

**Study Scheme: PG Programme  
(Batch 2023 Onwards)**

**M.Tech. in Computer Science and Engineering**

# **Vision & Mission of Department**

## **Vision**

To achieve technical & research excellence in the field of Computer Science and Engineering with industrial & social perspective.

## **Mission**

- To provide environment for imparting high quality technical education, skill development, research and development.
- To disseminate sound knowledge of recent Computer Technologies by organizing seminar/workshops/short-term courses.
- To develop interaction and collaboration with the industry.
- To facilitate Hand-on training to the students for promoting Self-Employment.

## **Program Outcomes (POs) – PG**

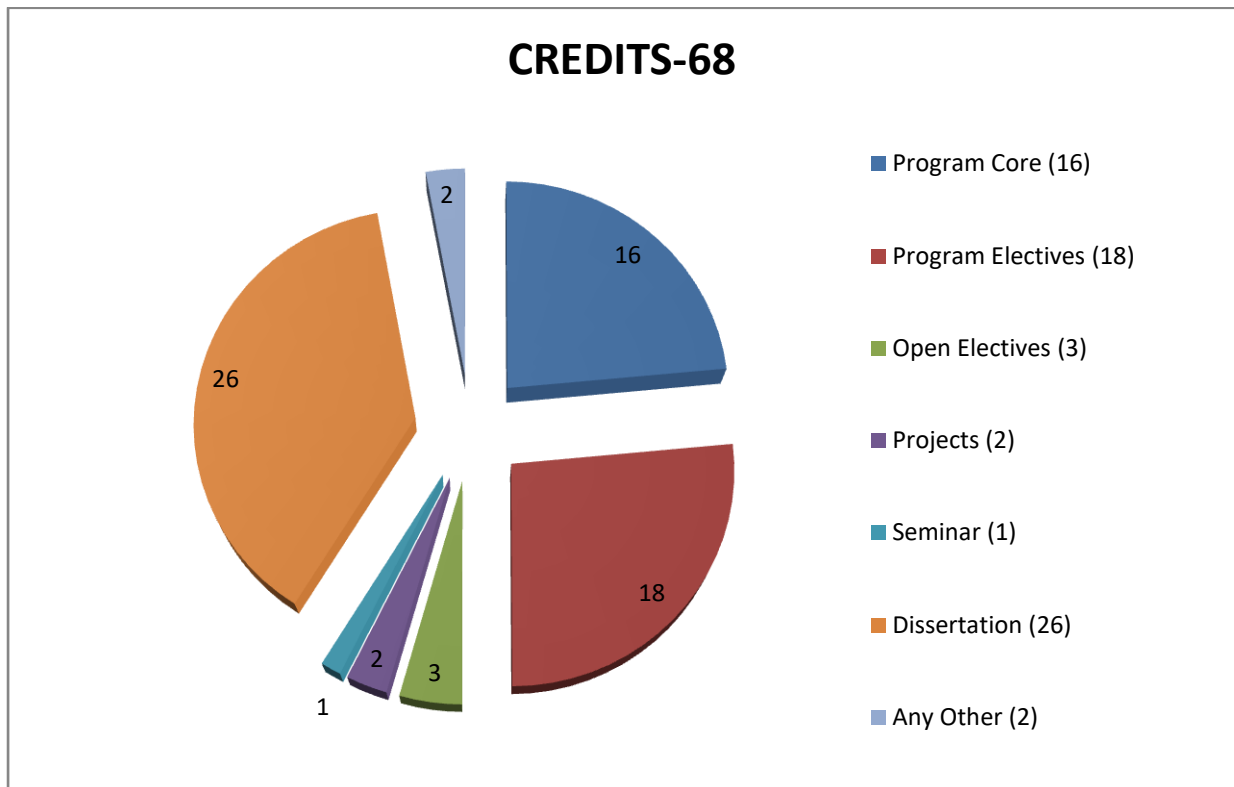
1. **Scholarship of Knowledge:** Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse, and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking:** Analyse complex engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving:** Think laterally and originally, conceptualise, and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal, and environmental factors in the core areas of expertise.
4. **Research Skill:** Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse, and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools:** Create, select, learn, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work:** Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity, and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.
8. **Communication:** Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

9. **Life-long Learning:** Recognise the need for and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility:** Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning:** Observe and examine critically the outcomes of one's actions and make corrective measures subsequently and learn from mistakes without depending on external feedback.

