Chauhan, Oxford University Press.
4. Introduction to Software Testing, P. Ammann & J. Offutt, Cambridge Univ. Press.
5. Effective methods of Software Testing, Perry, John Wiley, 2nd Edition, 1999.
6. Software Testing Concepts and Tools, P. Nageswara Rao, dreamtech Press.

Course Code	Course Title			Core/Elective
PE607	**Cyber Security**			**Elective**
	Contact Hours per Week			

Prerequisite	L	T	D	P	CIE	SEE	Credits
Basic Knowledge of Network	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

To learn about Cyber and Offence

To learn Cyber security tools and Method

To learn Social Media Protection

Course Outcomes:

Student will be able to:

- Understand basic Cyber crime and security issues.
- Ability to identify information Cyber crime devices and cyber offenses.
- Ability to understand the current legal issues towards information security.
- Understand about cyber security tools and social media protection

UNIT - I Introduction to Cybercrime: Introduction, Cyber crime and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

UNIT - II Cyber Offenses: How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.

UNIT - III Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies an Measures in Mobile Computing Era, Laptops.

UNIT - IV Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

UNIT - V Cyber Security: Organizational Implications, Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

TEXT BOOK:

1. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA.

REFERENCE BOOKS:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.

2. Introduction to Cyber Security, Chwan-Hwa (john) Wu, J. David Irwin. CRC Press T&F Group

Course Code	Course Title	Core/Elective

PE608	**Business Intelligence and Analytics**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Knowledge about Data Mining and Weka Tool	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

1. To Learn about BI and Data Analytics for Data Science
2. To learn the necessary procedure of BI Analytics
3. To learn to deal with Business Dataset.

Course Outcomes:

Student will be able to:

1. Understand the essentials of BI & data analytics and the corresponding terminologies
2. Analyze the steps involved in the BI - Analytics process
3. Illustrate competently on the topic of analytics
4. Understand & Implement the K-Means Clustering with Iris Dataset
5. Demonstrate the real time scenario (Case study) by using BI & Analytics techniques

Unit 1: **BUSINESS INTELLIGENCE – INTRODUCTION**

Introduction - History and Evolution: Effective and Timely decisions, Data Information and Knowledge, Architectural Representation, Role of mathematical Models, Real Time Business Intelligent System.

Unit 2: Data Mining - Introduction to Data Mining, Architecture of Data Mining and How Data mining works(Process) , Functionalities & Classifications of Data Mining, Representation of Input Data, Analysis Methodologies.

Data Warehousing - Introduction to Data Warehousing, Data Mart, Online Analytical Processing (OLAP) – Tools, Data Modelling, Difference between OLAP and OLTP, Schema – Star and Snowflake Schemas, ETL Process – Role of ETL

Unit 3: **BI – DATA PREPARTTION**

Data Validation - Introduction to Data Validation, Data Transformation – Standardization and Feature Extraction, Data Reduction – Sampling, Selection, PCA, Data Discretization

Unit 4: **BI – DATA ANALYTICS PROCESS**

Introduction to analytics process, Types of Analytical Techniques in BI – Descriptive, Predictive, Perspective, Social Media Analytics, Behavioral, Iris Datasets

Unit 5: **IMPLEMENTATION OF BI – ANALYTICS PROCESS**

Operational Intelligence: Technological – Business Activity Monitoring, Complex Event Processing, Business Process Management, Metadata, Root Cause Analysis.

TEXT BOOKS

1. Carlo-Vercellis, “Business Intelligence Data Mining and Optimization for Decision-Making”, First Edition Link : https://bit.ly/3d6XxOr
2. Drew Bentely, “Business Intelligence and Analytics” ,@2017 Library Pres., ISBN: 978-1-9789-2136-8 Link : https://www.academia.edu/40285447/Business_Intelligence_and_Analytics
3. Larissa T. Moss & Shaku Atre, “Business Intelligence Roadmap: The Complete Project Lifecycle For Decision-Support Applications”, First Edition, Addison-Wesley Professional,2003
4. Kimball, R., Ross, M., Thornthwaite, W., Mundy, J., and Becker, B. John, “The Data Warehouse Lifecycle Toolkit: Practical Techniques for Building Data Warehouse and Business Intelligence Systems”, Second Edition, Wiley & Sons, 2008.

REFERENCE BOOKS

1. Cindi Howson, "Successful Business Intelligence", Second Edition, McGraw-Hill Education, 2013.

E BOOKS

1.Ramesh Sharda, Dursun Delen, Efraim Turban, "Business Intelligence A Managerial Perspective on Analytics", Third Edition, Pearson Publications. Link : https://bit.ly/2YcuLHK

Course Code	Course Title						Core/Elective
PE609	**Principles of Speech Processing**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Knowledge about Data Mining and Weka Tool	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

• To understand the speech production mechanism and the various speech analysis techniques and speech models
• To understand the speech compression techniques
• To understand the speech recognition techniques
• To know the speaker recognition and text to speech synthesis techniques

Course Outcomes:

Student will be able to:

- Design speech compression techniques
- Configure speech recognition techniques
- Design speaker recognition systems
- Design text to speech synthesis systems

UNIT I SPEECH SIGNAL CHARACTERISTICS & ANALYSIS

Speech production process - speech sounds and features- - Phonetic Representation of Speech -- representing= speech in time and frequency domains - Short-Time Analysis of Speech - Short- Time Energy and Zero-Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception

UNIT II SPEECH COMPRESSION

Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Vector Quantization- Linear predictive coding (LPC) - Code excited Linear predictive Coding (CELP)

