Sri Sivasubramaniya Nadar College of Engineering

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Rajiv Gandhi Salai (OMR), Kalavakkam – 603110

Regulations 2022

Curriculum and Syllabi

for

Master of Engineering

in

Computer Science and Engineering

SRI SIVASUBRAMANIYA NADAR COLLEGE OF ENGINEERING, KALAVAKKAM – 603 110
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION

To emerge as a world class technology department through education, innovation, and collaborative research.

MISSION

• To impart quality education to students

• To create and disseminate knowledge for the betterment of mankind.

• To establish a center of excellence in collaboration with industries, research laboratories and other agencies to meet the changing needs of society.

• To provide individual attention and enable character building.

• To encourage entrepreneurship skills among students

M. E. Degree Programme in Computer Science and Engineering

Program Educational Objectives (PEOs)

To enable the graduates of the M.E degree program in Computer Science and Engineering to:

PEO1: Pursue research or be successfully employed in academia / industries associated with Computer Science and Engineering, or become entrepreneurs, adapting to new technologies and engaging in continuous education and training.

PEO2: Take leadership roles, making holistic decisions guided by professional, ethical, societal, economic, legal and environmental considerations, and communicating clearly with stakeholders.

Program Outcomes (POs)

The graduates of the M.E degree program in Computer Science and Engineering will be able to

PO1: Independently carry out research / investigation, and development work to solve practical problems (K6)

PO2: Read, write, and present a substantial technical report/document.

PO3: Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program (K6)

PO4: Analyze, learn, and build models from real world data using machine learning techniques and deploy them (K5)

Mapping of POs to PEOs

POs	PEOs	
	PEO1: Pursue research or be successfully employed in academia / industries associated with Computer Science and Engineering, or become entrepreneurs, adapting to new technologies and engaging in continuous education and training.	PEO2: Take leadership roles, making holistic decisions guided by professional, ethical, societal, economic, legal and environmental considerations, and communicating clearly with stakeholders.
PO1: Independently carry out research / investigation, and development work to solve practical problems	3	2
PO2: Read, write and present a substantial technical report/document	2	3
PO3: Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3	2
PO4: Analyze, learn, and build models from real world data using machine learning techniques and deploy them	3	2

Contribution 1: Reasonable 2: Significant 3: Strong

MAPPING OF COURSES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4
Semester I				
Linear Algebra and Estimation Theory	1		3	1
Advanced Data Structures and Algorithms	3		3	
Modern Operating systems	2		2	
Principles of Data Science	3	2	3	2
Advanced Software Engineering	2		2	1
Research Methodology & IPR	2	2	2	
Advanced Data Structures and Algorithms Lab	3		3	
Data Science Lab	3	3	3	3
Semester II				
Machine Learning	3	2	3	3
Internet of Things	2		2	
Advanced Databases	2		2	
Program Elective I				
Program Elective II				
Audit Course*				
Machine Learning Lab	3	3	3	3
Internet of Things Lab	3	2	3	
Internship with Seminar	3	3	3	3
Semester III				
Program Elective III				
Program Elective IV				
Program Elective V				
Open Elective				
Project Work Phase I	3	3	3	3
Semester IV				
Project Work Phase II	3	3	3	3
Professional Elective I				
Agile Software Engineering	2		2	
Natural Language Processing	3		3	3
Speech Processing and Synthesis	2		2	
Advanced Computer Networks	2		2	
Cloud Computing	2	1	2	2
Web Application Development	2	1	2	
Professional Elective 2				
Software Architecture and Design	2		2	
Cognitive computing	2		2	2
Image Processing and Analysis	2	2	2	2
Social Network Analysis	2		2	2
Wireless Sensor Networks and Protocols	2		2	
Embedded Software Development	2		2	

Professional Elective 3				
Formal System Verification	2		2	
Bioinformatics	2		2	2
Data Visualization Techniques	2	1	2	
Soft Computing	2		2	2
Cyber Security	2	1	2	
Multi-core Architectures & GPU Computing	2		2	
Professional Elective 4				
Software Project Management	2	1	2	
Healthcare Data Analytics	2	1	2	2
Edge Analytics	2		2	2
Functional programming	2		2	
Security Principles and Practice	2		2	
Mobile and Pervasive Computing	2		2	
Professional Elective 5				
Microservices & DevOps	2		2	
Deep Learning	2		2	2
Computer Vision	2		2	
Information Retrieval Techniques	2	2	2	2
Software Defined Networks	2	1	2	
Blockchain Technologies	2	1	2	

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REGULATIONS 2022
CHOICE BASED CREDIT SYSTEM
M.E. COMPUTER SCIENCE AND ENGINEERING
CURRICULUM

SEMESTER I								
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	PMA2157	Linear Algebra and Estimation Theory	FC	4	3	1	0	4
2	PCP2101	Advanced Data Structures and Algorithms	PC	3	3	0	0	3
3	PCP2102	Modern Operating Systems	PC	3	3	0	0	3
4	PCP2103	Principles of Data Science	PC	3	3	0	0	3
5	PCP2104	Advanced Software Engineering	PC	3	3	0	0	3
6	PGE2176	Research Methodology & IPR	MLC#	2	2	0	0	2
PRACTICALS								
7	PCP2111	Advanced Data Structures and Algorithms Lab	PC	3	0	0	3	1.5
8	PCP2112	Data Science Lab	PC	3	0	0	3	1.5
TOTAL				**24**	**17**	**1**	**6**	**21**

#Mandatory Learning Course

SEMESTER II								
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	PCP2201	Machine Learning	PC	3	3	0	0	3
2	PCP2202	Internet of Things	PC	3	3	0	0	3
3	PCP2203	Advanced Databases	PC	3	3	0	0	3
4		Program Elective I	PE	3	3	0	0	3
5		Program Elective II	PE	3	3	0	0	3
6		Audit Course*	AC	2	2	0	0	0
PRACTICALS								
7	PCP2211	Machine Learning Lab	PC	3	0	0	3	1.5
8	PCP2212	Internet of Things Lab	PC	3	0	0	3	1.5
9	PCP2216	Internship with Seminar	EEC	4	0	0	4	2
TOTAL				**27**	**17**	**0**	**10**	**20**

*No credit & Optional

SEMESTER III								
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1		Program Elective III	PE	3	3	0	0	3
2		Program Elective IV	PE	3	3	0	0	3
3		Program Elective V	PE	3	3	0	0	3
4		Open Elective	OE	3	3	0	0	3
PRACTICALS								
4	PCP2318	Project Work Phase I	EEC	12	0	0	12	6
TOTAL				**24**	**12**	**0**	**12**	**18**

SEMESTER IV								
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	PCP2418	Project Work Phase II	EEC	24	0	0	24	12
TOTAL				**24**	**0**	**0**	**24**	**12**

Total Credits: 71

L - Lecture
T - Tutorial
P - Practical
C - Credits
TCP - Theory-cum Practical

SUMMARY

S. NO.	SUBJECT AREA	CREDITS AS PER SEMESTER				CREDITS TOTAL	PERCENTAGE
		I	II	III	IV		
1	FC	4				4	6
2	MLC	2				2	3
3	AC					0	0
4	PC	15	12			27	38
5	EEC		2	6	12	20	28
6	OE			3		3	4
7	PE		6	9		15	21
		21	**20**	**18**	**12**	**71**	**100**

CATEGORY WISE LISTING OF COURSES

FOUNDATIONAL COURSE (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PMA2157	Linear Algebra and Estimation Theory	FC	4	3	1	0	4

MANDATORY LEARNING COURSE (MLC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PGE2176	Research-Methodology-IPR	MLC	2	2	0	0	2

AUDIT COURSE (AC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AGE2001	English for Research Paper Writing	AC	2	2	0	0	0
2	AGE2002	Disaster Management	AC	2	2	0	0	0
3	AGE2003	Value Education	AC	2	2	0	0	0
4	AGE2004	Constitution of India	AC	2	2	0	0	0
5	AGE2005	Pedagogy Studies	AC	2	2	0	0	0
6	AGE2006	Personality Development Through Life Enlightenment Skills	AC	2	2	0	0	0

PROGRAM CORE (PC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2101	Advanced Data Structures and Algorithms	PC	3	3	0	0	3
2	PCP2102	Modern Operating Systems	PC	3	3	0	0	3
3	PCP2103	Principles of Data Science	PC	3	3	0	0	3
4	PCP2104	Advanced Software Engineering	PC	3	3	0	0	3
5	PCP2111	Advanced Data Structures and Algorithms Lab	PC	3	0	0	3	1.5
6	PCP2112	Data Science Lab	PC	3	0	0	3	1.5
7	PCP2201	Machine Learning	PC	3	3	0	0	3
8	PCP2202	Internet of Things	PC	3	3	0	0	3
9	PCP2203	Advanced Databases	PC	3	3	0	0	3
10	PCP2211	Machine Learning Lab	PC	3	0	0	3	1.5
11	PCP2212	Internet of Things Lab	PC	3	0	0	3	1.5

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2216	Internship with Seminar	EEC	4	0	0	4	2
2	PCP2318	Project Work Phase-I	EEC	12	0	0	12	6
3	PCP2418	Project Work Phase-II	EEC	24	0	0	24	12

OPEN ELECTIVE (OE)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PGE2941	Business analytics	OE	3	3	0	0	3
2	PGE2942	Industrial safety	OE	3	3	0	0	3
3	PGE2943	Operation Research	OE	3	3	0	0	3
4	PGE2944	Cost Management of Research Projects	OE	3	3	0	0	3
5	PGE2945	Composite Materials	OE	3	3	0	0	3
6	PGE2946	Waste to Energy	OE	3	3	0	0	3
7	PGE2947	Introduction to Data Science	OE	3	3	0	0	3

PROFESSIONAL ELECTIVE 1

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2221	Agile Software Engineering	PE	3	3	0	0	3
2	PCP2222	Natural Language Processing	PE	4	2	0	2	3
3	PCP2223	Speech Processing and Synthesis	PE	3	3	0	0	3
4	PCP2224	Advanced Computer Networks	PE	3	3	0	0	3
5	PCP2225	Cloud Computing	PE	4	2	0	2	3
6	PCP2226	Web Application Development	PE	4	2	0	2	3

PROFESSIONAL ELECTIVE 2

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2227	Software Architecture and Design	PE	3	3	0	0	3
2	PCP2228	Cognitive Computing	PE	3	3	0	0	3
3	PCP2229	Image Processing and Analysis	PE	3	3	0	0	3
4	PCP2231	Social Network Analysis	PE	3	3	0	0	3
5	PCP2232	Wireless Sensor Networks & Protocols	PE	3	3	0	0	3
6	PCP2233	Embedded Software Development	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE 3

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2321	Formal System Verification	PE	3	3	0	0	3
2	PCP2322	Bioinformatics	PE	3	3	0	0	3
3	PCP2323	Data Visualization Techniques	PE	3	3	0	0	3
4	PCP2324	Soft Computing	PE	3	3	0	0	3
5	PCP2325	Cyber Security	PE	4	2	0	2	3
6	PCP2326	Multi-core Architectures & GPU Computing	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE 4

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2327	Software Project Management	PE	3	3	0	0	3
2	PCP2328	Healthcare Data Analytics	PE	4	2	0	2	3
3	PCP2329	Edge Analytics	PE	3	3	0	0	3
4	PCP2331	Functional programming	PE	3	3	0	0	3
5	PCP2332	Security Principles and Practice	PE	3	3	0	0	3
6	PCP2333	Mobile and Pervasive Computing	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE 5

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PCP2334	Microservices and DevOps	PE	3	3	0	0	3
2	PCP2335	Deep Learning	PE	4	2	0	2	3
3	PCP2336	Computer Vision	PE	3	3	0	0	3
4	PCP2337	Information Retrieval Techniques	PE	3	3	0	0	3
5	PCP2338	Software Defined Networks	PE	3	3	0	0	3
6	PCP2339	Principles of Blockchain Technology	PE	3	3	0	0	3

GROUPING OF ELECTIVES

	Semester 2			Semester 3	
	PE 1	**PE 2**	**PE 3**	**PE 4**	**PE5**
Software Engineering	Agile Software Engineering Web Application Development	Software Architecture and Design	Formal System Verification	Software Project Management Functional Programming	Microservices and DevOps
Data Science	Natural Language Processing Speech Processing and Synthesis	Cognitive Computing Image Processing and Analysis Social Network Analysis	Bioinformatics Data Visualization Techniques Soft Computing	Healthcare Data Analytics Edge Analytics	Deep Learning Computer Vision Information Retrieval Techniques
Computer Networks, OS and Security	Advanced Computer Networks Cloud Computing	Wireless Sensor Networks and Protocols Embedded Software Development	Cyber Security Multicore Architecture and GPU Computing	Security Principles and Practice Mobile and Pervasive Computing	Software Defined Networks Principles of Blockchain Technology

COURSE CODE	COURSE TITLE	L	T	P	C
PMA2157	LINEAR ALGEBRA AND ESTIMATION THEORY	3	1	0	4

OBJECTIVES

- To understand the basic concepts of linear space.
- To apply the linear transformation concepts in the diagonalization of a matrix.
- To represent networks using graph models
- To address the issues and the principles of estimation theory and multivariate analysis.

UNIT I VECTOR SPACES 12

Vector spaces – Subspaces – Linear combinations and system of Linear equations – Linear Independence and Linear dependence – Basis and Dimensions – Applications in data science.

UNIT II LINEAR TRANSFORMATIONS 12

Linear transformations – Null spaces Range – Matrix representation of linear transformation – Eigenvalues – Eigenvectors – Diagonalization.

UNIT III TESTING OF HYPOTHESIS 12

Large sample test based on Normal distribution for single mean and difference of means – Tests based on t, and F distributions for testing means and variances – Contingency table (Test for Independency) – Goodness of fit.

UNIT IV ESTIMATION THEORY 12

Unbiased estimators – Maximum likelihood estimation – Curve fitting by principle of least squares – Regression lines – Applications in data science.

UNIT V MULTIVARIATE ANALYSIS 12

Random vectors and matrices -- Mean vectors and covariance matrices -- Multivariate normal density and its properties -- Principal components -- Population principal components -Principal components from standardized variables

TOTAL PERIODS (THEORY): 60

COURSE OUTCOMES

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

- Solve the problems using the concepts of vector spaces, and subspaces. (K3)
- Apply linear transformation to diagonalize a given matrix and hence to find the eigenvalues of the given matrix. (K3)
- Apply statistical tests in testing hypotheses on data. (K3)
- Evaluate the consistency, efficiency and unbiasedness of estimators and apply for problems in data science. (K3)
- Perform exploratory analysis of multivariate data, such as multivariate normal density and Population principal components. (K3)

REFERENCE BOOKS

1. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Prentice Hall of India, New Delhi, 2004.
2. Strang G, Linear Algebra and its applications, Thomson (Brooks/Cole), New Delhi, 2005.
3. Gupta S. C., Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan and Sons, New Delhi, 2001.
4. Richard A. Johnson and Dean W. Wichern, Applied Multivariate Statistical Analysis, Pearson Education, Asia, 5th Edition, 2002.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2101	ADVANCED DATA STRUCTURES AND ALGORITHMS	3	0	0	3

OBJECTIVES

- To understand the use of algorithms in computing.
- To develop algorithms using hierarchical data structures.
- To select and use data structures and algorithms appropriate to the problems.
- To study NP hard and NP completeness of problems.

UNIT I ROLE OF ALGORITHMS IN COMPUTING 9

Algorithms -- Analyzing algorithms -- Growth of functions: Asymptotic notation -- Standard notations and common functions; Recurrences -- Methods for solving recurrences.

UNIT II HIERARCHICAL DATA STRUCTURES 9

Binary search trees: Basics -- Query, Insertion and Deletion; Red-black trees: Properties of Red-black trees -- Rotations -- Insertion -- Deletion; B-Trees: Basic operations on B-Trees; Binomial heaps: Structure -- Mergeable-heap operations; Disjoint-set operations -- Disjoint-set forests.

UNIT III GRAPHS 9

Representations of graphs -- Breadth-first search -- Depth-first search -- Topological sort -- Strongly connected components; Single-source shortest paths: Bellman-Ford algorithm; Single-source shortest paths in directed acyclic graphs: Dijkstra's algorithm; All-pairs shortest paths: Floyd-Warshall algorithm

UNIT IV ALGORITHM DESIGN TECHNIQUES 10

Greedy Algorithms: The job/event scheduling problem -- Minimum-spanning-tree -- Prim's and Kruskal's algorithms; Recursive backtracking: N-queens problem -- Map Colouring problem; Dynamic programming -- Longest common subsequence problem -- Knapsack problem

UNIT V NP COMPLETENESS 8

Reductions and NP -- Completeness -- Satisfiability – Proving NP-Completeness -- Circuit SAT, CNFSAT, 3SAT problems.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Apply asymptotic notations and methods to find the time complexity of iterative and recursive algorithms. (K3)
- Develop optimal algorithms using tree data structures (K3)
- Choose algorithms using graph data structures. (K5)
- Determine suitable design techniques for solving problems (K5)
- Explain NP type problems and their reductions (K2)

REFERENCE BOOKS

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, ``Introduction to Algorithms", Third Edition, Prentice-Hall, 2012
2. Jeff Edmonds, ``How to Think about Algorithms", Cambridge University Press, 2008
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, ``Data Structures and Algorithms", Pearson Education, Reprint 2006.
4. Robert Sedgewick and Kevin Wayne, ``Algorithms", Fourth Edition, Pearson Education, 2012
5. S. Sridhar, ``Design and Analysis of Algorithms", First Edition, Oxford University Press, 2014

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2102	MODERN OPERATING SYSTEMS	3	0	0	3

OBJECTIVES

- To understand virtualization and setup a cloud environment
- To apply the scheduling algorithms in real-time systems
- To apply the appropriate resource handling techniques for real-time systems
- To understand the alternatives and tradeoffs in operating system software design
- To make use of Containerization concepts in Linux

UNIT I VIRTUALIZATION AND THE CLOUD 9

History – Requirements – Type 1 and Type 2 Hypervisors – Techniques for Efficient Virtualization – Microkernels – Memory and I/O Virtualizations – Clouds – Case Study: VMware.