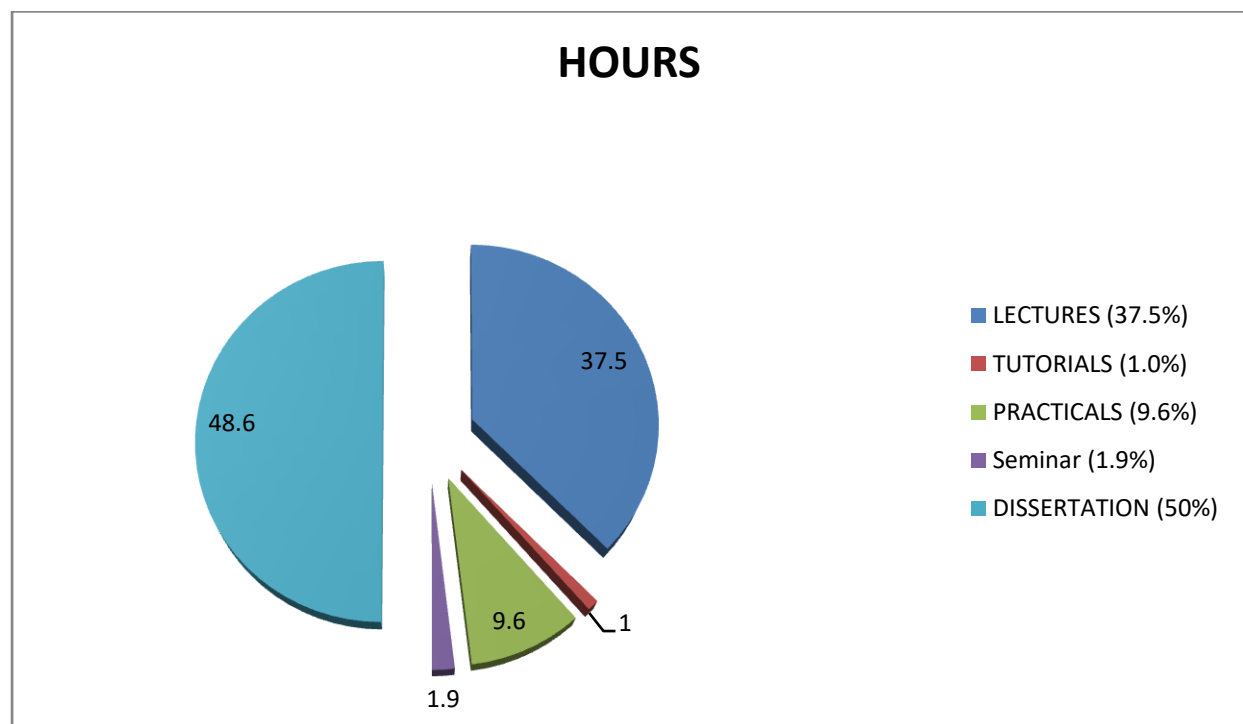
### **Program Specific Outcomes (PSO's) – PG**

- 1) **Program Specific Outcome (PSO) 1:** The ability to take up higher studies, research, and development in modern computing environment.
- 2) **Program Specific Outcome (PSO) 2:** The ability to apply mathematical foundation, algorithmic principles, comprehend the technical advancements, and use research based knowledge for modelling and simulation of the problems.