UNIT III SPEECH RECOGNITION

LPC for speech recognition- Hidden Markov Model (HMM)- training procedure for HMM- subword unit model based on HMM- language models for large vocabulary speech recognition - Overall recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition

UNIT IV SPEAKER RECOGNITION

Acoustic parameters for speaker verification- Feature space for speaker recognition-similarity measures- Text dependent speaker verification-Text independent speaker verification techniques

UNIT V SPEAKER RECOGNITION AND TEXT TO SPEECH SYNTHESIS

Text to speech synthesis(TTS)-Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of prosody

TEXT BOOKS:

1. L. R. Rabiner and R. W. Schafer, Introduction to Digital Signal Processing, Foundations and Trendsin Signal Processing Vol. 1, Nos. 1–2 (2007) 1–194

2. Ben Gold and Nelson Morgan ―Speech and Audio signal processing- processing and perception of speech and music‖, John Wiley and sons 2006

REFERENCES

1. Lawrence Rabiner, Biiing and– Hwang Juang and B.Yegnanarayana ―Fundamentals of Speech Recognition‖, Pearson Education, 2009
2. Claudio Becchetti and Lucio Prina Ricotti, ―Speech Recognition‖, John Wiley and Sons, 1999
3. Donglos O shanhnessy ―Speech Communication: Human and Machine ―, 2nd Ed. University press 2001.

Course Code	Course Title						Core/Elective
PE610	**Software Project Management**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Software Engineering	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

To Provide an overview & importance of application of project management tools and techniques to software projects.

Course Outcomes:

Student will be able to:

- Identify the different project contexts and suggest an appropriate management strategy.
- Practice the role of professional ethics insuccessful software development.
- Identify and describe the key phases of project management.
- Determine an appropriate project management approach through an evaluation of the business context and scope of the project

Unit I:Introduction to Software Project Management Project definition, Importance of software project management, software project versus other types, activities covered by software project management, categorizing software products, overview of project planning, step wise project planning

Unit II: Project Evaluation and cost estimation Strategic Assessment – Technical Assessment – Cost Benefit Analysis –Cash Flow Forecasting – Cost Benefit Evaluation Techniques – Risk Evaluation.– Basics of Software estimation – Effort and Cost estimation techniques – COSMIC Full function points - COCOMO II-a Parametric Productivity Model - Staffing Pattern.

Unit III: Activity Planning Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling – Network Planning models – Forward Pass & Backward Pass techniques – Critical path (CRM) method– Risk identification – Assessment – Monitoring – PERT technique – Monte Carlo simulation, Resource Allocation – Creation of critical patterns – Cost schedules.

Unit IV: Project Management and Control Framework for Management and control – Collection of data, Project termination – Visualizing progress – Cost monitoring – Earned Value Analysis- Project tracking – Change control- Software -Configuration Management – Managing contracts – Contract Management.

Unit V: Staffing In Software Projects Managing people – Organizational behavior – Best methods of staff selection – Motivation – The Oldham-Hackman job characteristic model – Ethical and Programmed concerns –

Working in teams –Decision making – Team structures – Virtual teams – Communications genres – Communication plans.

Suggested Books:

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi, 2012
2. Robert K. Wysocki "Effective Software Project Management" – Wiley Publication,2011.
3. Walker Royce: "Software Project Management"- Addison-Wesley, 1998.
4. Gopalaswamy Ramesh, "Managing Global Software Projects" – McGraw Hill Education (India),Fourteenth Reprint 2013.
6. Jalote, "Software Project Management in Practice", Pearson Education, 2002.

Course Code	Course Title						Core/Elective
PE611	**Information Retrieval System**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Knowledge about Data Mining and Weka Tool	**3**		**-**	**-**	**30**	**70**	**03**

Course Objectives:

- To Demonstrate genesis and diversity of information retrieval situations for text and hyper media.
- To Analyze the performance of information retrieval using advanced techniques such as classification, clustering, and filtering over multimedia
- To Demonstrate Information visualization technologies like Cognition and perception in the Internet or Web search engine.

Course Outcomes:

Student will be able to:

- Describe models like vector-space, probabilistic and language models to iidentify the similarity of query and document
- Implement clustering algorithms like hierarchical agglomerative clustering and k-means algorithm.
- Understand natural language systems to build semantic networks for text.
- Understand the measures to evaluate the performance of cross language information
- Understand the method to construct thesauri automatically and Manually

UNIT – I: Introduction: Retrieval strategies: vector space model, Probabilistic retrieval strategies: Simple term weights, Non binary independence model, Language models.

UNIT – II: Retrieval Utilities: Relevance feedback, clustering, N-grams, Regression analysis, Thesauri.

UNIT – III :Retrieval utilities: Semantic networks, parsing Cross –Language: Information Retrieval: Introduction, Crossing the Language barrier.

UNIT – IV: Efficiency: Inverted Index, Query processing, Signature files, Duplicate document detection.

UNIT – V:Integrating structured data and text. A historical progression, Information retrieval as relational application, Semi Structured search using a relational schema. Distributed Information Retrieval: A theoretical Model of Distributed retrieval, web search

Text books:

1. David A. Grossman, OphirFrieder, Information Retrieval – Algorithms and Heuristics, Springer, 2nd Edition(Distributed by Universal Press), 2004

Reference books:

1. Gerald J Kowalski, Mark T Maybury Information Storage and Retrieval Systems: Theory and Implementation, Springer, 2004.
2. SoumenChakrabarti, Mining the Web : Discovering Knowledge from Hypertext Data, Morgan – Kaufmann Publishers, 2002.
3. Christopher D Manning, PrabhakarRaghavan, HinrichSchutze, An Introduction to Information Retrieval By Cambridge University Press, England, 2009.