UNIT II SCHEDULING IN REAL-TIME SYSTEMS 9

Introduction – Applications – Basic Model – Characteristics of Real time system – Safety – Task types – Timing Constraints – Concepts and Characteristics of types of Real Time Task Scheduling – Clock Driven Scheduling – Event Driven Scheduling – Earliest Deadline First – Rate Monotonic Algorithm.

UNIT III RESOURCE HANDLING TECHNIQUES IN REAL-TIME SYSTEMS 9

Resource Sharing – Priority Inversion – Priority Inheritance Protocol – Highest Locker Protocol – Priority Ceiling Protocol– Types of Priority Inversions – Important Features – Issues and Task Dependencies.

UNIT IV OPERATING SYSTEM DESIGN 9

The Nature of the design Problem – Interface Design – Implementation– Performance – Project Management – Trends in Operating System Design.

UNIT V CONTAINERIZATION WITH LXC 9

Introduction to Linux Containers – The OS Kernels and its easy limitations – The Case for Linux Containers – Linux Namespaces-The foundation of LXC – Installing LXC – Building and Manipulating LXC Containers.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Apply virtualization techniques and set up a cloud environment(K3).
- Apply scheduling algorithms for real time systems (K3).
- Apply resource handling techniques in a real time environment (K3).
- Outline the alternatives and tradeoffs in operating system design (K2).
- Make use of Containerization concepts in Linux (K3)

REFERENCE BOOKS

1. Andrew S. Tanenbaum and Herbert Bos, “Modern Operating Systems”, 4th Edition, Pearson, 2015 (Units 1 and 4).
2. Rajib Mall, “Real Time Systems: Theory and Practice”, Pearson, 2007 (Units 2 and 3).
3. Konstantin Ivanov, “Containerization with LXC”, Packt, 2017 (Unit 5).
4. Matthew Portnoy, “Virtualization Essentials”, Wiley, 2012.
5. Jerome Saltzer M. and Frans Kaashoek, “Principles of Computer System Design”, 1st Edition, Elsevier, 2009.
6. Francis Cottet, Joelle Delacroix, et al, “Scheduling in Real-Time Systems”, Wiley, 2002.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2103	PRINCIPLES OF DATA SCIENCE	3	0	0	3

OBJECTIVES

- To learn the fundamentals of Data Science using Python.
- To develop python programs for analysis of data using Python libraries.
- To develop python programs for manipulating and visualizing data.
- To understand probability and Statistics for the data.
- To be familiar with supervised and unsupervised methods in machine learning.
- To be familiar with real time applications in data science.

UNIT I INTRODUCTION TO DATA SCIENCE 9

Introduction: Need for data science -- Benefits and uses -- Causality and Experimentation -- Facets of data-Data science process: Retrieving data -- Cleansing, integrating and transforming data -- Exploratory Data Analysis -- Build the models -- Presenting findings and building applications.

UNIT II PYTHON LIBRARIES FOR DATA SCIENCE 9

NumPy Basics: Arrays and Vectorized Computation -- The NumPy ndarray -- Creating ndarrays -- Data Types for ndarrays -- Arithmetic with NumPy Arrays -- Basic Indexing and Slicing -- Boolean Indexing -- Transposing Arrays and Swapping Axes. Introduction to pandas Data Structures: Series, DataFrame -- Essential Functionality: Dropping Entries -- Indexing, Selection, and Filtering -- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics -- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.

UNIT III DATA CLEANING, PREPARATION AND VISUALIZATION 9

Data Cleaning and Preparation: Handling Missing Data -- Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas and matplotlib: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

UNIT IV STATISTICAL ANALYSIS 9

Introduction -- Data Preparation -- Exploratory Data Analysis: Data summarization -- Data distribution -- Outlier Treatment -- Measuring asymmetry -- Continuous distribution -- Empirical Distribution; Estimation: Mean -- Variance -- Randomness -- Sampling -- Covariance -- Correlation, Measuring the Variability in Estimates: Point estimates -- Confidence intervals; Hypothesis Testing: Using confidence intervals -- Using p-values.

UNIT V PREDICTION AND INFERENCE WITH MACHINE LEARNING 9

Machine learning -- Modeling Process -- Training model -- Validating model -- Predicting new observations -- Supervised learning algorithms -- Linear Regression -- Unsupervised learning algorithms -- K Means Clustering -- Reinforcement learning.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Demonstrate the need and the fundamental concepts of data science. (K2)
- Choose appropriate functions in Python libraries for data analysis (K5)
- Develop Python programs for data preparation and visualizing the data. (K3)
- Apply statistical inferential analysis to find the properties of a population. (K3)
- Choose suitable Machine Learning algorithm to demonstrate data analysis in practice (K5)

REFERENCE BOOKS

1. Davy Cielen, Arno D B Meysman, Mohamed Ali, ``Introducing Data Science - Big data, Machine Learning, and more using Python tools", Manning Publications Co, 2016. (Unit I)
2. Wes McKinney, ``Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition,2018. (Unit II & III)
3. Laura Igual, Santi Segua, ``Introduction to Data Science - A Python Approach to Concepts, Techniques and Applications", Springer Nature, 2017 (Unit IV & V)
4. AniAdhikari, JohnDeNero,``Computational and Inferential Thinking: The Foundations of Data Science", GitBook, 2017. (Unit I & IV).
5. Jake VanderPlas, ``Python Data Science Handbook: ``Essential Tools for Working with Data", O'Reilly Media, 2016.
6. Foster Provost, Tom Fawcett, ``Data Science for Business", O'Reilly Media, 2013
7. Rachel Schutt, Cathy O'Neil, ``Doing Data Science", O'Reilly Media, 2016.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2104	ADVANCED SOFTWARE ENGINEERING	3	0	0	3

OBJECTIVES

- To review the best practices in the various phases of the software engineering lifecycle
- To learn selection of suitable software architectural styles and tactics to achieve software quality requirements.
- To learn selection of appropriate object-oriented design patterns to improve maintainability and software evolution.
- To understand the DevOps Practices
- To understand MLOps practices

UNIT I SOFTWARE ENGINEERING LIFECYCLE REVIEW 9

Requirement Analysis and Specification -- Software Requirements Specification Document -- Object Oriented Design using UML Diagrams-- Best Practices of Module Design: Coupling and Cohesion -- Testing: Blackbox and Whitebox Techniques Agile Methodology: Pair Programming -- Test-Driven Development

UNIT II SOFTWARE ARCHITECTURE 9

Architectural styles: Layered -- Client/server -- Tiered -- Pipe and filter- Event Driven -- Understanding Quality attributes -- Tactics for achieving qualities in software.

UNIT III SOFTWARE DESIGN 9

Object Oriented Design patterns -- Model-View-Controller -- Behavioral Patterns: Strategy -- Observer -- Structural patterns: Adapter -- Proxy -- Facade -- Creational Patterns: Factory Method

UNIT IV DEVOPS 9

DevOps: Motivation-Cloud as a platform -- Operations – Deployment Pipeline: Overall Architecture -- Building and Testing -- Deployment -- Crosscutting concerns: Monitoring – Security

UNIT V MLOPS 9

Introduction to MLOps: What is MLOps? -- DevOps and MLOps -- An MLops Hierarchy of needs -- MLOps Foundations: Machine Learning Key Concepts -- Build an MLOps Pipeline from Zero -- Continuous Delivery for ML Models: Packaging for ML Models -Infrastructure as Code for Continuous Delivery of ML Models -- Using Cloud Pipelines -- Monitoring and Logging: Observability for Cloud MLOps -- Monitoring and observability

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Make use of the UML diagrams and design software to meet the specified requirements (K3)
- Apply suitable software architectural styles and tactics to achieve software quality requirements(K3)

- Apply appropriate object-oriented design patterns to improve maintainability and software evolution (K3).
- Define the best practices of DevOps (K2)
- Summarize the MLOps Practices (K2).

REFERENCE BOOKS

1. Rajib Mall, ``Fundamentals of Software Engineering", 5th edition, PHI Learning Pvt Ltd, 2018 (Unit I)
2. Craig Larman, ``Applying UML and Patterns", 3rd edition, Pearson Education, 2005 (Unit I)
3. Mary Shaw, David Garlan, ``Software Architecture: Perspectives on an Emerging Discipline", Pearson Education, 1996 (Unit II)
4. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Addison-Wesley, 2003 (Unit II)
5. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Pearson Education, 1995 (Unit III)
6. Eric Freeman and Elisabeth Freeman, "Head First Design Patterns", O'Reilly Media, 2007 (Unit III)
7. Len Bass, Ingo Weber and Liming Zhu, ``DevOps: A Software Architect's Perspective", Pearson Education, 2016 (Unit IV)
8. Noah Gift, Alfredo Deza, "Practical MLOps", O'Reilly Media Shroff Publishers and Distributors pvt. Ltd, 2021 (Unit V)

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2176	RESEARCH METHODOLOGY AND IPR	2	0	0	2

OBJECTIVES

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics.
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem - Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICAL WRITING / PRESENTATION 6

Effective technical writing, how to write a report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TOTAL PERIODS (THEORY): 30

COURSE OUTCOMES

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

- Ability to formulate research problems.
- Ability to carry out research analysis.
- Ability to follow research ethics.
- Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow the world will be ruled by ideas, concept, and creativity.
- Ability to understand IPR and filing patents in R & D.

REFERENCE BOOKS

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”, 2010

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2111	ADVANCED DATA STRUCTURES AND ALGORITHMS LAB	0	0	3	1.5

OBJECTIVES

- To learn advanced tree and graph structures.
- To learn the need for heap and disjoint set representations.
- To understand algorithm design techniques and apply suitable techniques for problems.

SUGGESTED PROGRAMMING LANGUAGES

- C, Java or Python

SUGGESTIVE EXERCISES

1. Insertion sort and merge sort with complexity analysis
2. Application of binary search trees
3. Min heaps
4. Disjoint sets
5. Application of graph traversals -- BFS and DFS
6. Single source Shortest Path Algorithms (e.g. Dijkstra's and Bellman Ford algorithms)
7. All-pairs Shortest Path Algorithms: (e.g. Floyd's algorithm)
8. Dynamic programming (e.g. Longest common subsequence, 0/1 Knapsack)
9. Recursive backtracking (e.g. N-Queen's problem)
10. Greedy technique (e.g. Job/event scheduling, Minimum spanning tree)

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Solve problems using basic data structures and sorting algorithms. (K3)
- Solve problems using tree and graph structures. (K3)
- Choose appropriate algorithm design techniques and develop efficient algorithms(K5)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2112	DATA SCIENCE LAB	0	0	3	1.5

OBJECTIVES

- To get familiar with the python programming for data science
- To develop python programs for data preparation and manipulation using NumPy and Pandas.
- To construct python programs for data visualization
- To make use of python packages for statistical analysis
- To apply business analytics on real world applications.

SUGGESTIVE EXPERIMENTS

1. Implement basic data types and user defined functions using Python.
2. Develop python programs for packages and working on files.
3. Perform basic computations and manipulation on arrays using the NumPy package.
4. Perform manipulations on the CSV files and images using NumPy package.
5. Perform data manipulation on the input CSV file using Pandas Package.
6. Perform data preparation and visualization on the input CSV file using Pandas matplotlib packages.
7. Perform Exploratory Data Analysis on a CSV file. Import any CSV file and perform Exploratory Data Analysis: Data summarization.
8. Compute the following for the given data set using the NumPy package. Compute Mean, Variance, Standard Deviation, Sampling, Covariance, Correlation.
9. Download data from UCI Machine Learning Repository or Kaggle and perform the business analytics for the application “Predictive analytics in healthcare”.
10. Download data from UCI Machine Learning Repository or Kaggle and perform the business analytics for the application “Weather predictions in agriculture sector”.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Analyze the significance of python packages for data creation and manipulation (K4)
- Experiment the methods of data handling and visualization through NumPy, Pandas and MatplotLib modules (K3).
- Construct Python programs for obtaining statistical inference on data and choose suitable machine learning algorithms for real-world applications. (K5)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2201	MACHINE LEARNING	3	0	0	3

OBJECTIVES

- To have a basic knowledge of the concepts and techniques of machine learning.
- To learn the working of various machine learning algorithms on different learning types.
- To understand the evolution and need of deep learning from machine learning.
- To learn the basis of machine learning with python and H2O library.

UNIT I INTRODUCTION 8

Machine Learning: History -- Applications; Types of machine learning -- Design of a learning system -- Perspectives and issues in machine learning; Basic statistics: Variance and Covariance -- Bias Variance tradeoff -- Curse of dimensionality -- Conditional Probability -- Naive Bayes Classifier; Testing ML algorithms.

UNIT II SUPERVISED LEARNING 10

Regression: Introduction -- Linear Regression -- Least Squares -- Under fitting and Overfitting -- Cross-Validation - Lasso Regression -- Logistic Regression; Classification: Linear and Non-linear models -- Support Vector Machines -- Kernel Methods; K-Nearest Neighbours; Learning with Trees: constructing Decision Tree using ID3 - Classification and regression trees (CART); Ensemble Methods -- Bagging -- Boosting -- Random Forest; Evaluation of Classification Algorithms.

UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9

Unsupervised Learning: Clustering Algorithms – K-Means – Hierarchical Clustering – Cluster Validity; Dimensionality Reduction: Linear discriminant analysis – Principal component analysis; Reinforcement Learning: Terminologies – Markov decision process – Sarsa and Q-learning Algorithms.

UNIT IV NEURAL NETWORKS AND DEEP LEARNING 9

Neural Networks: The Brain and the Neuron -- Perceptron learning algorithm; Multi-Layer Perceptron: Back propagation algorithm -- Error -- Multi-layer perceptron in Practice -- Examples of using the MLP; Deep Learning: Introduction -- Convolution Neural Networks -- Recurrent Neural Networks -- Use cases.

UNIT V ML USING PYTHON AND H2O 9

ML Libraries: Introduction – H2O – Installation; Data preparation; Modelling, Running model; Grid search; Integration with Scikit learn.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Explain the basic concepts of machine learning (K2)
- Analyze linear and non-linear techniques for classification problems (K4)
- Apply unsupervised and reinforcement algorithms for the given problems (K3)
- Choose suitable machine learning and deep learning algorithms for a given application (K5)
- Determine appropriate solutions for real world problems using H2O.ai (K5)

REFERENCE BOOKS

1. Stephen Marsland, ``Machine Learning - An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2015.
2. Pasha Stetsenko, "Machine Learning with Python and H2O", Published by H2O.ai, Inc., 2017
3. Ethem Alpaydin, ``Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)", Fourth Edition, MIT Press, 2020
4. Tom M Mitchell, ``Machine Learning", First Edition, McGraw Hill
5. Education, 2013.
6. Peter Flach, ``Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2202	INTERNET OF THINGS	3	0	0	3

OBJECTIVES

- To understand the basics of IoT devices, protocols, communication APIs and deployment templates
- To design the simple IoT systems using Raspberry Pi/Arduino Pi
- To understand various IoT protocols
- To design an IoT system using cloud environments
- To develop IoT solutions for industries.

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Basic computer networking to Internet of things: Network Types -- Layered network models -- Addressing -- TCP/IP transport Layer. Definition and Characteristics of IoT -- Physical Design of IoT -- Logical Design of IoT -- IoT Enabling Technologies -- IoT Levels & Deployment Templates -- IoT and M2M

UNIT II BUILDING IOT SYSTEMS 9

IoT Physical devices and Endpoints: Basic building blocks of IoT Device -- Raspberry Pi -- Linux on Raspberry Pi -- Interfaces -- Programming Raspberry Pi with Python --Python packages for IOT: JSON -- XML -- HTTPLib -- URLLib -- SMTPLib -- XMPP -- Contiki OS -- Other IoT Platform: Arduino -- Intel Galileo and Beaglebone boards. RFID--sensors.

UNIT III IOT PROTOCOLS 9

Introduction to IoT Protocols -- 6LoWPAN -- IEEE 802.11 -- WiFi -- 802.15 Bluetooth -- 802.15.4 -- Zigbee-- CoAP.

UNIT IV CLOUD OFFERINGS AND IOT CASE STUDIES 9

Cloud Storage Models and Communication APIs for IoT-- WAMP-Xively Cloud-- Python Web Application framework-- Designing a RESTful Web API-- Amazon Web Services for IoT-- MQTT --Case studies for IoT Design : Home automation-- Smart Agriculture.

UNIT V INDUSTRIAL INTERNET OF THINGS (IIOT) 9

Introduction -- Industrial Process-- The Computer Integrated Manufacturing Pyramid (CIM)-- IIoT data flow-- Understanding the IIoT edge: features of the edge -- architecture and implementations. Implementing IOT industrial solution with cloud services.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Explain the basics of IoT devices, protocols, communication APIs and deployment templates (K2)
- Design the simple IoT systems using Raspberry Pi/Arduino Pi (K3)
- Explain various IoT protocols (K2)
- Design an IoT system using cloud environments (K3)
- Design IoT solutions for industries. (K3).

REFERENCE BOOKS

1. Sudip Misra, Anandarup Mukherjee and Arijit Roy, “Introduction to IOT”, Published online by Cambridge University Press: 09 January 2021 (Unit 1)
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on Approach, University Press, 2015 (1st edition) (Unit 1,2,3,4)
3. Giacomo Veneri, "Antonio Capasso, "Hands-On Industrial Internet of Things Create a Powerful Industrial IoT Infrastructure Using Industry 4.0", 2018 (Unit 5)
4. Adrian McEwen Hakim Cassimally, Designing the Internet of Things,Wiley, Nov2013, (1st edition)
5. Olivier Hersent, David Boswarthick, Omar Elloum, ``The Internet of Things – Key applications and Protocols", Wiley, 2012.
6. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand, David Boyle,"From Machine - to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2203	ADVANCED DATABASES	3	0	0	3

OBJECTIVES

- Understand the concepts of distributed databases.
- Understand the data models for data lake.
- Learn the basics of columnar and key-value databases.
- Expose to document and graph databases.
- Gain knowledge about streaming data.