# DISTRIBUTION OF COURSE CREDITS (PG)



# CONTACT HOURS DISTRIBUTION (PG)



## Study Scheme PG Programme: M.Tech. in Computer Science and Engineering

Semester-I							
Sr. No.	Subject Code	Subject Name	L	T	P	Hrs.	Credits
1	PCCS-811	Artificial Intelligence	3	0	0	3	3
2	PCCS-812	Operating System Design	3	0	0	3	3
3	PECS-811	Core Elective-I	3	0	0	3	3
4	PECS-812	Core Elective-II	3	0	0	3	3
5	RMAL-811	Research Methodology and IPR	2	0	0	2	2
6	ACMH-811	English research paper writing & Professional Communication	2	0	0	2	0
7	PCCS-813	Artificial Intelligence Lab	0	0	4	4	2
8	PECS-813	Core Elective-I Lab	0	0	4	4	2
<b>Total</b>			<b>16</b>	<b>0</b>	<b>8</b>	<b>24</b>	<b>18</b>
Semester-II (A)							
Sr. No.	Subject Code	Subject Name	L	T	P	Hrs.	Credits
1	PCCS-821	Machine Learning	3	1	0	4	4
2	PCCS-822	Advanced Network Principles and Protocols	3	0	0	3	3
3	PCCS-823	Cyber Security	3	0	0	3	3
4	PECS-821	Core Elective-III	3	0	0	3	3
5	PECS-822	Core Elective-IV	3	0	0	3	3
6	ACMH-821	Constitution Of India	2	0	0	2	0
7	PECS-823	Core Elective-IV Lab	0	0	2	2	1
8	PCCS-824	Seminar	0	0	2	2	1
<b>Total</b>			<b>17</b>	<b>1</b>	<b>4</b>	<b>22</b>	<b>18</b>
<p><b>Students are to be encouraged to go to industrial training/ Internship during summer break</b></p>							
Semester-III							
Sr. No.	Subject Code	Subject Name	L	T	P	Hrs.	Credits
1	PECS-911	Core Elective-V	3	0	0	3	3
2	OECS-911	Open Elective	3	0	0	3	3
3	PCCS-911	Dissertation (Part-1)	0	0	20	20	10
<b>Total</b>			<b>6</b>	<b>0</b>	<b>20</b>	<b>26</b>	<b>16</b>
Semester-IV							
Sr. No.	Subject Code	Subject Name	L	T	P	Hrs.	Credits
1	PCCS-921	Dissertation (Part-2)	0	0	32	32	16
<b>Total</b>			<b>0</b>	<b>0</b>	<b>32</b>	<b>32</b>	<b>16</b>

## List of Core Electives

<b>CORE ELECTIVE-I (PECS-811)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-811A	Parallel Computing
2	PECS-811B	Data Preparation and Analysis
3	PECS-811C	Advance Database Systems
<b>CORE ELECTIVE-I LAB(PECS-813)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-813A	Parallel Computing Lab
2	PECS-813B	Data Preparation and Analysis Lab
3	PECS-813C	Advance Database Systems Lab
<b>CORE ELECTIVE-II (PECS-812)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-812A	Distributed Systems
2	PECS-812B	Advance Algorithms
3	PECS-812C	Big Data Analytics
<b>CORE ELECTIVE-III (PECS-821)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-821A	Deep Learning
2	PECS-821B	Software Project Management
3	PECS-821C	Computer Vision
<b>CORE ELECTIVE-IV (PECS-822)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-822A	Cloud Computing
2	PECS-822B	Internet of Things
3	PECS-822C	Bioinformatics
<b>CORE ELECTIVE-IV LAB (PECS-823)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-823A	Cloud Computing Lab
2	PECS-823B	Internet of Things Lab
3	PECS-823C	Bioinformatics Lab
<b>CORE ELECTIVE-V (PECS-911)</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	PECS-911A	Optimization Techniques
2	PECS-911B	Pattern Recognition
3	PECS-911C	Data Sciences

## List of Open Electives

<b>OPEN ELECTIVE</b>		
<b>Sr. No.</b>	<b>Subject Code</b>	<b>Subject Name</b>
1	OECS-911A	Big Data Analytics
2	OECS-911B	Internet of Things
3	OECS-911C	Deep Learning
4	OECS-911D	Cloud Computing
5	OECS-911E	Cyber Security

# **SEMESTER-I**



**Title of the course : Artificial Intelligence**

**Subject Code : PCCS-811**

**Weekly load : 3Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcome: After completion of this course students will be able to**

CO1	Understanding the basics of AI and various applications of AI.
CO2	Problem Solving using Search and Control strategies.
CO3	Understanding the knowledge representation and reasoning
CO4	Understanding the basics of Expert Systems, Neural Networks and Genetic Algorithms
CO5	Understanding the basics of Planning, Understanding and Learning and Common sense

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
COs	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	3	3	1	1	1	1	3	1	3	3	3
CO2	3	3	3	3	1	1	1	2	2	1	2	3	3
CO3	3	3	3	3	1	1	1	3	2	1	2	3	3
CO4	3	3	3	3	1	2	3	3	3	1	2	3	3
CO5	1	3	3	3	2	2	1	3	3	1	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Definitions, Goals of AI, AI Approaches, AI Techniques, AI application Areas	06
	2. Problem solving	General problem solving, Search and control strategies, Exhaustive searches, Heuristic search techniques, Constraint satisfaction problems (CSPs), models. Heuristic Search of Game trees, Problem Reduction (AND/OR Search).	09
	3. Knowledge representation and reasoning	Knowledge representation, KR using predicate logic, representing instance and Isa relationship, computable functions and predicates, Resolution, Natural Deduction, representing knowledge using rules, Weak Slot and Filler Structure, Strong slot and Filler structure	09
<b>Unit-2</b>	4. Advanced Reasoning and learning	Non-monotonic reasoning, Logics for non-monotonic reasoning, Augmenting a problem solver, Bayes Theorem, Bayesian networks, reasoning with Bayes network, Decision Tree	09
	5. Expert Systems, Neural Networks, GA	Introduction to Expert Systems, Expert System Architecture, Introduction to neural network and learning, Introduction to Genetic algorithms, operators.	09
	6. Advance AI topics	Introduction to Planning, Understanding, Learning, Common Sense	06