UNIT I DISTRIBUTED DATABASES 9

Distribution Models: Single Server-- Sharding-- Master—Slave Replication --Peer-to-Peer Replication -- Combining Sharding and Replication; Consistency: Update Consistency-- Read Consistency-- Relaxing Consistency--The CAP Theorem-- Relaxing Durability-- Quorums; HDFS.

UNIT II DATA MODELS FOR DATA LAKE 9

Data Models -- Categorizing Data Models -- Data Model vs Data Format -- Data Stream -- Understanding Data Lake -- Inside Data Lake -- Generic Structure of Data Ponds -- Applications of Data Pond – Data Warehousing vs Data Lake -- Data Ingestion -- ETL vs ELT -- Big Data Integration with Data Lake -- Apache Sqoop.

UNIT III NoSQL DATABASES - COLUMNAR AND KEY-VALUE 9

Introduction to NoSQL Databases -- Cassandra Data Model -- Clusters -- Keyspaces --Column Families -- Columns -- Super Columns -- Design Differences Between RDBMS and Cassandra -- Design Patterns -- Cassandra Architecture; Key-Value Databases: Key-Value Store -- Features -- Use Cases.

UNIT IV NoSQL DATABASES - DOCUMENT AND GRAPH DATABASES 9

Database for modern Web: MongoDB -- MongoDB Shell -- Creating, Updating, and Deleting Documents -- Querying; Graph Databases: An Overview -- Started with Neo4j -- Modelling data for Neo4j -- Use Case Examples: Recommender Systems & Impact Analysis and Simulation -- Visualization for Neo4j.

UNIT V STREAMING DATA 9

Capture Streaming Data with Change-Data-Capture: Concepts; Strategies for Data Capture -- Types of CDC -- CDC Trade-offs --CDC Tools -- Analyzing a Centralized Data Store -- Publishing to Kafka – AVRO Schema and Data.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

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

- Explain the distribution, consistency models and replication for distributed databases (K2)
- Apply the concepts of data lakes and ingest big data into data lake (K3)
- Apply the techniques of wide-column and key-value store to create databases and run the queries (K3)
- Apply the concepts of document and graph databases and run the queries (K3)
- Explain the concepts of streaming data and how to make use of Kafka (K3)

REFERENCE BOOKS

1. Sadalage, Pramod J., and Martin Fowler, "NoSQL distilled: a brief guide to the emerging world of polyglot persistence", Pearson Education, 2013 (Unit I)
2. Bill Inmon, "Data Lake Architecture: Designing the data lake and avoiding the garbage dump", 1st Edition, Technics Publications, 2016 (Unit II)
3. Aaron Ploetz, Tejaswi Malepati, Nishant Neeraj, "Mastering Apache Cassandra 3.x", 3rd Edition, Packt Publishers, 2018 (Unit III)
4. Bradshaw, Shannon, Eoin Brazil, and Kristina Chodorow, "MongoDB: the definitive guide: powerful and scalable data storage", O'Reilly Media, 2019 (Unit IV)
5. Gupta, Saurabh, and Venkata Giri, "Practical Enterprise Data Lake Insights: Handle Data-Driven Challenges in an Enterprise Big Data Lake", Apress, 2018 (Unit V)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2211	MACHINE LEARNING LAB	0	0	3	1.5

OBJECTIVES

- To understand and implement machine learning algorithms.
- To select suitable ML algorithms for a given problem and analyze its performance.
- To learn the emerging technologies for implementing ML algorithms

SUGGESTIVE EXPERIMENTS (Python - Numpy, Scipy, Scikit-learn, Matplotlib)

1. Linear Regression and Logistic Regression
2. Support Vector Machine with kernel functions
3. Decision Tree algorithm
4. K-means clustering
5. Ensemble algorithms: Random Forest and AdaBoost
6. Dimensionality reduction techniques: LDA, PCA
7. Perceptron algorithm
8. Multi-layer Perceptron using Backpropagation algorithm.
9. Convolutional Neural Network
10. ML algorithms using H2O.ai.
11. Mini project

TOTAL PERIODS: 45

HARDWARE/SOFTWARE REQUIREMENTS

- Python 3.x
- JupyterLab
- Scientific Computing Libraries: Numpy, Scipy, MatplotLib, Pandas
- Machine Learning Libraries: Scikit-Learning
- Deep Learning Libraries: Pytorch 1.0, Tensorflow 2.0
- Cloud for application deployment and testing: Google Colab, autoML, Azure, H2O.AI, AWS
- Intel Core i7 CPU, with minimum 16GB RAM

COURSE OUTCOMES

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

- Develop machine learning algorithms (K3)
- Choose suitable ML algorithm to solve the given application (K5)
- Apply H_2O.ai library to develop an application (K3)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2212	INTERNET OF THINGS LAB	0	0	3	1.5

OBJECTIVES

- To build simple IoT systems using Arduino/Raspberry Pi and sensors.
- To build low cost embedded systems using various communication protocols and web APIs
- To develop cloud based IoT solutions for real time applications.

SUGGESTIVE LIST O F EXPERIMENTS

1. Interface Arduino board to read analog and digital values using Light Dependent Resistor and Ultrasonic sensors.
2. Interface Raspberry Pi board to read analog and digital values using temperature and humidity sensors.
3. Construct a Raspberry Pi based system to control the LED using a switch.
4. Interface Arduino/Raspberry Pi with a sensor and LED to read the status in a smartphone using Bluetooth protocol.
5. Develop an Arduino/Raspberry Pi based system which communicates to the cloud for sending and retrieving the temperature and humidity data.
6. Develop an Arduino/Raspberry Pi based system to publish/subscribe temperature data using MQTT.
7. Develop an Arduino/Raspberry Pi based system to measure the light intensity in the room and output the data to a web API.
8. Mini Project (Suggestions: Develop a system to analyze the quality of drinking water using required IoT devices, cloud, mobile and web app, develop a basic home automation system using cloud platform, Develop a basic smart agriculture system using cloud platform)

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Build simple IoT systems using Arduino/Raspberry Pi and sensors (K3).
- Build low-cost embedded systems using various communication protocols and web APIs (K3)
- Develop cloud based IoT solutions for real time applications (K6).

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2216	INTERNSHIP WITH SEMINAR	0	0	4	2

OBJECTIVES

- To develop the students logical thinking skills
- To learn the strategies of solving quantitative ability problems
- To enrich the verbal ability of the students
- To enhance critical thinking and innovative skills

COURSE OUTCOMES

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

- Demonstrate ability to survey literature, identify gaps and write well-documented report (K3)
- Solve social issues and engineering problems (K6)
- Demonstrate effective technical presentation skills

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2318	PROJECT WORK PHASE - I	0	0	12	6

OBJECTIVES

- To develop the ability to solve a specific problem right from literature.
- review till the successful solution of the same.
- To inculcate research culture
- To enhance the rational and innovative thinking capabilities
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

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

- Formulate complex engineering problems and choose suitable technologies and tools required to solve them effectively (K4)
- Analyse the related literature on the proposed problem and its feasibility (K4)
- Design high level solutions by applying software engineering principles (K6)
- Develop and summarize the solution by documenting (K3).
- Analyse the issues pertaining to society, health, safety, legal, environment, culture applicable to the project and examine the impact of the proposed solution on these issues .
- Apply best practices and follow ethics in developing the solutions

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2418	PROJECT WORK PHASE - II	0	0	24	12

OBJECTIVES

- To develop the ability to solve a specific problem right from literature.
- review till the successful solution of the same.
- To inculcate research culture
- To enhance the rational and innovative thinking capabilities
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

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

- Use suitable technologies and tools to solve complex engineering problems effectively (K4)
- Analyse the related literature on the proposed problem and its feasibility (K4)
- Construct suitable solutions by applying software engineering principles (K6)
- Evaluate the performance of the solution using appropriate metrics (K5)
- Analyze the impact of the proposed solution on the issues pertaining to society, health, safety, legal, environment, culture and apply ethical principles.
- Apply ethical principles in developing the solutions and present the solution with good documentation

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2221	AGILE SOFTWARE ENGINEERING	3	0	0	3

OBJECTIVES

- Understand agile software development practices.
- Demonstrate Agile development and testing techniques.
- Know the benefits and pitfalls of working in an Agile team.
- Understand agile development and testing.

UNIT I AGILE SOFTWARE DEVELOPMENT 9

Agile software development; Traditional software development -- waterfall approach – requirements -- design phase – implementation – testing – support -- advantages and disadvantages; incremental development; Lean software development; scrum; test driven development; extreme programming; rational unified process; agile unified process; Agile model driven development.

UNIT II AGILE XP PRODUCT DEVELOPMENT 9

People and Teams working together -- Team behaviour in XP projects -- setting up a team -- developing team skills -- training together; organizational framework; planning -- PERT -- Gantt charts; Dealing with problem -- basic strategies -- when things go really wrong; risk analysis; starting XP project -- business analysis and problem discovery; techniques for requirement elicitation; Developing the requirement documents.

UNIT III BUILDING USER STORIES AND TESTING 9

Identifying stories and preparing to build -- looking at the user stories; collection of stories; user interfaces; communicating clearly with the customer and building confidence; demonstrating the non-functional requirements -- nonfunctional requirements; Estimating
resources -- software cost estimation -- object point analysis -- COSMIC FFP -- Design for test; Automating unit tests -- writing unit tests in JUnit -- managing tests.

UNIT IV AGILE PRACTICE VALIDATION 9

Study Design -- Survey field study -- Questionnaire Design – Data collection procedure; Construct operationalization -- Adoption of agile practices -- teamwork and contextual variables – team performance -- instrument validation; Analysis methods – regression analysis -- structural equation modeling -- selecting appropriate analysis techniques; Assessment of team performance; Hypotheses: Test and Evaluation -- measurement model effects on team potency and team performance.

UNIT V AGILITY AND QUALITY ASSURANCE 9

Agile Interaction Design -- Agile product development -- Agile Metrics -- Feature Driven Development (FDD) -- Financial and Production Metrics in FDD -- Agile approach to Quality Assurance -- Test Driven Development -- Pair programming: Issues and Challenges – Agile approach to Global Software Development.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Define the agile process model (K2)
- Apply XP agile methods for iterative software development. (K3)
- Identify the impact of customers on the success of software development process (K3)
- Evaluate the agile approach for assessing team performance. (K3)
- Explain the quality assurance in agile methods. (K2).

REFERENCE BOOKS

1. Thomas Stober, Uwe Hansmann, Agile Software Development: Best Practices for Large Software Development Projects, Springer-Verlag Berlin Heidelberg 2010 (Unit 1)
2. Mike Holcombe, Running an Agile Software Development Project, University of Sheffield, United Kingdom, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.(Unit 2,3)
3. Christoph Schmidt, Agile Software Development Teams, Springer International Publishing Switzerland 2016. (Unit 4)
4. Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, 2010 (Unit 5)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2222	NATURAL LANGUAGE PROCESSING	2	0	2	3

OBJECTIVES

- To learn the fundamentals in language processing.
- To understand syntactic parsing in language processing.
- To understand language modeling using vector semantics.
- To understand semantics of words and sentences in languages.
- To understand information extraction techniques.

UNIT I INTRODUCTION 6

Knowledge in language processing -- Ambiguity; Text Normalization -- N-grams -- Evaluation -- Sampling -- Generalization -- Smoothing.

UNIT II WORD LEVEL AND SYNTACTIC ANALYSIS 6

English Word Classes -- Part-of-Speech Tagging; Constituency Grammar: Context-Free Grammar -- Grammar rules for English -- Treebanks; Dependency Parsing: Dependency Relations -- Formalisms -- Dependency Treebanks.

UNIT III LEXICAL AND VECTOR SEMANTICS 6

Lexical Semantics -- Vector Semantics -- Words and vectors -- Cosine similarity -- TF-IDF -- PPMI -- Word2Vec -- Semantic properties of embeddings -- Evaluating vector model.

UNIT IV SEMANTIC ANALYSIS 6

Word Senses: Senses Relations -- WordNet -- Word Sense Disambiguation; Semantic Roles: Diathesis Alternations -- Problems -- Proposition Bank -- Semantic Role Labeling.

UNIT V INFORMATION EXTRACTION AND COREFERENCE 6

Named Entities -- Named Entity Tagging; Relation Extraction -- Algorithms -- Extracting Times -- Extracting Events and their Times -- Template Filling; Coreference:Linguistic Background – Tasks and Datasets.

TOTAL PERIODS(THEORY): 30

SUGGESTED EXERCISES (30 Hours)

1. Apply Tokenizer, n-grams in text normalization.
2. Apply TF-IDF, Word2Vec vectors for the given text data for word similarity.
3. Apply treebanks for context-free and dependency parsing.
4. Apply semantics to find the word sense/SRL.
5. Apply IE techniques to extract the Named Entities/Relations**.**

TOTAL PERIODS(LAB): 30
TOTAL PERIODS: 60

COURSE OUTCOMES

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

- Apply the text normalization techniques. (K3)
- Apply syntactic analysis in language processing (K3)
- Apply vector semantics for word embeddings (K3)
- Apply semantic analysis for words and sentences (K3)
- Apply extraction techniques to extract the information (K5)

REFERENCE BOOKS

1. Daniel Jurafsky and James H Martin, “Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 3rd Edition
2. Christopher D. Manning, Hinrich Schutze, “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
3. Steven Bird, Ewan Klein, and Edward Loper, “Natural Language Processing with Python”, O'Reilly, 2009.
4. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.
5. Nitin Indurkhya, Fred J. Damerau, “Handbook of Natural Language Processing”, 2nd Edition, CRC Press, 2010.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2223	SPEECH PROCESSING AND SYNTHESIS	3	0	0	3

OBJECTIVES

- To explore the fundamentals of digital speech processing.
- To understand the basic concepts and algorithms of speech processing.
- To familiarize the students with the various speech signal representation, coding and recognition techniques.
- To study the concepts and evaluation method of speech synthesis.

UNIT I FUNDAMENTALS OF DIGITAL SPEECH PROCESSING 9

Introduction: Discrete-Time signals and systems – Transform representation of Signals and systems -- Fundamentals of digital filters -- Sampling; Process of Speech Production -- Acoustic theory of speech production -- Digital models for speech signals.

UNIT II |SPEECH SIGNAL ANALYSIS IN TIME DOMAIN 9

Time-dependent processing of speech -- Methods for extracting the parameters: Energy -- Average Magnitude -- Zero-crossing rate; Silence discrimination using ZCR and energy -- Short-time autocorrelation function -- Pitch period estimation using autocorrelation function.

UNIT III SPEECH SIGNAL ANALYSIS IN FREQUENCY DOMAIN 9

Short time Fourier analysis -- Fourier transform and linear interpretations -- Sampling rates -- Spectrographic Displays -- Formant extraction -- Pitch extraction -- Linear predictive coding: Autocorrelation method -- Covariance method; Solution of LPC equations -- Durbin's Recursive solution -- Application of LPC parameters -- Pitch detection.

UNIT IV SPEECH RECOGNITION 9

Introduction -- Preprocessing -- Parametric representation – Speech segmentation -- Dynamic time warping -- Vector quantization – Hidden Markov Model -- Language Models -- Developing an isolated digit recognition system.

UNIT V SPEECH SYNTHESIS 9

Attributes of speech synthesis -- Formant speech synthesis -- Concatenative speech synthesis -- Prosodic modification of speech -- Source filter models for prosody modification -- Evaluation of TTS system.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Illustrate how the speech production is modeled (K2)
- Apply various techniques to extract features from speech signal in time domain (K3)
- Choose the techniques to extract features from speech signal in frequency domain (K3)
- Develop a speech recognition system using a statistical approach (K4)
- Compare the various methods of speech synthesis (K2).

REFERENCE BOOKS

1. L. R. Rabiner and R. W. Schaffer, “Digital Processing of Speech Signals”, Pearson, 2009 (Unit 1-4)
2. Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, “Spoken Language Processing - A guide to Theory, Algorithm and System Development”, Prentice Hall PTR, 2001 (Unit - 5)
3. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Prentice Hall Signal Processing Series, 1993.
4. Thomas F.Quatieri, “Discrete-Time Speech Signal Processing”, Pearson Education, 2003.
5. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing”, John Wiley and Sons Inc., Singapore, 2006.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2224	ADVANCED COMPUTER NETWORKS	3	0	0	3

OBJECTIVES

- To study the network fundamentals.
- To study the 5G network functional architecture
- To study 2G and 4G cellular networks.
- To understand and build software defined networks.

UNIT I NETWORK FUNDAMENTALS 7

Introduction -- Networking Hardware -- Network Cabling -- Wireless Networking – IP addressing -- Protocols -- Internet.

UNIT II CELLULAR NETWORKS 9

GSM -- Mobility management and call control -- GPRS -- GPRS State model -- Network elements -- Mobility management and session management -- Small Screen Web Browsing over GPRS and EDGE -- MMS over GPRS.

UNIT III 4G NETWORKS 9

LTE -- Network architecture and interfaces -- Mobility management and power optimization -- LTE security architecture -- Interconnection with UMTS and GSM -- 4G networks and composite radio environment -- Protocol boosters -- Hybrid 4G wireless networks protocols.

UNIT IV 5G NETWORKS 10

Use cases and requirements –- 5G system concepts –- 5G Architecture: NFV and SDN -- Basics about RAN architecture -- High-level requirements -- Functional architecture and 5G flexibility: Functional split criteria -- Functional split alternatives -- Functional optimization for specific applications -- Integration of LTE and new air interface to fulfill 5G Requirements -- Enhanced Multi-RAT coordination features -- Physical architecture and 5G deployment.

UNIT V SOFTWARE DEFINED NETWORKS 10

Introduction -- Centralized and distributed control and data planes -- Open flow -- Wire protocol -- Architecture -- Hybrid approaches - SDN controllers -- Building SDN using Emulator.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the fundamentals of networking (K2).
- Analyse the working of GSM network (K4)
- Analyse the use of various 4G Networks (K4).