Total=48

Recommended Books:

1. Rich E, K. Knight, “Artificial Intelligence”, Tata McGraw Hill.
2. George F. Luger, “Artificial Intelligence – Structures and Strategies for Complex Problem Solving”, Pearson Education.
3. Russell, Norvig, “Artificial Intelligence ‘a Modern Approach””, Pearson Education.
4. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, PHI.
5. E. Charniak, D. McDermott, “Introduction to Artificial Intelligence”, Addison-Wesley Publishing Company.
6. Christopher Thronton, Benedict du Bouldy,”Artificial Intelligence”, New Age International Publishers.
7. Nils J. Nilsson, “Principles of Artificial Intelligence”, Narosa Publishing Co.
8. Ela Kumar “Artificial Intelligence”, I.K International Publishing House.

**Title of the course : Operating System Design**

**Subject Code : PCCS-812**

**Weekly load : 3 Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to**

CO1	Acquire the basic understanding of OS functionality.
CO2	Understand the role of OS in process management.
CO3	Comprehensive knowledge of data storage management by OS
CO4	Implement file management strategies
CO5	In depth knowledge of different types of OS environments.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
COs	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	1	1	2	3	2	2	3	3
CO2	3	2	3	3	2	1	2	2	3	2	2	3	3
CO3	3	3	2	3	3	1	1	3	3	3	2	3	3
CO4	2	3	3	3	2	1	1	3	3	2	2	3	3
CO5	3	3	3	2	3	2	1	2	3	3	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Structure of Operating System	Monolithic, Microkernel, Multi Kernel, Services and components, OS design issues.	06
	2. Process Management	The process and the kernel Mode, Process abstraction, Threads, Process Synchronization, Semaphores, Monitors, Inter Process Communication, Schedulers, CPU Scheduling.	10
	3. Memory and Input Output Management	Memory management, Virtual memory, Demand Paging and Page Replacement Algorithms, I/O and Device management, buffering and spooling.	08
<b>Unit-2</b>	4. File Management	The user interface to Files, File systems, Special files, File system framework, File storage, Access methods and free space management.	08
	5. Deadlocks and Operating System Security	Deadlocks, External & Operational security, Access control, H/W security.	08
	6. Distributed Operating Systems	Architectures, Synchronization, Communication, Resource Management, Distributed File Systems, Distributed Shared Memory, Code migration and Distributed Scheduling, Recovery and Fault Tolerance.	08

**Total=48**

**Recommended Books:**

1. Abraham Silberschatz, Peter Baer Galvin, “Operating System Concepts”, Addison-Wesley.
2. Andrew S. Tanenbaum, “Modern Operating Systems”, Pearson Education.
3. H.M. Deitel, “An Introduction to Operating System”, Pearson Education.
4. William Stallings, “Operating Systems”, Pearson Education.

**Title of the course : Parallel Computing**

**Subject Code : PECS-811A**

**Weekly load : 3 Hrs**

**LTP 3 0 0**

**Credit : 3**

**Course Outcomes:** At the end of the course, the student will be able to:

CO1	Understand the concepts related to parallel computing
CO2	Learn how to measure the performance of parallel computers
CO3	Understand the advanced processor technology and memory hierarchy
CO4	Acquire knowledge of memory organization
CO5	Learn the concepts behind multithreaded architecture and multi-core programming