- Explain the functional architecture of 5G networks (K2)
- Build software defined networks using an emulator (K3).

REFERENCE BOOKS

1. James Bernstein, “Networking made Easy”, 2018 (Unit - I)
2. Martin Sauter, “From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband”, Wiley, 2014 (Unit - II, III)
3. Savo G Glisic, “Advanced Wireless Networks -- 4G Technologies”, John Wiley & Sons, 2007 (Unit - III)
4. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press Second Edition 2011 (Unit – IV)
2. Thomas D. Nadeau and Ken Gray, “SDN -- Software Defined Networks”, O'Reilly Publishers, 2013 (Unit - V).

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2225	CLOUD COMPUTING	2	0	2	3

OBJECTIVES

- To understand the principles of Cloud Architecture, Models and Infrastructure.
- To understand the concepts of virtualization and virtual machines.
- To gain knowledge about virtualization Infrastructure.
- To explore and experiment various Cloud deployment environments.
- To learn about the security issues in the cloud environment.

UNIT I CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE 6

Cloud Architecture: System Models for Distributed and Cloud Computing -- NIST Cloud Computing Reference Architecture -- Cloud deployment models -- Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds -- Design Challenges.

UNIT II VIRTUALIZATION BASICS 6

Virtual Machine Basics -- Taxonomy of Virtual Machines -- Hypervisor -- Key Concepts – Virtualization structure -- Implementation levels of virtualization -- Virtualization Types: Full Virtualization -- Para Virtualization -- Hardware Virtualization -- Virtualization of CPU, Memory and I/O devices.

UNIT III VIRTUALIZATION INFRASTRUCTURE AND DOCKER 7

Desktop Virtualization -- Network Virtualization -- Storage Virtualization -- System-level of Operating Virtualization -- Application Virtualization -- Virtual clusters and Resource Management -- Containers vs. Virtual Machines -- Introduction to Docker -- Docker Components -- Docker Container -- Docker Images and Repositories. methods, string module.

UNIT IV CLOUD DEPLOYMENT ENVIRONMENT 6

Google App Engine -- Amazon AWS -- Microsoft Azure; Cloud Software Environments -- Eucalyptus -- OpenStack.

UNIT V CLOUD SECURITY 5

Virtualization System-Specific Attacks: Guest hopping -- VM migration attack – hyperjacking; Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.

TOTAL PERIODS(THEORY): 30

SUGGESTED EXERCISES (30 Hours)

1. Install VirtualBox/VMware Workstation with different flavors of Linux or windows OS on top of windows7 or 8.
2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs
3. Install Google App Engine. Create a hello world app and other simple web applications using python/java.
4. Use GAE launcher to launch the web applications.
5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.

6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Install Hadoop single node cluster and run simple applications like word count.
8. Creating and Executing Your First Container Using Docker.
9. Run a Container from Docker Hub

TOTAL PERIODS(LAB): 30
TOTAL: 60

COURSE OUTCOMES

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

- Describe the design challenges in cloud (K2)
- Apply the concept of virtualization and its types (K3)
- Experiment with virtualization of hardware resources and Docker (K3)
- Develop and deploy services on cloud and set up a cloud environment (K3)
- Explain security challenges in cloud environments (K2).

REFERENCE BOOKS

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012. (Units I, II, III, IV)
2. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005 (Unit II)
3. James Turnbull, "The Docker Book", O'Reilly Publishers, 2014 (Unit III)
4. Krutz, R. L., Vines, R. D, "Cloud security. A Comprehensive Guide To Secure Cloud Computing", Wiley Publishing, 2010 (Unit V)
5. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009 (Unit V)
6. Danielle Ruest, Nelson Ruest, "Virtualization: A Beginner's Guide", McGraw-Hill Osborne Media, 2009.
7. Suresh J, Srinivasan A, "Cloud Computing: A practical Approach for Learning and Implementation", Pearson Education India, 2014.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2226	WEB APPLICATION DEVELOPMENT	2	0	2	3

OBJECTIVES

- To understand the concepts of web site development
- To learn web application development using Javascript based framework.
- To learn web application development using Python based framework.

UNIT I INTRODUCTION 5

Web Essentials: Web clients, web servers, communication protocol, HTTP request and response message; HTML5: Tables - Lists - Image - Control and semantic elements - CSS3 - Inline, embedded and external style sheets - Rule cascading - Backgrounds - Colors - Text - Transformations - Transitions - Animations.

UNIT II CLIENT SIDE PROGRAMMING 5

Introduction to JavaScript - Variables - Data types- Statements - Operators - Functions - Objects - Arrays - Built-in objects - Event handling.

UNIT III ANGULARJS 8

Introduction to Angular - Typescript: Built-in types, classes - Components: Decorator, input, output - Built-in Directives: NgIf, NgFor, NgSwitch, NgStyle, NgClass - Forms: Using FormBuilder, Adding Validations - HTTP API - Routing: Components of Routing, Nested routes - Services: Observables and RxJS. Implementation.

UNIT IV NODE.JS & EXPRESS.JS 6

Getting Started with Node.JS; Introduction to Express; Saving time with Express: Scaffolding - views and layouts - Static files and views- Dynamic content in views; Request and Response Objects; Templates using Handlebars.

UNIT V BUILDING WEB APPLICATIONS 6

Form Handling: Sending Client data to Server - HTML forms - Form Handling with Express; Sending Email; Implementing MVC in Express.

TOTAL PERIODS(THEORY): 30

SUGGESTED MINI-PROJECTS (30 Hours)

- Create a college website using HTML5 and CSS3.
- Develop a MVC based web application for a Super Market Billing System.
- Develop online exam web application using AngularJS.
- Develop a web application for personal website using ExpressJS.
- Develop a web application for student information system that allows to perform CRUD operations using ExpressJS and MySQL

- Develop Library Management System using ExpressJS and MySQL

TOTAL PERIODS(LAB): 30
TOTAL: 60

COURSE OUTCOMES

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

- Build a website using HTML and CSS (K3).
- Outline client-side programming (K2)
- Develop web application using AngularJS MVW framework (K3).
- Examine the web applications built using NodeJS (K4).
- Develop web applications using java script-based framework (K3).

REFERENCE BOOKS

1. Jeffrey C Jackson, "Web Technologies A Computer Science Perspective", Pearson Education, 2011 (Unit I)

2. Deitel and Deitel, Nieto, "Internet and World Wide Web - How to Program", Prentice Hall, 5th Edition, 2011 (Unit II)

3. Nate Murray, Felipe Coury, Ari Lerner, and Carlos , "Ng-book: The Complete Guide to Angular", Fullstack.io, 2020 (Unit III)

4. Ethan Brown, "Development with Node and Express", O'Reilly, 1st Edition, 2014 (Unit IV)

5. Adrian Holovaty, Jacob K Moss, "Django - The definitive Guide to Django", Apress Publishers, 2008 (Unit V)

Course Code	COURSE TITLE	L	T	P	C
PCP2227	SOFTWARE ARCHITECTURE AND DESIGN	3	0	0	3

OBJECTIVES

- To understand the need, design approaches for software architecture to bridge the dynamic requirements and implementation.
- To learn the design principles and to apply for large scale systems.
- To design architectures for distributed heterogeneous systems, environment through brokerage interaction.
- To build knowledge on service-oriented and model driven architectures and aspect-oriented architecture.
- To develop appropriate architectures for various Case studies like semantic web services, supply chain cloud services.

UNIT I SOFTWARE ARCHITECTURE BASICS 9

Agile software development; Traditional software development -- waterfall approach – requirements -- design phase – implementation – testing – support -- advantages and disadvantages; incremental development; Lean software development; scrum; test driven development; extreme programming; rational unified process; agile unified process; Agile model driven development.

UNIT II SOFTWARE ARCHITECTURE DESIGN PRINCIPLES 9

People and Teams working together -- Team behavior in XP projects -- setting up a team -- developing team skills -- training together; organizational framework; planning -- PERT -- Gantt charts; Dealing with problem -- basic strategies -- when things go really wrong; risk analysis; starting XP project -- business analysis and problem discovery; techniques for requirement elicitation; Developing the requirement documents.

UNIT III DISTRIBUTED ARCHITECTURE AND ADAPTATION 9

Identifying stories and preparing to build -- looking at the user stories; collection of stories; user interfaces; communicating clearly with the customer and building confidence; demonstrating the non-functional requirements -- nonfunctional requirements; Estimating resources -- software cost estimation -- object point analysis -- COSMIC FFP -- Design for test; Automating unit tests -- writing unit tests in JUnit -- managing tests.

UNIT IV SOFTWARE PRODUCT LINE ARCHITECTURE 9

Study Design -- Survey field study -- Questionnaire Design – Data collection procedure; Construct operationalization -- Adoption of agile practices -- teamwork and contextual variables – team performance -- instrument validation; Analysis methods – regression analysis -- structural equation modeling -- selecting appropriate analysis techniques; Assessment of team performance; Hypotheses: Test and Evaluation -- measurement model effects on team potency and team performance.

UNIT V ASPECT ORIENTED AND CLOUD ARCHITECTURE 9

Agile Interaction Design -- Agile product development -- Agile Metrics -- Feature Driven Development (FDD) -- Financial and Production Metrics in FDD -- Agile approach to Quality Assurance -- Test Driven Development -- Pair programming: Issues and Challenges – Agile approach to Global Software Development.

TOTAL PERIODS(THEORY): 45

OUTCOMES

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

- Explain the need of software architecture to develop sustainable dynamic systems (K2)
- Apply design principles to develop large scale systems (K3)
- Apply design architectures to develop distributed heterogeneous systems (K3)
- Explain various architectures such as service oriented, aspect oriented and model driven (K2)
- Select appropriate software architectures to design solution for various case studies (K3)

REFERENCE BOOKS

1. Ion Gorton, “Essentials of Software Architecture”, Second Edition, Springer-verlag, 2011 (Units IV, V)
2. Kai Qian, “Software Architecture Design Illuminated”, Jones and Bartlett Publishers, Canada, 2010 (Units I, II, III)
3. David Budgen, “Software Design”, Second Edition, Pearson Education, 2020.
4. Len Bass, Paul Clements, Rick Kazman, “Software Architecture in Practice”, Third Edition, Addison Wesley, 2012.
5. Mary Shaw and David Garlan, “Software Architecture Perspectives On An Emerging Discipline”, Pearson education, 2015.
6. Richard N. Taylor, Nenad Medvidovic and Eric M. Dashofy, “Software Architecture, Foundations, Theory and Practice”, Wiley 2010.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2228	COGNITIVE COMPUTING	3	0	0	3

OBJECTIVES

- To understand foundations of cognitive computing
- To explore the role of AI, Big Data, Machine learning, NLP in cognitive systems
- To understand business implications of cognitive computing and develop solutions.

UNIT I FOUNDATIONS OF COGNITIVE COMPUTING 9

Cognitive computing as a new generation -- uses of cognitive systems -- gaining insights from data -- Artificial Intelligence as the foundation of cognitive computing -- understanding cognition; Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus -- bringing data into a cognitive system -- machine learning -- hypotheses generation and scoring -- presentation and visualization services.

UNIT II NLP IN SUPPORT OF A COGNITIVE SYSTEM 9

Role of NLP in a cognitive system -- semantic web -- Applying natural language technologies to Business problems; Representing knowledge in Taxonomies and Ontologies: Knowledge representation -- Models for knowledge representation -- Implementation considerations.

UNIT III RELATIONSHIP BETWEEN BIG DATA AND COGNITIVE COMPUTING 9

Dealing with human-generated data -- defining big data -- architectural foundation -- analytical data warehouses; Hadoop -- data in motion and streaming data; integration of big data with traditional data; Applying Advanced Analytics to cognitive computing: Key capabilities in advanced analytics -- Impact of open source tools on advanced analytics.

UNIT IV BUSINESS IMPLICATIONS OF COGNITIVE COMPUTING 9

Preparing for a change -- advantages of new disruptive models -- comparison with a cognitive systems approach -- meshing data together differently -- using business knowledge to plan for the future -- answering business questions in new ways, building business specific solutions; Process of building a cognitive application: Emerging cognitive platform -- objective and the domain -- understanding the intended users and their attributes -- questions and exploring insights -- training and testing.

UNIT V BUILDING A COGNITIVE HEALTH CARE APPLICATION 9

Foundations of cognitive computing for healthcare -- constituents in healthcare ecosystem -- learning from patterns in healthcare Data -- cognitive applications across the healthcare ecosystem; Smarter cities: Cognitive Computing in Government -- smarter approaches to preventative healthcare -- building a smarter transportation infrastructure -- creating a cognitive community infrastructure -- next phase of cognitive cities.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain how Artificial Intelligence, Machine Learning and Cognitive Computing are related and are used for application development (K2)
- Describe Cognitive computing and NLP based techniques and models (K2)
- Apply advanced analytics to cognitive computing (K3)
- Apply technical and managerial issues in developing applications based on cognitive computing and Artificial Intelligence techniques (K3)
- Apply and assess cognitive computing and Artificial Intelligence Applications in an organizational setting (K3)

REFERENCE BOOKS

1. Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive computing and Big Data Analytics", Wiley, 2015 (Units 1, 2, 3, 4 and 5)
2. Pradeep Kumar Mallick, Samarjeet Borah, "Emerging Trends and Applications in Cognitive Computing", IGI Global, 2018
3. Vishal Jain, Akash Tayal, Jaspreet Singh, "Cognitive Computing Systems - Applications and Technological Advancements", Taylor & Francis, 2021
4. Rob High, Tanmay Bakshi, "Cognitive Computing with IBM Watson", Packt, 2019

Course Code	COURSE TITLE	L	T	P	C
PCP2229	IMAGE PROCESSING AND ANALYSIS	2	0	2	3

OBJECTIVES

- To understand basics of digital images
- To understand spatial and frequency domain processing
- To learn image segmentation techniques
- To learn feature detection and multi-resolution analysis
- To learn various applications of image processing.

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 5

Introduction -- Elements of visual perception -- Steps in Image Processing Systems -- Image Acquisition -- Sampling and Quantization -- Pixel Relationships -- Image Modalities -- File Formats; Image Operations: Arithmetic -- Logical -- Statistical and Spatial operations.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 8

Spatial Domain processing: Filtering operations; Histograms; Smoothing filters; Sharpening filters; Frequency Domain processing: Fourier Transform -- DFT and FFT; Filtering operations; Smoothing and Sharpening -- Selective filters; Homomorphic filtering; Restoration: Model of Image Degradation/Restoration Process, Noise Models -- Filters for noise removal in Spatial and Frequency domain.

UNIT III IMAGE SEGMENTATION 5

Thresholding techniques: Region growing -- splitting and merging -- Adaptive -- Otsu method; Edge detection; Template matching; Gradient operation; Hysteresis Thresholding - Canny operator – Laplacian tor; Image morphology -- Binary and Gray Level morphology operations -- erosion; dilation -- opening-- closing operations -- Morphological watersheds.

UNIT IV FEATURE DETECTION AND MULTI RESOLUTION ANALYSIS 6

Features -- Corner and interest point detection -- boundary representation and detections -- texture descriptors -- regional descriptors and feature selection techniques; Multi Resolution Analysis: Image Pyramids -- Multi resolution expansion -- Wavelet Transforms; Fast Wavelet transforms.

UNIT V CASE STUDIES IN IMAGE PROCESSING 6

Image Recognition: Fingerprint Recognition; Image Classification: Tumor classification from Medical Images; Image Understanding: CBIR; Image Fusion: Satellite image enhancement; Object tracking: Surveillance applications.

TOTAL PERIODS(THEORY): 30

SUGGESTIVE EXPERIMENTS

1. Generate noisy images by adding Uniform, Gaussian, Salt and pepper noise to an input image. Observe the performance of smoothing filters in the spatial domain.
2. Take a low contrast image and do the following:
    a) Generate a histogram of the image and observe how the intensity values are distributed
    b) Apply histogram equalization and matching
    c) Apply fuzzy sets for intensity transformation
3. Implement a program to perform a Fourier transform followed by the application of high pass filters and then retransform the data to show the filtered images.
4. Implement a program to segment an image
    a) By calculating a threshold setting using the histogram of brightness values.
    b) Using adaptive thresholding
    c) Using watershed algorithm
5. Take a microscope cell image that has undergone a threshold operation. Perform the following morphological transform
    a) erosion and dilation with a circular structuring element
    b) erosion and dilation with a square structuring element
    c) closing and opening with a cross shaped structuring element
6. Perform skeletonization on an input image which contains different shape objects. Observe the resultant images after 20, 30 and 40 iterations.
7. Generate the edges of an image by applying the following edge detection operators: Roberts, Sobel, Prewitt, Laplacian and Canny operators.
8. Perform line, circle, and ellipse detection using Hough transform for images.
9. Write a program to implement a discrete wavelet transform and its inverse for an image. (the user can decide the number of decomposition). Apply Daubechies, Haar and Morlet.
10. Consider images of following characteristics:
    a) With features of varying sizes
    b) With features of varying sizes that are not convex
    c) With a series of lines of approximately the same length
    d) With features with different numbers of internal holes.

Develop a program to count the features, label the pixels with a unique identifying number, and measure the area, total perimeter for the images.

TOTAL PERIODS(LAB): 30
TOTAL: 60

COURSE OUTCOMES

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

- Explain the fundamental concepts of a digital image processing system (K2)
- Apply image enhancement and restoration techniques in spatial and frequency domains (K3)
- Make use of image segmentation techniques for object detection (K3)
- Analyze the multi resolution methods and image transforms for color images (K4)
- Apply techniques of object enhancement, detection, recognition, and classification in various applications (K3)

REFERENCE BOOKS

1. Rafael C.Gonzalez, Richard E.Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018 (Units I, II, III, IV)
2. Wilhelm Burger, Mark J. Burge, “Principles of Digital Image Processing : Core Algorithm”, Springer, 2009 (Unit V)
3. Anil K.Jain, “Fundamentals of Digital Image Processing”, PHI, 2006.
4. Rafael C.Gonzalez, Richard E.Woods, Eddins, “Digital Image Processing using MATLAB”, Second Edition, Tata McGraw-Hill, 2009.
5. Davis, E. R., “Machine Vision”, Second Edition, 1997.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2231	SOCIAL NETWORK ANALYSIS	3	0	0	3

OBJECTIVES

- To understand the components of social networks.
- To execute the models and visualize the social network using tools.
- To learn the mining of communities in the social network.
- To study the evolution of social networks.
- To know the applications of social networks in real time systems.

UNIT I INTRODUCTION 9

The Semantic Web: Limitations of current web -- Development of semantic web -- Emergence of the social web; Statistical properties of social networks; Social Network Analysis: Development of social network analysis -- Key concepts and measures in network analysis -- Discussion; Blogs and online communities -- Web-based networks.

UNIT II MODELING AND VISUALIZATION 9

Modeling and aggregating social network data: Aggregating and reasoning with social network data -- Advanced representations; Visualization of Social Networks: Centrality -- Clustering -- Node-Edge diagrams; Visualizing online social networks: Node-Link Diagrams -- Matrix-based representations.

UNIT III MINING COMMUNITIES 9

Random walks in social networks and their applications: Random walks on graphs -- Algorithms -- Applications; Detecting Communities in Social Networks: Core methods -- Emerging fields and problems; Node classification in social networks.

UNIT IV EVOLUTION OF SOCIAL NETWORKS 9

Evolution in Social Networks: Framework -- Tracing evolving communities; Models and Algorithms for social influence analysis: Influence related statistics -- Social similarity and influence -- Influence maximization in viral marketing; Algorithms and systems for expert locations in social networks: Expert location without graph constraints -- Score propagation -- Expert team formation; Link Prediction in social networks: Feature based link prediction -- Bayesian probabilistic models -- Probabilistic relational models.

UNIT V APPLICATIONS 9

Behavioral Analytics: A learning based approach for real time emotion classification of tweets; A new linguistic approach to assess the opinion of users in social network environments; Explaining scientific and technical emergence forecasting; Recommendation Systems.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the components of the social network (K2).
- Make use of the tools to visualize the social network (K3).
- Explain the mining of communities in the social network (K2).

- Utilize the models and algorithms to find the experts and links of the social network (K3).
- Apply the social networking concepts in the various real time systems (K3).

REFERENCE BOOKS

1. Peter Mika, "Social Networks and the Semantic Web", Springer, 1st edition, 2007 (Unit 1 - Chapters 1, 2, 3 & Unit 2 - Chapter 5)
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1st edition, 2011 (Unit 2 - Chapters 27, 28)
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer, 2014 (Unit 3 – Chapters 3, 4 & Unit 4 - Chapter 7, 8, 9)
4. Przemyslaw Kazienko, Nitesh Chawla, "Applications of Social Media and Social Network Analysis", Springer, 2015 (Unit 5)
5. Safia Kanwal, Sidra Nawaz, Muhammad Kamran Malik, Zubair Nawaz, "A Review of Text-Based Recommendation Systems", IEEE, 2021 (Unit 5)
6. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.
7. Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st edition, 2012
8. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel, "Computational Social Network Analysis: Trends, Tools and Research Advances"", Springer, 2012

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2232	WIRELESS SENSOR NETWORKS AND PROTOCOLS	3	0	0	3

OBJECTIVES

- To study sensor node hardware and design principles.
- To study the functionalities of various MAC protocols for WSNs.
- To understand the working of data centric routing protocols in WSNs.
- To understand the working of localization and topology control in WSNs.
- To explore the various platforms and tools for WSN.

UNIT I INTRODUCTION TO WIRELESS SENSOR NETWORKS 9

Introduction: Challenges -- Applications -- Single node architecture: Hardware components -- Energy consumption of sensor nodes -- Network architecture: Sensor network scenarios -- Optimization goals -- Design principles -- Service interfaces -- gateway concepts.

UNIT II MEDIUM ACCESS CONTROL LAYER 9

Fundamentals of wireless MAC protocols -- Low duty cycle protocols and wakeup concepts -- Contention based protocols -- Schedule-based protocols -- The IEEE 802.15.4 MAC protocol.

UNIT III DATA CENTRIC ROUTING 9

Query processing -- Data aggregation -- Localized vs Centralized protocols -- Data gathering without memorizing links towards the sink -- Data dissemination from the sink -- Data gathering based on memorized broadcasting trees -- Periodic reports by all sensors -- Data gathering with data aggregation.

UNIT IV LOCALIZATION AND TOPOLOGY CONTROL 9

Localization and positioning: Properties of localization and positioning procedures -- Approaches -- Mathematical basics for the lateration problem -- Single-hop localization -- Positioning in multihop environments; Topology control: Concepts -- Controlling topology in flat networks -- Hierarchical networks by dominating sets -- Hierarchical networks by clustering -- Combining hierarchical topologies and power control.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor Network Hardware: Berkeley Motes -- Arduino IDE -- Node Level Software: Platforms -- Tiny OS -- Imperative Language -- nesC -- Simulators: NS-3, Contiki OS and COOJA IDE, TOSSIM -- State Centric Programming: PIECES.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain sensor node architecture and design principles (K2)
- Choose specific MAC protocols for the application (K3)
- Select data-centric routing based on application needs (K3)
- Choose suitable localization and topology control techniques (K3)
- Explain various WSN platforms and build a network using a simulator (K3)

REFERENCE BOOKS

1. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005 (Units - 1, 2, 4)
2. Ivan Stojmenovic, “Handbook of Sensor Networks: Algorithms and Architectures”, Wiley Interscience, 2005 (Unit 3)
3. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Morgan Kaufmann, 2004 (Unit 5)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2233	EMBEDDED SOFTWARE DEVELOPMENT	3	0	0	3

OBJECTIVES

- To understand the architecture of embedded processor, microcontroller and peripheral
- devices.
- To interface memory and peripherals with embedded systems.
- To study the embedded network environment.
- To understand challenges in Real time operating systems.
- To study, analyze and design applications on embedded systems.

UNIT I EMBEDDED PROCESSORS 9

Embedded Computers - Characteristics of Embedded Computing Applications - Challenges in Embedded Computing System Design - Embedded System Design Process- Formalism for System Design - Structural Description - Behavioural Description - ARM Processor - Intel ATOM Processor.

UNIT II EMBEDDED COMPUTING PLATFORM 9

CPU Bus Configuration - Memory Devices and Interfacing - Input/Output Devices and Interfacing - System Design - Development and Debugging – Emulator – Simulator - JTAG Design Example – Alarm Clock - Analysis and Optimization of Performance - Power and Program Size.

UNIT III EMBEDDED NETWORK ENVIRONMENT 9

Distributed Embedded Architecture - Hardware And Software Architectures - Networks for Embedded Systems - I2C - CAN Bus - SHARC Link Supports – Ethernet – Myrinet – Internet - Network-based Design - Communication Analysis - System Performance Analysis – Hardware Platform Design - Allocation and Scheduling - Design Example - Elevator Controller.

UNIT IV REAL-TIME CHARACTERISTICS 9

Clock Driven Approach - Weighted Round Robin Approach - Priority Driven Approach – Dynamic versus Static Systems - Effective Release Times and Deadlines - Optimality of the Earliest Deadline First (EDF) Algorithm - Challenges in Validating Timing Constraints in Priority Driven Systems - Off-Line versus On-Line Scheduling.

UNIT V SYSTEM DESIGN TECHNIQUES 9

Design Methodologies - Requirement Analysis – Specification - System Analysis and Architecture Design - Quality Assurance - Design Examples - Telephone PBX - Ink jet printer - Personal Digital Assistants - Set-Top Boxes.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the basic concepts of embedded system design and the architecture of embedded processors. (K2)
- Develop and debug the memory and peripheral interfacing with embedded systems. (K3)
- Apply the concepts of network based embedded system design (K3)

- Summarize the challenges in design of embedded systems with real-time characteristics. (K2)
- Develop an embedded system using various design methodologies. (K3)

REFERENCE BOOKS

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things" Wiley Publication, First edition, 2013.
2. Andrew N Sloss, D. Symes, C. Wright, "Arm system developers guide", Morgan Kauffman/Elsevier, 2006.
3. ArshdeepBahga, Vijay Madisetti, "Internet of Things: A Hands-on-Approach" VPT First Edition, 2014
4. C. M. Krishna and K. G. Shin, "Real-Time Systems" , McGraw-Hill, 1997
5. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons.
6. Jane.W.S. Liu, "Real-Time systems", Pearson Education Asia.
7. Michael J. Pont, "Embedded C", Pearson Education , 2007.
8. Muhammad Ali Mazidi , SarmadNaimi , SepehrNaimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C" Pearson Education, First edition, 2014
9. Steve Heath, "Embedded SystemDesign" , Elsevier, 2005
10. Wayne Wolf, "Computers as Components:Principles of Embedded Computer System Design", Elsevier, 2006.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2321	FORMAL SYSTEM VERIFICATION	3	0	0	3

OBJECTIVES

- To understand the need of logics for specification and verification of computer systems
- To learn program correctness using Hoare Logic
- To learn the skill of writing formal specifications in LTL and CTL
- To learn model checking algorithms for LTL and CTL
- To learn model checking for Timed Systems

UNIT I FOUNDATIONS 9

Propositional Logic: Syntax -- Semantics -- Natural deduction; Predicate Logic: Syntax -- Semantics -- Natural deduction; Linear-time Temporal Logic: Syntax -- Semantics -- Specifications in LTL; Branching-time Logic: Syntax -- Semantics -- Specifications in CTL; CTL* and the expressive powers of LTL and CTL.

UNIT II HOARE LOGIC AND PROGRAM CORRECTNESS 9

A Framework for Program Correctness: A core programming language -- Hoare triples -- Partial and total correctness – Program variables and logical variables; Proof Calculus for Partial Correctness: Proof rules -- Proof tableaux; Proof Calculus for Total Correctness.

UNIT III MODEL CHECKING 9

Model-checking Algorithms: The CTL model-checking algorithm -- CTL model checking with fairness -- The LTL model-checking algorithm; CTL* Model-checking Algorithm; Model Checking using Automata; Checking Emptiness; Translating LTL into Automata; On-the-fly Model checking.

UNIT IV SYMBOLIC MODEL CHECKING 9

Binary Decision Diagrams: Representing Boolean formulas – Representing Kripke structures; Fixpoint Representations; Symbolic Model Checking for CTL; Fairness in Symbolic Model Checking; Counterexamples and Witnesses; Relational Product Computations; Symbolic Model Checking for LTL; NuSMV.

UNIT V MODEL CHECKING TIMED SYSTEMS 9

Timed Automata: Semantics -- Time divergence – Time Lock -- Zenoness; Timed Computation Tree Logic; TCTL Model Checking: Eliminating timing parameters -- Region transition systems -- The TCTL model-checking algorithm; Model checkers for Timed Automata: UPPAAL -- KRONOS.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Identify an appropriate model checking algorithm to verify the given computer system (K3)
- Construct proofs for partial correctness of simple programs using Hoare logic (K3)
- Develop formal properties and specifications in CTL and LTL (K3)
- Develop and verify simple systems using NuSMV (K3)
- Develop and verify simple systems using UPPAAL (K3)

REFERENCE BOOKS

1. M Huth, M Ryan, “Logic in Computer Science -- Modeling and Reasoning About Systems”, 2nd Edition, Cambridge University Press, 2012 (Units I, II and III).
2. Edmund Clarke, Orna Grumberg, Doron Peled, “Model Checking”, The MIT Press, 2018 (Units III and IV).
3. C Baier, J Katoen, “Principles of Model Checking”, The MIT Press, 2008 (Unit V).
4. Michael Clarke, Thomas Henzinger, Helmut Veith, Roderick Bloem, “Handbook of Model Checking”, Springer 2018.
5. Orna Grumberg, Helmut Veith, “25 Years of Model Checking: History, Achievements, Perspectives”, Springer-Verlag, 2008.
6. Zohar Manna, Amir Pnueli, “Temporal Verification of Reactive Systems: Safety”, Springer-Verlag, 2012.
7. Krzysztof R. Apt, Frank S. de Boer, Ernst-Rudiger Olderog, “Verification of Sequential and Concurrent Programs”, Springer, 3rd edition, 2009.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2322	BIOINFORMATICS	3	0	0	3

OBJECTIVES

- To understand the concept and need of Bioinformatics.
- To transform biological data into knowledge and perform data analysis.
- To learn machine learning algorithms for bioinformatics
- To learn hidden Markov modeling and probabilistic modeling
- To know the importance of microarray data analysis.

UNIT I INTRODUCTION 9

Introduction to Bioinformatics: Need for Bioinformatics technologies -- Overview of Bioinformatics technologies; Overview of structural bioinformatics: Organization of structural bioinformatics – Primary resource: protein data bank -- Secondary resources and applications.

UNIT II DATA WAREHOUSING AND DATA MINING IN BIOINFORMATICS 9

Data warehousing in Bioinformatics: Bioinformatics data -- Transforming data to knowledge -- Data warehousing architecture -- Data quality; Data mining for Bioinformatics: Biomedical data analysis -- DNA data analysis -- Protein data analysis.

UNIT III MACHINE LEARNING IN BIOINFORMATICS 9

Machine learning in Bioinformatics: Artificial neural network – Neural network architecture and applications -- Genetic algorithm – Fuzzy system; Genome Analyses; Transcriptome Analyses.

UNIT IV MODELING FOR BIOINFORMATICS 9

Modeling for Bioinformatics: Hidden Markov modeling for biological data analysis -- Comparative modeling -- Probabilistic modeling -- Molecular modeling.

UNIT V MICROARRAY DATA ANALYSIS 9

Microarray Data Analysis: Microarray technology for genome expression study -- Image analysis for data extraction -- Data Analysis for Pattern Discovery.

TOTAL PERIODS(THEORY): 45

OUTCOMES

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

- Explain the concept and need of bioinformatics (K2)
- Identify genome, protein data and their equivalent storage and mining process (K3)
- Apply machine learning algorithms on bioinformatics data (K3)
- Apply Hidden Markov Modeling and probabilistic modeling for bioinformatics data (K3)
- Infer the importance of microarray data analysis (K2)

REFERENCE BOOKS

1. Yi-Ping Phoebe Chen (Ed), “Bioinformatics Technologies”, First Indian Reprint, Springer Verlag, 2007 (Units 1, 2 3, 4, 5)
2. Arthur M Lesk, “Introduction to Bioinformatics”, Fourth Edition, Oxford University Press, 2008
3. Rui Jiang, Xuegong Zhang, Michael Q Zhang, “Basics of Bioinformatics”, Tsinghua University Press, Springer, 2013

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2323	DATA VISUALIZATION TECHNIQUES	3	0	0	3

OBJECTIVES

- To introduce visual perception and core skills for visual analysis.
- To visualize time-series, part-to-whole and ranking analysis patterns.
- To analyze the deviation and distribution of data in real time.
- To analyze correlation and multivariate patterns of data.
- To understand issues and best practices in information dashboard design.

UNIT I BUILDING CORE SKILLS FOR VISUAL ANALYSIS 10

Information Visualization -- Prerequisites for Enlightening Analysis: Aptitudes and attitudes of effective Analysts -- Traits of meaningful data; Power of Visual Perception -- How Visual Perception Works -- Making Abstract Data Visible -- Analytical Interaction -- Analytical Navigation -- Optimal Quantitative Scales -- Reference Lines and Regions -- Trellises and Crosstabs -- Multiple Concurrent Views -- Focus and Context -- Details on Demand -- Over-plotting reduction.

UNIT II TIME-SERIES ANALYSIS, PART-TO-WHOLE AND RANKING ANALYSIS 9

Time-series Analysis: Introduction -- Time-series patterns -- Time-series displays -- Time-series analysis techniques and best practices; Part-to-whole and Ranking Analysis: Introduction -- Part-to-whole and ranking patterns -- Part-to-whole and ranking displays -- Part-to-whole and ranking techniques and best practices; Creating graphs for time-series and ranking analysis (e.g. sales revenue)

UNIT III DEVIATION ANALYSIS AND DISTRIBUTION ANALYSIS 9

Deviation Analysis: Introduction -- Deviation analysis displays -- Deviation analysis techniques and best practices; Distribution Analysis: Introduction -- Describing distributions - Distribution patterns -- Distribution displays -- Distribution analysis techniques and best practices; Creating plots for deviation and distribution analysis (e. g. salary distribution of employees).

UNIT IV CORRELATION ANALYSIS AND MULTIVARIATE ANALYSIS 9

Correlation Analysis: Introduction -- Describing correlations -- Correlation patterns -- Correlation displays -- Correlation analysis techniques and best practices; Multivariate Analysis: Introduction -- Multivariate patterns -- Multivariate displays -- Multivariate analysis techniques and best practices; Creating graphs and heatmaps for correlation and multivariate analysis of data (e. g. Marketing expenses)

UNIT V INFORMATION DASHBOARD DESIGN 8

Information Dashboard: Definition -- Thirteen Common Mistakes in Dashboard Design -- Gestalt Principles of Visual Perception -- Characteristics of Well-designed Dashboard – Designing Dashboards for Usability -- Creating a Simple Dashboard using Metabase (e. g. Sales, Marketing Analysis).