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	1	2	2	2	3	2	2	3	3
CO2	3	3	3	2	1	2	2	2	3	2	2	3	3
CO3	3	3	3	3	2	1	3	2	3	1	3	3	3
CO4	2	3	2	3	1	1	2	2	3	2	1	3	3
CO5	2	3	2	3	1	3	3	2	3	1	3	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Parallel Computer Models	The State of Computing, Multiprocessors and Multicomputer, Multi-vector and SIMD Computers, Architectural Development Tracks.	06
	2. Program and Network Properties	Conditions of Parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architecture.	06
	3. Metrics and Scalability	Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.	06
	4. Processor Hierarchy	Advanced Processor Technology, Superscalar and Vector Processors.	06
<b>Unit-2</b>	5. Memory Hierarchy	Memory Hierarchy Technology, Virtual Memory Technology.	06
	6. Bus, Cache, and Shared Memory	Bus Systems, Cache Memory Organizations, Shared-Memory Organizations, Sequential and Weak Consistency Models, Cache Coherence and Synchronization Mechanisms, Message-Passing Mechanisms.	06
	7. Pipelining and Superscalar Techniques and Multivector Computers	Linear Pipeline Processors, Nonlinear Pipeline Processors, Instruction Pipeline Design, Arithmetic Pipeline Design, Superscalar Pipeline Design, Vector Processing Principles, Compound Vector Processing, Latency-Hiding Techniques.	06

	8. Principles of Multithreading	Threads Versus Processes, Types of Thread-Level Parallelism: Chip-Level Multiprocessing, Interleaved Multithreading, Simultaneous Multithreading, Hyper threading.	06
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**Total=48**

**Recommended Books:**

1. Kai Hwang, Advanced Computer Architecture, McGraw-Hill.
2. Kai Hwang, F Briggs, Computer Architecture and Parallel Processing, McGraw Hill.
3. M Flynn, Computer Architecture: Pipelined and Parallel Processor Design, 1/E, Jones and Bartlett.
4. Harry F Jordan, Fundamentals of Parallel Processing, Prentice Hall.
5. Hesham El-Rewini, Mostafa Abd-El-Barr, Advanced Computer Architecture and Parallel Processing, Wiley-Interscience.
6. Shameem Akhter, Jason Roberts, Multi-Core Programming, Intel Press.

**Title of the course : Data Preparation and Analysis**  
**Subject Code : PECS-811B**  
**Weekly load : 3Hrs LTP 3 0 0**  
**Credit : 3**

**Course Outcomes: At the end of the course the student will be able to:**

CO1	Acquire knowledge of data gathering strategies
CO2	Prepare and Present the Data
CO3	Extract the data for performing the Analysis
CO4	Understand Data Clustering and association
CO5	Design visualization and time series

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	3	1	1	2	3	3	2	1	3	3
CO2	3	3	3	3	2	3	2	3	3	1	2	3	3
CO3	3	2	3	2	1	1	3	3	3	2	3	3	3
CO4	3	3	3	2	1	2	2	3	3	1	2	3	3
CO5	3	3	3	3	1	1	3	3	3	1	1	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Data Gathering and Preparation	Data formats, parsing and transformation, Scalability and real-time issues.	09
	2. Data Cleaning	Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.	11
<b>Unit-2</b>	3. Exploratory Analysis	Descriptive and comparative statistics, Clustering and association, Hypothesis generation.	13
	4. Visualization	Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and network interactivity.	15

**Total = 48**

### Reference Books:

1. Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt

Title of the course : **Advance Database Systems**

Subject Code : **PECS-811C**

Weekly load : **3 Hrs**

**L T P 3 0 0**

Credit : **3**

**Course Outcomes: At the end of the course the student will be able to:**

CO1	To understand the basic concepts and terminology related to DBMS and Relational Database Design
CO2	To the design and implement Distributed and Parallel Databases
CO3	Demonstrate the knowledge of Object Oriented Databases
CO4	To understand the concept of Transaction Management in the Database
CO5	Understanding the concept of Emerging and Internet Database Technologies

Cos	CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):												
	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	3	3	3
CO2	2	3	2	3	1	2	1	3	3	2	1	3	3
CO3	3	3	3	3	1	1	3	3	3	2	3	3	3
CO4	2	3	3	3	2	1	2	3	3	2	2	3	3
CO5	3	2	3	3	1	2	3	3	3	2	1	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Database System Concepts and Architecture, Data Independence, Data Models, SQL: DDL, DML, DCL, Database Integrity, Normalization: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF.	06
	2. Advanced Transaction Processing and Concurrency Control	Transaction Concepts, Concurrency Control: Locking Methods, Time-stamping Methods, Optimistic Methods for Concurrency Control, Concurrency Control in Distributed Systems	06
	3. Object Oriented and Object Relational Databases	Object Oriented Concepts with respect to Database Systems, OODBMS, OORDBMS, ORDBMS Design, Mapping of classes to relations, OORDBMS Query Language	04
	4. Parallel Databases	Parallel Databases, Distributed Databases, Difference between them, Architecture of Distributed Databases, Architecture of Parallel Databases	04