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the core skills for visual analysis (K2)
- Apply visualization techniques for time-series data and ranking patterns (K3)
- Apply visualization techniques for finding the deviation and distribution of data patterns (K3)
- Analyze correlation and multivariate patterns among data (K4)
- Explain the characteristics of dashboard and develop dashboard for simple applications (K3)

REFERENCE BOOKS

1. Stephen Few, “Now you see it: Simple Visualization techniques for quantitative analysis”, Analytics Press, 2009. (Units I, II, III, IV)
2. Stephen Few, “Information dashboard design: The Effective Visual Communication of Data”, First edition, O'Reilly, 2006. (Unit V)
3. Tim Abraham, “Metabase Up and Running”, Packt Publishing Limited, 2020.
4. Ben Fry, “Visualizing data: Exploring and explaining data with the processing environment”, O'Reilly, 2008.
5. Edward R. Tufte, “The visual display of quantitative information”, Second Edition, Graphics Press, 2001.
6. Nathan Yau, “Data Points: Visualization that means something”, Wiley, 2013.
7. Tamara Munzner, “Visualization Analysis and Design”, AK Peters Visualization Series, CRC Press, 2014

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2324	SOFT COMPUTING	3	0	0	3

OBJECTIVES

- To learn the basic concepts of Soft Computing
- To study various Artificial Neural network architectures
- To learn fuzzy sets, fuzzy logic and fuzzy inference system
- To learn the concepts of genetic algorithms and their applications
- To learn hybrids of neuro, fuzzy and genetic algorithms, and their applications.

UNIT I INTRODUCTION TO SOFT COMPUTING 8

Introduction: Neural networks -- Fuzzy logic -- Genetic algorithm -- Hybrid systems; Artificial Neural Network: Fundamental concepts -- Evolution of neural networks -- Basic modals of ANN -- McCulloch and Pitts neuron -- Linear separability -- Hebb network.

UNIT II SUPERVISED, UNSUPERVISED AND ASSOCIATIVE LEARNING NETWORKS 11

Supervised Learning Network: Perceptron networks -- Adaptive linear neuron -- Multiple adaptive linear neurons -- Back propagation networks -- Radial bias function network; Associative Memory Networks: Auto associative memory network -- Bidirectional associative memory -- Hopfield networks; Unsupervised Learning Networks: Hamming network -- Kohonen neural network -- Learning vector quantization – Adaptive resonance theory networks.

UNIT III FUZZY SYSTEMS 9

Introduction to fuzzy logic -- Classical sets -- Fuzzy sets – Fuzzy relations -- Membership functions -- Defuzzification methods – Fuzzy arithmetic -- Fuzzy measures -- Fuzzy rule base and approximate reasoning -- Fuzzy decision making.

UNIT IV GENETIC ALGORITHMS 8

Genetic Algorithm and search space -- General genetic algorithm -- Operators -- Stopping condition -- Constraints -- Classification -- Genetic programming; Applications of genetic algorithms.

UNIT V HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS 9

Neuro-Fuzzy hybrid systems -- Genetic neuro hybrid systems – Genetic fuzzy hybrid and fuzzy genetic hybrid systems; Applications of Soft Computing: A fusion approach of multispectral images with SAR -- Optimization of Traveling Salesman Problem using genetic algorithm -- Soft computing-based hybrid fuzzy controllers.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain various soft computing techniques (K2)
- Design and develop different neural network algorithms (K3)
- Analyse and apply fuzzy logic and fuzzy inference system (K3)
- Solve problems using Genetic Algorithms (K3)
- Applications of soft computing to solve problems in varieties of application domains (K3).

REFERENCE BOOKS

1. 1. S N Sivanandam, S N Deepa, “Principles of Soft Computing”, Wiley India, 3rd Edition, 2019.
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, Prentice-Hall of India, 2002.
3. Kwang H Lee, “First course on Fuzzy Theory and Applications”, Springer, 2005.
4. George J Klir, Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Prentice Hall, 1996.
5. James A Freeman, David M Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Addison Wesley, 2003.
6. S Rajasekaran, G A Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications”, PHI Learning, 2017.
7. N P Padhy, S P Simon, “Soft Computing with MATLAB Programming”, Oxford University Press, 2015.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2325	CYBER SECURITY	2	0	2	3

OBJECTIVES

- To get introduced to cyber security cybercrime and law
- To understand the attacks and tools
- To understand information gathering
- To understand how to detect an attack
- To understand how to prevent an attack.

UNIT I INTRODUCTION TO CYBER SECURITY 9

Cyber Security the need of the hour -- History of Internet -- Impact of Internet -- CIA Triad; Reason for Cyber Crime -- Need for cyber security -- History of cybercrime; Cybercriminals -- Classifications of Cybercrimes -- A Global Perspective on Cybercrimes; Need Cyber laws -- The Indian IT Act -- Cyber Crime and Punishment.

UNIT II ATTACKS AND COUNTERMEASURES 6

OSWAP; Malicious attack Threats and Vulnerabilities: Scope of cyber-attacks -- Security breach -- Types of malicious attack -- Malicious software -- Common attack vectors -- Social Engineering attack -- Wireless Network attack -- Web application attack -- Attack tools -- Countermeasures.

UNIT III RECONNAISSANCE 5

The Harvester -- Whois -- Netcraft -- Host -- Extracting Information from DNS -- Extracting Information from E-mail Servers -- Social Engineering Reconnaissance; Scanning -- Port Scanning -- Network Scanning and Vulnerability Scanning -- Understand Scanning Methodology -- Ping Sweep Techniques -- Nmap Command Switches -- SYN -- Stealth -- XMAS -- NULL -- IDLE -- FIN Scans -- Banner Grabbing and OS Fingerprinting Techniques.

UNIT IV INTRUSION DETECTION 5

Intrusion Detection: Host-Based Intrusion Detection -- Network-Based Intrusion Detection -- Distributed or Hybrid Intrusion Detection -- Intrusion Detection Exchange Format -- Honeypots -- Example System Snort.

UNIT V INTRUSION PREVENTION 5

Firewalls and Intrusion Prevention Systems:The Need for Firewalls -- Firewall Characteristics and Access Policy -- Types of Firewalls -- Firewall Basing -- Firewall Location and Configurations -- Intrusion Prevention Systems -- Example Unified Threat Management Products.

TOTAL PERIODS(THEORY): 30

SUGGESTIVE EXPERIMENTS (30 Hours)

1. Install Kali Linux on virtual box
2. Explore Kali Linux and bash scripting
3.Perform open source intelligence gathering using Netcraft, Whois Lookups, DNS Reconnaissance, Harvester and Maltego
4. Understand namp commands and scan a target using nmap
5. Install metasploitable2 on the virtual box and search for unpatched vulnerability
6. Use Metasploit to exploit an unpatched vulnerability

7. Install linux server on the virtual box and install ssh
8. Use Fail2ban to scans log files and bans IPs that show the malicious signs
9. Brute force attack on the linux server using hydra
10. Real-time network traffic analysis and data packet logging using snort

TOTAL PERIODS(LAB): 30
TOTAL : 60

COURSE OUTCOMES

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

- Explain the basics of cyber security, cyber crime and law (K2)
- Classify various types of attacks and learn the tools to launch the attacks (K2)
- Apply various tools to perform information gathering (K3)
- Apply intrusion detection techniques to detect intrusion (K3)
- Apply intrusion prevention techniques to prevent intrusion (K3)

REFERENCE BOOKS

1. Anand Shinde, “Introduction to Cyber Security Guide to the World of Cyber Security”, Notion Press, 2021 (Unit 1)
2. Nina Godbole, Sunit Belapure, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley publisher, 2011 (Unit 1)
3. https://owasp.org/Top10/, 2021 (Unit 2)
4. David Kim, Michael G. Solomon, “Fundamentals of Information Systems Security”, Jones & Bartlett Learning publisher, 2013 (Unit 2)
5. Patrick Engebretson, “The Basics of Hacking and Penetration Testing Ethical Hacking and Penetration Testing Made Easy”, Elsevier, 2011 (Unit 3)
6. Kimberly Graves, “CEH Official Certified Ethical Hacker Review Guide”, Wiley publisher, 2007 (Unit 3)
7. William Stallings, Lawrie Brown, “Computer Security Principles and Practice”, Third Edition, Pearson Education, 2015 (Units 4 and 5)
8. Georgia Weidman, “Penetration testing A Hands-On Introduction to Hacking”, San Francisco, 2014 (Lab)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2326	MULTI-CORE ARCHITECTURES AND GPU COMPUTING	3	0	0	3

OBJECTIVES

- To understand the basics of multi-core architectures.
- To understand the architectures of SIMD and MIMD systems
- To learn CUDA programming constructs, and solutions.

UNIT I MULTICORE PROCESSORS 9

Single core to multicore architectures; Homogeneous and heterogeneous Multi-core architectures: Intel multicore architectures -- SUN CMP architecture -- IBM cell architecture; Introduction to warehouse-scale computers architectures -- Physical infrastructure and costs..

UNIT II MULTI PROCESSOR ARCHITECTURES AND ISSUES 9

MIMD systems: Symmetric and distributed shared memory architectures; Cache coherence; Interconnection networks; Performance issues; Parallel program design.

UNIT III VECTOR, SIMD AND GPU ARCHITECTURES 9

IMD Systems: Introduction -- Vector architecture -- SIMD extensions for multimedia -- Graphics Processing Units; Detecting and enhancing loop level parallelism; Case studies -- GPGPU computing.

UNIT IV GPU PROGRAMMING USING CUDA 9

CUDA Hardware Overview: Threads -- Blocks -- Grids -- Warps -- Scheduling; Memory handling with CUDA: Shared memory -- Global memory -- Constant memory and texture memory.

UNIT V COMMON PROBLEMS, CAUSES, AND SOLUTIONS IN CUDA 8

Common Problems: CUDA error handling -- Parallel programming issues -- synchronization -- Algorithmic issues -- Finding and avoiding Errors.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Apply the concepts of different multicore architectures in exploiting parallelism (K3)
- Interpret the features and issues of MIMD systems (K2)
- Explain the features of SIMD systems (K2)
- Develop programs using CUDA (K3)
- Apply and identify issues in CUDA programming (K3)

REFERENCE BOOKS

1. 1. John L. Hennessey and David A. Patterson, “Architecture – A Quantitative Approach”, 6th edition, Morgan Kaufmann / Elsevier, 2017. (Units I, III)

2. Peter S. Pacheco, “An Introduction to Parallel Programming”, Morgan Kaufmann, 2014. (Unit II)
3. Shane Cook, “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing)”, First Edition, Morgan Kaufmann, 2012. (Units IV, V)
4. Sanders J. Kandrot E. “CUDA by example: An Introduction to General-Purpose GPU Programming”, Addison-Wesley, 2011.
5. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming”, Addison - Wesley, 2013.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2327	SOFTWARE PROJECT MANAGEMENT	3	0	0	3

OBJECTIVES

- To understand the basic concept of project management
- To learn the various costings and life cycle management
- To understand the role played by risk in software projects
- To appreciate the use of metrics for software project management
- To know the challenges in people management

UNIT I PROJECT MANAGEMENT 9

Software Project Management: Approaches - Project acquisition - Initiation - Planning - Execution - Execution control - Change management - Scheduling - Project closure

UNIT II PROCESS MODELS & LIFECYCLE MANAGEMENT 9

Introduction to life cycle models - Agile development models - Extreme programming - Scrum; Project planning - Metrics of project size estimation - Project estimation techniques - Empirical estimation techniques - COCOMO - Halstead - Staffing level; ISO 9000 - SEI CMM -SPICE - PSP.

UNIT III RISK MANAGEMENT 9

Perspectives of Risk Management - Risk Definition - Risk Categories - Risk Assessment: Approaches, techniques and good practices - Risk Identification / Analysis / Prioritization - Risk Control (Planning / Resolution / Monitoring) - Risk Retention - Risk Transfer - Failure Mode and Effects Analysis (FMEA) - Operational Risks - Supply Chain Risk Management.

UNIT IV METRICS 9

Need for Software Metrics: scope, basics, framework for software measurement - Product Metrics: Size Metrics, Complexity Metrics, Halsteads Product Metrics, Quality Metrics- Process metrics: Empirical Models, Statistical Models,Theory based Models,Composite Models, Reliability Models- Measuring Internal and External Product Attributes.

UNIT V PEOPLE MANAGEMENT 9

Leadership styles - Developing Leadership skills - Leadership assessment - Motivating People - Organizational strategy - Management - Team building - Delegation - Art of Interviewing People - Team Management - Rewarding - Client Relationship Management.

TOTAL PERIODS(THEORY): 45

OUTCOMES

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

- Summarize various steps involved in software project management (K2)
- Choose an appropriate process model and estimate project cost and effort required (K5)
- Identify existing risks and perform risk assessment (K3)
- Choose appropriate metrics for software project management (K3)
- Outline leadership styles and team building. (K2)

REFERENCE BOOKS

1. Murali Chemuturi, Thomas M. Cagley, ``Mastering Software Project Management: Best Practices, Tools and Techniques", J. Ross Publishing, 2010.(UNIT I)
2. Rajib Mall, ``Fundamentals of Software Engineering", 3rd edition, PHI Learning Pvt. Ltd., 2009.(UNIT II)
3. Ravindranath Pandian, ``Applied Software Risk Management A Guide for Software Project Managers", Auerbach Publication, 2007. (UNIT III)
4. Antonio Borghesi, Barbara Gaudenzi, ``Risk Management: How to Assess, Transfer and Communicate Critical Risks: Perspectives in Business Culture",Illustrated Edition, Springer, 2012. (UNIT III)
5. Norman Fenton, James Bieman, ``Software Metrics: A Rigorous and Practical Approach", 3rd edition, CRC Press, 2015.(UNIT IV)
6. Bob Hughes, Mike Cotterell, Rajib Mall, ``Software Project Management", Sixth Edition, Tata McGraw Hill, 2018.(UNIT I, V)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2328	HEALTHCARE DATA ANALYTICS	2	0	2	3

OBJECTIVES

- Discuss the role of basic and advanced data analytics in healthcare systems.
- Identify the Data Sources for Healthcare and describe the methods and techniques used for data analytics in EHR.
- Describe the methods and ways for processing big medical data
- Evolve how Machine learning and AI can be used for healthcare.
- Identify the challenges and future of big data in healthcare.

UNIT I INTRODUCTION TO HEALTHCARE DATA ANALYTICS 6

Introduction - Healthcare Data Sources and Basic Analytics – Advanced Data Analytics for Healthcare - Applications

UNIT II HEALTHCARE DATA SOURCES 6

Introduction - Electronic Health Records (EHR) - Components of EHR - Benefits of EHR - Challenges of using EHR Data – Clinical Applications: EHR and Decision Support System.

UNIT III HEALTHCARE ANALYTICS 6

Introduction; Making Predictive Models in Healthcare; Healthcare Predictive Models - Predictive Healthcare Analytics (State-of-the-art) - ML Applications for Cancer - Readmission Prediction.

UNIT IV AI AND MACHINE LEARNING FOR HEALTHCARE 6

AI in Healthcare - Diagnosing - Predicting - Mining the EHR; Use Cases: Breast Cancer Detection - Autism Screening.

UNIT V FUTURE OF BIG DATA IN HEALTHCARE 6

Management of Big Biomedical Data - Future directions of Healthcare and Big Data Analytics - Use Case: Prediction of diabetics.

TOTAL PERIODS (THEORY): 30

SUGGESTIVE EXPERIMENTS (Python)

1. Text Classification on Medical-Data (EHR)

2. Healthcare Recommendation Evaluator (Decision Support)

3. Breast Cancer Detection

4. Autism Screening with Machine Learning algorithms

5. Prediction of diabetics using binary classification

TOTAL PERIODS(LAB): 30
TOTAL DS: 60

OUTCOMES

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

- Explain the basic and advanced data analytics in public health (K2)
- Utilize the available data sources for healthcare and develop a decision support system (K3)

- Explain the predictive models and ways for processing healthcare data (K2)
- Develop a model for diagnosing and predicting health issues using AI and machine learning (K3)
- Analyze big data in healthcare using machine learning techniques (K4)

REFERENCE BOOKS

1. Chandan K. Reddy and Charu C. Aggarwal, ``Healthcare Data Analytics", CRC Press, Taylor & Francis Group, LLC., 2020 (Unit I & II)
2. Vikas, "Healthcare Analytics Made Simple: Techniques in Healthcare Computing using Machine Learning", PACKT publishers, 2018 (Unit III)
3. Eduonix Learning Solutions, "Machine Learning for Healthcare Analytics Projects", PACKT Publishers, 1st Edition, 2018. (Unit IV)
4. Panta Keikhosrokiani, "Big Data Analytics for Healthcare", Academic Press, 1st Edition, 2022. (Unit V)
5. Arjun Panesar, "Machine Learning and AI for Healthcare", APress publications, 2nd Edition, 2020.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2329	EDGE ANALYTICS	3	0	0	3

OBJECTIVES

- To understand the various computing paradigms and challenges of edge computing environment.
- To explore the various hardware needed for edge architecture.
- To learn about federated learning techniques and inferences at edge systems.
- To understand the technologies and components used to create an edge analytics application.
- To learn different applications of edge computing.

UNIT I INTERNET OF THINGS (IOT) AND NEW COMPUTING PARADIGMS 9

Introduction -- Relevant Technologies -- Fog and Edge Computing -- Hierarchy of Fog and Edge Computing; The Networking Challenge -- Networking Challenges in a Federated Edge Environment -- Addressing the Networking Challenge -- The Management Challenge -- Miscellaneous and Research challenges.

UNIT II EDGE COMPUTING HARDWARE 8

Edge Hardware for AI -- Edge Data Analysis for Edge AI -- Communication and Computation Modes for Edge AI -- Tailoring Edge Frameworks for AI – Performance Evaluation for Edge AI; Basic edge analytics components -- Communications Protocols -- Edge Computing State--of--the--Art Interfaces and Devices -- Edge Computing Simulators.

UNIT III ARTIFICIAL INTELLIGENCE FOR EDGE COMPUTING 9

Distributed DL Training -- Potential DL Libraries for Edge; Artificial Intelligence Training at Edge: Distributed Training at Edge -- Vanilla Federated Learning at Edge -- Resource--Optimized FL -- Security--Enhanced FL-- Communication--Efficient FL; Artificial Intelligence Inference in Edge: Optimization of AI Models in Edge -- Segmentation of AI Models -- Early Exit of Inference (EEoI) -- Sharing of AI Computation.

UNIT IV EDGE ANALYTICS 10

Edge Data Analytics -- Potential of Edge Analytics -- Architecture of Edge Analytics -- Machine Learning for Edge Devices -- Edge Analytics: Case Study; Key benefits of edge analytics --Working with Microsoft Azure IoT Hub -- Using the Raspberry Pi with Azure IoT Edge; Types of attacks against our edge analytics applications -- Protecting our edge analytics applications -- Monitoring and auditing our edge analytics applications.

UNIT V EDGE COMPUTING APPLICATIONS 9

Edge Computing use Cases -- Realization of Edge Computing in Healthcare Ensuring Storage Security; Industrial Internet of Things (IIoT) Applications of Edge and Fog Computing: A Review and Future Directions -- Leveraging Edge Computing for Mobile Augmented Reality; Smart Surveillance Video Stream Processing at the Edge for Real--Time Human Objects Tracking.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Describe the fundamentals and challenges of edge computing (K2)
- Explain the use and need of different hardware components of edge computing (K2)
- Apply the advanced concepts and frameworks of edge AI (K3)
- Apply the technologies used for edge analytics and developing solutions (K3)
- Identify the applications developed using edge architecture (K3)

REFERENCE BOOKS

1. Rajkumar Buyya and Satish Narayana Srirama, Fog and Edge Computing Principles and Paradigms, Wiley, 2019. (Units 1, 5)
2. K. Anitha Kumari G. Sudha Sadasivam D. Dharani M. Niranjanamurthy, Edge Computing Fundamentals, Advances and Applications, CRC Press, 2022. (Units 2, 4, 5)
3. Xiaofei Wang, Yiwen Han, Victor C.M.Leung, Dusit Niyato, Xueqiang Yan, Xu ChenEdge, AI Convergence of Edge Computing and Artificial Intelligence, Springer, 2020. (Units 2, 3)
4. Wei Chang, Jie Wu Fog, Edge Computing For Security, Privacy, and Applications, Springer, 2021. (Unit 5)
5. Colin Dow, Hands-On Edge Analytics with Azure IoT- Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Packt Publishing, 2020. (Unit 4)

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2331	FUNCTIONAL PROGRAMMING	3	0	0	3

OBJECTIVES

- To write small to medium-sized functional programs for a variety of applications
- To exploit a variety of programming techniques typical in functional programming such as use of recursion, modeling with recursive datatypes, abstraction, and reuse with the help of higher order functions and monads
- To appreciate the strengths and possible weaknesses of the functional programming paradigm

UNIT I FUNCTIONS 9

Functions and functional programming -- Sessions and scripts -- Types and classes -- Defining functions.

UNIT II LISTS, RECURSION, HIGHER-ORDER FUNCTIONS 9

Lists -- List comprehensions -- Recursive functions -- Higher order functions.

UNIT III TYPES, CLASSES 9

Declaring types and classes -- Interactive programming.

UNIT IV MONADS 9

Monads -- Monadic Parsing -- Foldables -- Traversable.

UNIT V LAZY EVALUATION 9

Lazy evaluations -- Infinite objects -- Pascal's triangle, digits of a number, sieve of Eratosthenes -- Reasoning about programs.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the basics of functional programming and write programs in a functional style (K2)
- Use lists, recursion, and higher order functions (K3)
- Apply polymorphism and higher-order functions (K3)
- Separate stateful functions using monads and apply them for problem solving (K3)
- Use infinite data structures and reason formally about functional programs (K3)

REFERENCE BOOKS

1. Richard Bird, ``Introduction to Functional Programming using Haskell", second edition, Prentice-Hall International, 1998.
2. Graham Hutton, ``Programming in Haskell", second edition, Cambridge University Press, 2016.
3. Bryan O'Sullivan, John Goerzen, Donald Bruce Stewart, "Real World Haskell", O'Reilly Media, Inc., 2008
4. Alejandro Serrano Mena, "Practical Haskell: A Real World Guide to Programming", 2nd Edition APRESS, 2019

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2332	SECURITY PRINCIPLES AND PRACTICE	3	0	0	3

OBJECTIVES

- To study about the essentials of computer security
- To acquire knowledge in encryption Techniques
- To understand authentication applications
- To learn various access control mechanisms
- To understand different security policies

UNIT I OVERVIEW OF SECURITY AND ENCRYPTION TECHNIQUES 9

Computer Security Concepts -- Security Architecture -- Attacks, Services and Mechanisms -- Fundamental Security Design Principles -- Attack Surfaces and Attack Trees -- Algebraic structures – Modular arithmetic -- Euclid's algorithm -- Congruence and matrices -Groups, Rings, Fields- Finite fieldsBlock Cipher -- Data Encryption Standard -- Advanced Encryption Standard -- Stream Ciphers and RC4 – Cipher Block Modes of Operation

UNIT II PUBLIC KEY CRYPTOGRAPHY 9

Primes -- Primality Testing --Factorization -- Euler's totient function, Fermat's and Euler's Theorem -- Chinese Remainder Theorem -- Exponentiation and logarithm -- Public-Key Cryptography and Message Authentication: Secure Hash Functions -- HMAC -- RSA --Diffie-Hellman -- Elliptic curve arithmetic -- Elliptic curve cryptography.

UNIT III NETWORK PROTOCOLS 9

Protocols Using Shared Key Cryptography: Entity Authentication Protocols -- Server-Less Key Establishment -- Server-Based Key Establishment; Authentication and Key Transport Using Public Key Cryptography: Entity Authentication Protocols -- Key Transport Protocols; Key Agreement Protocols: Diffie-Hellman Key Agreement --Diffie-Hellman Protocols with Explicit Authentication.

UNIT IV IOT AND CLOUD SECURITY 9

Cloud and IoT security: Cloud Computing -- Cloud Security Concepts -- Cloud Security Approaches; Transport Layer Security: TLS -- HTTPS -- SSH; Electronic Mail security: PGP, S/MIME -- IP security – Web Security; IP Security: IPSec.

UNIT V INFORMATION SECURITY 9

The Nature of Security Policies -- Types of Security Policies – The Role of Trust; Confidentiality policy:The Bell-LaPadula Model; Integrity policy: Clark-Wilson Integrity Model; Availability policy: Denial of Service Models; Hybrid policy: Chinese Wall Model

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the fundamentals of networks security, security architecture, threats and vulnerabilities, and apply the different cryptographic operations of symmetric cryptographic algorithms (K3)
- Apply the different cryptographic operations of public key cryptography (K3)

- Outline the authentication schemes and key distribution protocols (K3)
- Outline the security mechanisms adapted in OS, Cloud and IoT (K2)
- Explain the functionality of access control mechanisms, Compare and contrast various security policies (K3).

REFERENCE BOOKS

1. William Stallings, Lawrie Brown, ``Computer Security Principles and Practice", Seventh Edition, Pearson, 2019. (Unit I, II)
2. William Stallings, "Network Security Essentials: Applications and Standards", Sixth edition, Pearson, 2017 (Unit IV)
3. Colin Boyd, Anish Mathuria, Douglas Stebila, "Protocols For Authentication And Key Establishment", Springer, 2020. (Unit III)
4. Matt Bishop, ``Computer Security: Art and Science", Second edition, Addison Wesley, 2019 (Unit IV, V).
5. Salomon, David , ``Data Privacy and Security", Springer
6. Dorothy Elizabeth Rob, Ling Denning , ``Cryptography and data Security", ADDISON-WESLEY PUBLISHING COMPANY, 2003
7. Houbing Song , Glenn A. Fink , Sabina Jeschke , ``Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications", Wiley-IEEE Press, November 2017
8. Charlie Kaufman, Radia Perlman and Mike Speciner , ``Network Security: Private Communication in a Public World", Second Edition, Pearson Education, 2017.
9. Wenliang Du, ``Computer Security: A Hands-on Approach", CreateSpace Independent Publishing Platform, First Edition, 2017.
10. William Stallings, ``Network Security Essentials: Applications and Standards", Sixth Edition, Pearson, 2017.
11. Mauricio Arregoces, Maurizio Portolani, ``Data Center Fundamentals", Cisco Press, 2003.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2333	MOBILE AND PERVASIVE COMPUTING	3	0	0	3

OBJECTIVES

- To learn basic mobile concepts.
- To understand 4G telecommunication system principles.
- To introduce a broad perspective of pervasive concepts and management.
- To explore HCI in a pervasive environment.
- To apply pervasive concepts in a mobile environment.

UNIT I INTRODUCTION 9

History; Telecommunications: GSM -- GPRS -- DECT -- TETRA -- UMTS and IMT- 2000 Wireless LAN: WiFi, Bluetooth, WiMAX, Wireless ATM.

UNIT II OVERVIEW OF A MODERN 4G TELECOMMUNICATIONS SYSTEM 9

Introduction -- LTE-A System Architecture: LTE RAN -- OFDM Air Interface -- Evolved Packet Core -- LTE Requirements -- LTE-Advanced -- Enhancements in LTE-A; Introduction to 5G.

UNIT III PERVASIVE COMPUTING CONCEPTS AND ELEMENTS 9

Perspectives of Pervasive Computing -- Challenges -- Technology -- Infrastructure and Devices -- Middleware for Pervasive Computing Systems -- Pervasive Computing Environments -- Context Collection and Wireless Sensor Networks -- User Tracking -- Context Reasoning..

UNIT IV HUMAN COMPUTER INTERFACE IN PERVASIVE ENVIRONMENTS 9

HCI Service and Interaction Migration -- Context Driven HCI Service Selection -- Interaction Service Selection Overview -- User Devices -- Service-Oriented Middleware Support -- User History and Preference -- Context Manager -- Local Service Matching -- Global Combination Selection -- Effective Region -- User Active Scope – Service Combination Selection Algorithm -- A web based HCI migration framework.

UNIT V PERVASIVE MOBILE TRANSACTION 9

Introduction to Pervasive Transactions -- Mobile Transaction Framework -- Context-Aware Pervasive Transaction Model -- Dynamic Transaction Management -- Formal Transaction Verification.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the Basic architecture and concepts of Mobile Computing. (K2)
- Outline the functionalities of 4G Telecommunication System. (K2)
- Identify the features of pervasive computing. (K3)
- Apply HCI in a pervasive environment. (K3)
- Choose appropriate pervasive transactions for a pervasive environment. (K3)

REFERENCE BOOKS

1. J. Schiller, ``Mobile Communications", Addison Wesley, 2003.(Unit I)
2. Minyi Guo, Jingyu Zhou, Feilong Tang, Yao Shen, ``Pervasive Computing: Concepts, Technologies and Applications " CRC Press, 2016 (Unit III, IV, V)
3. Juha Korhonen, ``Introduction to 4G Mobile Communications" , Artech House Publishers, 2014(Unit II)
4. Kolomvatsos, Kostas, ``Intelligent Technologies and Techniques for Pervasive Computing", IGI Global, 2013.
5. M. Bala Krishna, Jaime Lloret Mauri, ``Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks", CRC 2016.
6. Alan Colman, Jun Han, and Muhammad Ashad Kabir, ``Pervasive Social Computing Socially-Aware Pervasive Systems and Mobile Applications", Springer, 2016.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2334	MICRO SERVICES AND DEVOPS	3	0	0	3

OBJECTIVES

- Understand and demonstrate microservices.
- Explore and deploy microservices in a container.
- Install and explore networking services.
- Modify configuration techniques using Kubernetes and Docker swarm
- Explore google cloud platform.

UNIT I MICROSERVICES 9

An Introduction to Microservices: What Are Microservices? Switching to Microservices: Cost Components; Interprocess Communication: Putting It All Together; Case Study: Migration to Microservices -- Planning for Migration -- Applying Microservices Criteria -- Converting to Microservices -- Application Build and Deployment.

UNIT II CONTAINERS 9

Docker Containers: Virtual Machines -- Containers -- Docker Architecture and Components -- The Power of Docker: A Simple Example; Docker Interface: Key Docker Commands -- Docker file -- Docker Compose; Case Study: Containerizing a Helpdesk Application: Containerizing Microservices -- Deploying the Catalog Microservice.

UNIT III NETWORKING AND DISCOVERY 9

Docker Networking: Bridge Mode Networking -- Host Mode Networking -- Container Mode Networking -- No Networking -- Wrapping It Up; Service Discovery; Service Registry.

UNIT IV ORCHESTRATION 9

Container Orchestration: Kubernetes -- Kubectl -- Master Node -- Worker Nodes -- Kubernetes Cluster; Docker Swarm : Nodes -- Services -- Task -- Example: Swarm Cluster.

UNIT V GOOGLE CLOUD PLATFORM 9

Get Started with Google Cloud Platform (GCP) : Get Started with Google Cloud Platform (GCP) -- Understanding GCP Projects -- Creating a Project -- Create a VM Instance -- Delete a Project; Understanding Cloud Shell : Using Cloud Shell -- Deploy a VM Instance Using Cloud Shell -- Work with Projects in Cloud Shell -- Cloud Shell Editor; Google Cloud SDK : Secure and Manage Your GCP Account -- Multi-Factor Authentication -- Create an Account with Specific Roles.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Develop and deploy microservices (K3)
- Build a container and deploy a microservice (K3)
- Explain networking concepts in containers (K2)
- Choose configuration features using Kubernetes and Docker swarm (K3).
- Use GCP services to create project with authentication. (K2)

REFERENCE BOOKS

1. Parminder Singh Kocher Boston, ``Microservices and Containers", Addison-Wesley, 2018. (Unit 1,2,3,4)
2. Michael Hausenblas, `Docker Networking and Service Discovery", O'Reilly Publication, 2016. (Unit 3)
3. Shimon Ifrah, "Getting Started with Containers in Google Cloud Platform - Deploy, Manage, and Secure Containerized Applications", Apress Publication 2021. (Unit - 5)
4. Thomas Uphill, ``Mastering Puppet", Second Edition,PACKT Publishing, 2016
5. Scott Coulton, ``Puppet for Containerization", PACKT Publishing, 2016
6. Cesar de la Torre, Bill Wagner, Mike Rouses, ``.NET Microservices: Architecture for Containerized .NET Applications", Microsoft Corporation, V5.) Edition, 2020.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2335	DEEP LEARNING	2	0	2	3

OBJECTIVES

- To understand basics of deep neural networks
- To understand CNN and RNN architectures of deep neural networks
- To comprehend advanced deep learning models
- To learn deep learning algorithms and their applications to solve real world problems.

UNIT I DEEP NETWORKS BASICS 6

Linear Algebra: Scalars -- Vectors -- Matrices and tensors; Probability Distributions; Gradient-based Optimization; Machine Learning Basics: Capacity -- Overfitting and underfitting -- Hyperparameters and validation sets -- Estimators -- Bias and variance -- Stochastic gradient descent -- Challenges motivating deep learning; Deep Networks: Deep feedforward networks.

UNIT II CONVOLUTIONAL NEURAL NETWORKS 6

Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers --
Gradient Computation -- CNN through Visualization.

UNIT III RECURRENT NEURAL NETWORKS 6

Unfolding Graphs -- RNN Design Patterns: Acceptor -- Encoder -- Transducer; Gradient Computation -- Sequence Modeling Conditioned on Contexts -- Bidirectional RNN -- Sequence to Sequence RNN – Deep Recurrent Networks -- Long Term Dependencies; Leaky Units: Skip connections and dropouts.

UNIT IV AUTOENCODERS AND GENERATIVE MODELS 6

Autoencoders: Undercomplete autoencoders -- Regularized autoencoders -- Stochastic encoders and decoders -- Learning with autoencoders; Deep Generative Models: Variational autoencoders -- Generative adversarial networks

UNIT V TRANSFORMER MODELS FOR NATURAL LANGUAGE PROCESSING 6

The Encoder-Decoder Framework -- Attention Mechanisms -- Transfer Learning in NLP -- Hugging Face Transformers -- Transformer Applications -- The Hugging Face Ecosystem; Transformer Anatomy: The Transformer Architecture -- The Encoder -- The Decoder; Summarization: GPT-2 -- T5

TOTAL PERIODS (THEORY): 30

LIST OF EXPERIMENTS

1. XOR implementation using neural networks

2. Multi-class Classification deep neural networks

3. Digit recognition using CNN

4. Next word prediction using RNN

5. Named entity recognition using Seq2Seq model

6. Image denoising using autoencoders
7. Image augmentation using GAN
8. Text summarization using T5/GPT-2

TOTAL PERIODS(LAB): 30
TOTAL:60

COURSE OUTCOMES

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

- Explain the basic concepts of deep neural networks (K2)
- Apply convolution neural networks for real-world problems in image processing (K5)
- Apply recurrent neural networks and its variants for text analysis (K3)
- Apply generative models for data augmentation (K3)
- Apply transformer models for natural language processing (K3)

REFERENCE BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning", MIT Press, 2016. (Units 1,2,3,4)
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, ``Natural Language Processing with Transformers", O'Reilly Media, Inc., February 2022. (Unit 5)
3. Seth Weidman. ``Deep Learning from Scratch: Building with Python from First Principles", O'Reilly Media, Inc, September 2019.
4. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, ``A Guide to Convolutional Neural Networks for Computer Vision", Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
5. Yoav Goldberg, ``Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
6. Santanu Pattanayak, ``Pro Deep Learning with TensorFlow: A Mathematical Approach to Advanced Artificial Intelligence in Python", Apress, 2017.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2336	COMPUTER VISION	3	0	0	3

OBJECTIVES

- To review image processing techniques for computer vision.
- To understand shape and region analysis.
- To understand Hough Transform and its applications to detect lines, circles, ellipses.
- To understand three-dimensional image and motion analysis techniques.
- To understand video processing and study some applications of computer vision algorithms.

UNIT I IMAGE PROCESSING FOUNDATIONS 9

Review of Image Processing Techniques: Segmentation: Edge detection techniques --Corner and interest point detection; Mathematical morphology; Texture; Binary Shape Analysis; Boundary Tracking Procedures

UNIT II BOUNDARY AND REGION DESCRIPTORS AND HOUGH TRANSFORM 9

Boundary Descriptors: Chain codes; Fourier Descriptors; Region Descriptors; Moments; Line Detection: Hough Transform (HT) for line detection -- RANSAC for straight line detection; HT based circular object detection; HT based ellipse detection

UNIT III 3D VISION AND MOTION 9

Methods for 3D vision: Projection schemes -- Shape from shading -- Photometric stereo -- Shape from texture -- Shape from focus – Active range finding; Surface Representations; Point-based Representations; Volumetric Representations; Introduction to Motion: Triangulation -- Bundle adjustment -- Translational alignment -- Parametric motion -- Spline-based motion -- Optical flow -- Layered motion

UNIT IV IMAGE REGISTRATION AND TRANSFORMATION 9

Image Registration: Preprocessing – Feature selection -- Feature correspondence -- Transformation functions; Camera Calibration -- Intrinsic and Extrinsic Parameters -- Correcting for Radial Distortions -- Multiple view vision -- generalized epipolar geometry -- Essential Matrix -- fundamental matrix -- image rectification -- 3D reconstruction.

UNIT V VIDEO PROCESSING AND VISION APPLICATIONS 9

Introduction –- Video Sampling and Interpolation-- Motion Detection and Estimation – Video Enhancement and Restoration, Video Segmentation-- Motion Segmentation-- Motion Tracking in Video--Video Quality Assessment, Application: Photo album -- Face detection -- Face recognition -- Eigenfaces -- Active appearance and 3D shape models of faces; Application: Surveillance -- Foreground - background separation -- Particle filters -- Chamfer matching -- Tracking and occlusion -- Combining views from multiple cameras -- Human gait analysis; Application: In -vehicle vision system -- locating roadway -- road markings -- identifying road signs -- locating pedestrians.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Apply fundamental image processing techniques required for computer vision. (K3)
- Apply boundary and region descriptors and hough transforms. (K3)
- Apply 3D vision techniques. (K3)
- Apply image registration and transformation of image and perform camera calibration (K3)
- Apply video processing techniques and develop applications using computer vision techniques. (K4)

REFERENCE BOOKS

1. E R Davies, ``Computer and Machine Vision", Fifth Edition, Academic Press, 2017. (Units 1 to 5)
2. A. Murat Tekalp, “Digital Video Processing”, Pearson, 2015. (Unit 5)
3. D L Baggio et al., ``Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012.
4. Jan Erik Solem, ``Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images", O'Reilly Media, 2012.
5. Mark Nixon, Alberto S Aquado, ``Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
6. R Szeliski, ``Computer Vision: Algorithms and Applications", Second edition, Springer 2022.
7. Simon J D Prince, ``Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2337	INFORMATION RETRIEVAL TECHNIQUES	3	0	0	3

OBJECTIVES

- To understand the basics of information retrieval with pertinence to modeling techniques
- To learn various components of IR systems
- To learn machine learning techniques for text classification and clustering
- To explore various IR applications using case studies

UNIT I INTRODUCTION AND MODELING 9

Basic Concepts: Retrieval process -- Architecture – Boolean retrieval; IR Models: Taxonomy and characterization of IR models -- Classical IR models -- Alternative set theoretic models – Alternative algebraic models; Models for Browsing; Retrieval Evaluation: Performance evaluation

UNIT II INDEXING AND QUERYING 9

Indexing: Inverted indices -- Suffix trees -- Suffix arrays -- Burrows-wheeler transform; Querying: Query languages -- Query operations: Relevance feedback and query expansion - Automatic local and global analysis; Text Properties; Text Operations: Text preprocessing – Text compression

UNIT III SEARCHING 9

Searching: Sequential searching -- Pattern matching -- Compression; Searching the Web: Characteristization the Web -- Search engines -- Browsing -- Searching using hyperlinks

UNIT IV CLASSIFICATION AND CLUSTERING 9

Text Classification: Naive Bayes; Vector Space Classification: Rocchio -- k-Nearest Neighbor; Flat Clustering: K-Means -- Model-based clustering; Hierarchical Clustering; Matrix Decompositions and Latent Semantic Indexing

UNIT V APPLICATIONS 9

XML Retrieval -- Multimedia IR -- Parallel and Distributed IR -- Digital Libraries -- Social Media Retrieval -- Content-based Image Retrieval -- Advancements in Reference collection.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Apply information retrieval models for document retrieval. (K3)
- Develop components of an information retrieval system. (K3)
- Apply search strategies for information retrieval. (K3)
- Apply machine learning techniques to text classification and clustering to improve performance of IR system. (K3)
- Apply IR techniques for various applications. (K3)

REFERENCE BOOKS

1. Ricardo Baeza-Yates, Berthier Ribeiro Neto, ``Modern Information Retrieval: The concepts and Technology behind Search", ACM Press Books, Second Edition, 2011. (Units 1, 2, 3, 5)
2. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, ``Introduction to Information Retrieval", Cambridge University Press, First South Asian Edition, 2008. (Unit 4)
1. 3. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, ``Information Retrieval - Implementing and Evaluating Search Engines", The MIT Press, Cambridge, Massachusetts London, England, 2010

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2338	SOFTWARE DEFINED NETWORKS	3	0	0	3

OBJECTIVES

- To learn the concepts and basics of SDN, and Openflow.
- To demonstrate SDN Controller and programming with SDN.
- To learn virtualization of data center and network functions.
- To study Network Topology & SDN Framework.
- To investigate various use cases using SDN.

UNIT I SDN PLANE SEPARATION & OPENFLOW 9

Separation of Control Plane and Data Plane -- Distributed and centralized control plane -- OpenFlow protocol -- Hybrid Approaches.

UNIT II SDN CONTROLLER AND PROGRAMMING SDN 9

SDN Controller: General Concepts -- Layer3 Centric -- Plexi -- CiscoOnePK ; Programming in SDN: The Management Interface -- Application-Network Divide -- Modern Orchestration ; Programmable Data Planes.

UNIT III DATA CENTER & NETWORK FUNCTION VIRTUALIZATION 9

Data Center: Multi-Tenant Datacenter -- Virtualized Multi-Tenant Data Center -- SDN solution for Data Center -- VLAN -- NVGRE; Network Function Virtualization: Virtualization and Data Plane I/O – Service Locations and Chaining - NFV at ETSI and Non-ETSI.

UNIT IV NETWORK TOPOLOGY & SDN FRAMEWORK 9

Network Topology: Traditional methods, LLDP, BGP - TE/LS, ALTO, I2RS Topology; SDN Framework: Juniper SDN framework -- IETF SDN Frameworks -- Open Daylight Controller Framework.

UNIT V USE CASES 9

Use cases for bandwidth scheduling -- manipulation and calendaring --Use Cases for Data Center Overlays -- Big Data -- and Network Function Virtualization -- Input traffic classification and triggered actions

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the concepts, basics of SDN and Openflow (K2)
- Explain SDN Controller and programming with SDN (K2)
- Analyze various SDN solutions for data center and about Network Function Virtualization. (K4)
- Make use of SDN Framework (K3)
- Analyze various use cases in implementing SDN (K4)

REFERENCE BOOKS

1. Thomas D. Nadeau, ``SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", First Edition, Ken Gray Publisher: O'Reilly Media, 2013. (Unit 1 - Chapters 1,2 and 3; Unit 2 - Chapters 4,5; Unit 3 - Chapters 6,7; Unit 4 - Chapters 8,9; Unit 5 - Chapters 10,11 and 12)
2. Silvano Gai, ``Building a Future-Proof Cloud Infrastructure: A Unified Architecture for Network, Security, and Storage Services", O'Reilly Media, 2020.
3. Paul Goransson and Chuck Black, ``Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann, 2014.
4. Vivek Tiwari, ``SDN and OpenFlow for Beginners" Amazon Digital Services, Inc., 2013.
5. Fei Hu, ``Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, 2014.

COURSE CODE	COURSE TITLE	L	T	P	C
PCP2339	PRINCIPLES OF BLOCKCHAIN TECHNOLOGY	3	0	0	3

OBJECTIVES

- To understand blockchain technology and distributed systems
- To learn how decentralization of trust is achieved
- To study the technologies behind cryptocurrencies
- To impart knowledge of distributed ledgers in business
- To acquire knowledge in emerging concepts using blockchain

UNIT I INTRODUCTION TO BLOCKCHAIN 9

Defining the Terms - Building blocks of Blockchain frameworks - Where is and where it's going - Blockchain in Enterprise - Technology Considerations - Identity - Scalability - Security - Consensus - CAP - ACID Property - Benefits and Limitation of Blockchain.

UNIT II DECENTRALIZATION 9

Methods of Decentralization - Routes to Decentralization - Smart Contract - Decentralized Organization - Platforms for Decentralization - Consensus Algorithms.

UNIT III CRYPTOCURRENCIES 9

Digital Money - Cryptography; Cryptocurrencies - Bitcoin - Ethereum; Digital Token; Alternative Coins

UNIT IV DISTRIBUTED LEDGERS FOR BUSINESS 9

Ethereum: Introduction - Ethereum Network - Components - Programming Languages; Hyperledger: Introduction - Reference Architecture - Fabric - Sawtooth Lake - Corda.

UNIT V BLOCKCHAIN DEVELOPMENT TOOLS AND FRAMEWORKS 9

Compilers: Solidity - Ganache - Metamask - Truffle; Languages: Solidity - Go - Java - NodeJS; Blockchain Use Case: Financials - Insurance - Supply Chain Management - HealthCare - IoT.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Explain the importance of distributed ledgers and need of block chain (K2)
- Describe decentralization concepts and apply consensus algorithms (K3)
- Explain the basics of cryptography and its applications in cryptocurrencies (K2)
- Apply various distributed ledgers for business (K3)
- Analyse appropriate techniques for designing trust-based business networks (K4)

REFERENCE BOOKS

1. Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna, "Hands-on Blockchain with Hyperledger", Packt Publishers, 2018. (Unit I & IV)
2. Antony Lewis, "The basics of Bitcoins and Blockchains", Mango Publishing, Coral Gabels (Unit III)
3. Imran Bashir, ``Mastering Blockchain" Packt 2nd Edition, 2018. (Unit II, IV & V)
4. Kevin Solorio, Randall Kanna, David H. Hoover, "Hands-On Smart Contract Development with Solidity and Ethereum: From Fundamentals to Deployment", First Edition, OReilly Publications, 2019.
5. Will Button, "Hands-On Blockchain Development in 7 Days: Create a decentralized gaming application using Ethereum Paperback", Packt Publishers, 2019.

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2941	BUSINESS ANALYTICS	3	0	0	3

OBJECTIVES

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process – Converting real-time decision-making problems into hypothesis.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards – Solve numerical problems on basic statistics.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing – Real time applications.

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UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

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

- Identify the real-world business problems and model with analytical solutions. (K3)
- Solve analytical problems with relevant mathematics background knowledge. (K3)
- Convert any real-world decision-making problem to hypothesis and apply suitable statistical testing. (K3)

- Solve simple applications involving analytics using Hadoop and MapReduce. (K3)
- Summarize open-source frameworks for modeling and storing data. (K2)

REFERENCE BOOKS

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2942	INDUSTRIAL SAFETY	3	0	0	3

OBJECTIVES

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment like, i. Any one machine tool, Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Ability to summarize basics of industrial safety
- Ability to describe fundamentals of maintenance engineering
- Ability to explain wear and corrosion
- Ability to illustrate fault tracing
- Ability to identify preventive and periodic maintenance

REFERENCE BOOKS

1. Audels, Pump-hydraulic Compressors, Mcgraw Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2943	OPERATIONS RESEARCH	3	0	0	3

OBJECTIVES

- Solve linear programming problems and solve using graphical methods.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis.

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- To formulate linear programming problems and solve them using graphical methods.
- To solve LPP using simplex method
- To formulate and solve transportation, assignment problems
- To solve project management problems
- To solve scheduling problems

REFERENCE BOOKS

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Panneerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2944	COST MANAGEMENT OF ENGINEERING PROJECTS	3	0	0	3

OBJECTIVES

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETARY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Benchmarking; Balanced Scorecard and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Understand the costing concepts and their role in decision making
- Understand the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution

- Gain knowledge of costing techniques in service sector and various budgetary control techniques
- Become familiar with quantitative techniques in cost management

REFERENCE BOOKS

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2945	COMPOSITE MATERIALS	3	0	0	3

OBJECTIVES

- Summarize the characteristics of composite materials and the effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Know the characteristics of composite materials and effect of reinforcement in composite materials.
- Know the various reinforcements used in composite materials.
- Understand the manufacturing processes of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.

- Analyze the strength of composite materials.

REFERENCE BOOKS

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2946	WASTE TO ENERGY	3	0	0	3

OBJECTIVES

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Biodiesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- Understand the various types of wastes from which energy can be generated
- Gain knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Gain knowledge on biomass combustors and its applications on generating energy
- Understand the principles of bio-energy systems and their features

REFERENCE BOOKS

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

COURSE CODE	COURSE TITLE	L	T	P	C
PGE2947	INTRODUCTION TO DATA SCIENCE	3	0	0	3

OBJECTIVES

- To understand data science process
- To learn the python packages for data analysis and visualization.
- To differentiate the different pre-processing steps
- To compute point estimate and perform statistical analysis.
- To build models using machine learning.

UNIT I DATA SCIENCE PROCESS 9

Data science: Overview – Types of Data - Process: Overview – Defining research goals – Data collection – Data quality check - Data Cleansing – Data integration – Data transformation – Data Exploration – Model Building.

UNIT II DATA SCIENCE PACKAGES 9

Introduction to Essential Data Science Packages: Numpy, Scipy, Jupyter, Stats models and Pandas Package – Data Munging: Introduction to Data Munging – Data Visualization Using Matplotlib: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots – Interactive Visualization with Advanced Data Learning Representation in Python.

UNIT III DATA PREPROCESSING 9

Reading and Writing Data in Text Format -- Data Cleaning and Preparation: Handling Missing Data -- Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping – Replacing values – Detecting and filtering outliers.

UNIT IV DESCRIPTIVE STATISTICS AND INFERENCE 9

Estimate: Mean, Median, Covariance and Correlation- Empirical Distributions: Sampling from a Population – Bootstrap sample- Empirical Distribution of a Statistic – Confidence Interval: Using Bootstrap sampling- Using population parameter - Testing Hypotheses: Using Confidence Intervals – Using p-values.

UNIT V MODEL BUILDING 9

Model building: Overview – Machine learning for model building - Machine learning: Definition - Types of learning approaches - Supervised learning algorithms: Linear Regression -- Unsupervised learning algorithms: Clustering - K Means – Simple model building using python - Evaluation metrics.

TOTAL PERIODS : 45

COURSE OUTCOMES

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

- Explain the fundamental concepts of data science. (K2)
- Develop Python programs to perform data analysis. (K3)
- Apply the pre-processing steps to clean and transform the data. (K3)
- Apply statistical inferential analysis to find the properties of a population. (K3)
- Build a model using machine learning. (K3)

REFERENCE BOOKS

1. Davy Cielen, Arno D B Meysman, Mohamed Ali, ``Introducing Data Science - Big data, Machine Learning, and more using Python tools", Manning Publications Co, 2016. (Unit I)
2. Wes McKinney, ``Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition,2018. (Unit II & III)
3. AniAdhikari, JohnDeNero,``Computational and Inferential Thinking: The Foundations of Data Science", GitBook, 2017. (Unit IV & V).
4. Laura Igual, Santi Segua, ``Introduction to Data Science - A Python Approach to Concepts, Techniques and Applications", Springer Nature, 2017
5. Jake VanderPlas, ``Python Data Science Handbook: ``Essential Tools for Working with Data", O'Reilly Media, 2016. (Unit V)
6. Frank Pane, ``Hands On Data Science and Python Machine Learning”, Packt Publishers, 2017.
7. Rachel Schutt, Cathy O'Neil, ``Doing Data Science", O'Reilly Media, 2016.

COURSE CODE	COURSE TITLE	L	T	P	C
AGE2001	ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title
- Understand the skills needed when writing the Conclusion
- Ensure the good quality of paper at very first-time submission

REFERENCE BOOKS

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

COURSE CODE	COURSE TITLE	L	T	P	C
AGE2002	DISASTER MANAGEMENT	2	0	0	0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- Ability to summarize basics of disaster
- Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Ability to describe an understanding of standards of humanitarian response and practical

relevance in specific types of disasters and conflict situations.

- Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCE BOOKS

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

COURSE CODE	COURSE TITLE	L	T	P	C
AGE2003	VALUE EDUCATION	2	0	0	0

OBJECTIVES

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I INTRODUCTION 6

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II DEVOTION AND FAITH 8

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III PERSONALITY DEVELOPMENT 8

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV SELF MANAGEMENT 8

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

REFERENCE BOOKS

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

COURSE CODE	COURSE TITLE	L	T	P	C
AGE2004	CONSTITUTION OF INDIA	2	0	0	0

OBJECTIVES

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION 6

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION 6

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES 6

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE 6

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION 6

District's Administration head: Role and Importance ,Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION 6

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

REFERENCE BOOKS

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

COURSE CODE	COURSE TITLE	L	T	P	C
AGE2005	PEDAGOGY STUDIES	2	0	0	0

OBJECTIVES

- Review existing evidence on there view topic to inform programme design and policy
- Making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY 6

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and searching.

UNIT II THEMATIC OVERVIEW 6

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 6

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT 6

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS 6

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- What pedagogical practices are being used by teachers in informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

REFERENCE BOOKS

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, ‘learning to read’ campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

COURSE CODE	COURSE TITLE	L	T	P	C
AGE2006	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	2	0	0	0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality, and determination
- To awaken wisdom in students

UNIT I INTRODUCTION 10

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II DUTIES & BHAGAWAT GEETA 10

Approach to day-to-day work and duties - Shrimad Bhagwat Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

.

UNIT III KNOWLEDGE & BHAGAWAT GEETA 10

Statements of basic knowledge - Shrimad Bhagwat Geeta: Chapter 2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - Shrimad Bhagwat Geeta – Chapter 2- Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- Study of Shrimad-Bhagwat-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Geeta will help in developing versatile personality of students.

REFERENCE BOOKS

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.