	5. Distributed Databases	Fragmentation, Replication and Allocation for distributed databases, Intra-query parallelism, Inter-query parallelism, Intra-operation parallelism, Inter-operation parallelism.	04
<b>Unit-2</b>	6. Database Security and Integrity	Data security risks, Data user, Access control and encryption.	02
	7. Backup and Recovery Techniques	Backup and Recovery Concepts, Types of Database Failures, Types of Database Recovery, Recovery Techniques: Deferred Update, Immediate Update, Shadow Paging, Checkpoints, Buffer Management, Recovery Control in Distributed Systems.	08
	8. Introduction to PL/SQL	Procedure, trigger and cursor	02
	9. XML and Internet Databases	Structured, Semi Structured, and Unstructured Data, XML Hierarchical Data Model, XML Documents, DTD, XML Schema, XML Querying: XPath, XQuery	04
	10. Emerging Database Technologies	Introduction to Mobile Databases, Main Memory Databases, Deductive Database Systems and brief overview of Datalog, Temporal Databases and brief introduction to TSQL, Multimedia Databases brief overview of respective query language and Spatial and Multidimensional Databases, Brief Introduction to Data Warehouse, Data Mining and OLAP	08

**Total=48**

**Recommended Books:**

1. Raghu Ramakrishnan, Johannes Gehrke, "Database Management System", McGraw Hill.
2. RamezElmasri, Shamkant B. Navathe, "Fundamentals of Database System", Pearson Education.
3. G.W. Hansen, J.V. Hansen, "Database Management and Design", PHI.
4. C.J. Date, A. Kannan, S. Swamynathan, "An Introduction to Database Systems", Pearson Education.

**Title of the course : Distributed Systems**

**Subject Code : PECS-812A**

**Weekly load : 3Hrs.**

**L T P: 3 0 0**

**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Students can implement programming projects that display knowledge of a variety of distributed system architectural styles. Some of these assignments represent significant programming projects with wide leeway in design and implementation choices.
CO2	Students will analyze problems, determine solutions within an assigned architectural style, and successfully implement those solutions.
CO3	Students will use cloud-based systems to run and implement assignments
CO4	Students will design and implement projects both individually and as part of a team.
CO5	Students will manage a cloud-based Web server and properly configure it.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	3	1	3	3	3	3	2	3	3	3
CO2	3	2	3	3	1	3	3	3	3	2	3	3	3
CO3	3	3	2	3	1	3	3	3	3	2	3	3	3
CO4	3	2	3	3	1	3	3	3	3	2	3	3	3
CO5	3	3	3	3	1	3	3	3	3	2	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction to Distributed Systems	Definition of distributed systems, their objectives, types, hardware and software concepts, architecture.	06
	2. Web Services Concepts	Introduction to XML, SOAP, Web and Grid services concepts.	06
	3. Communication	Inter process communication, Remote Procedure Call (RPC), Remote Method Invocation (RMI), Remote Object Invocation, and Message Oriented Communication.	08
	4. Processes	Introduction to threads, Threads in distributed and non-distributed systems, Client side software, Design issues for Servers, Software agents.	06
<b>Unit-2</b>	5. Naming	General issues with respect to naming, Name resolution, implementation of a name space, Domain name Systems, X.500 name space.	06

	6. Security	Introduction to security in distributed systems, General issues in authentication and access control, Security management: Key management, secure group management, authorization management; examples: Kerberos, x.509 certificates.	08
	7. Distributed Object-based Systems	Introduction to distributed object based systems, Overview of CORBA and DCOM and their comparison.	04
	8. Distributed File System and Document Based Systems	Introduction to distributed file system, distributed document-based systems, their examples.	04

**Total=48**

**Recommended Books:**

1. Andrew S Tanenbaum, Principles and Paradigms of Distributed Sytsems, Pearson Education.
2. George Coulouris, Distributed Systems, Addison Wesley.

**Title of the course : Advance Algorithms**

**Subject Code : PECS-812B**

**Weekly load : 3Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Analyze worst-case running times of algorithms using asymptotic analysis.
CO2	Prove the correctness of algorithms using inductive proofs and invariants.
CO3	Analyze randomized algorithms with respect to expected running time
CO4	Classify problems into different complexity classes corresponding to both deterministic and randomized algorithms
CO5	Analyze approximation algorithms

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	3	3	3	3	2	2	3	3
CO2	3	2	3	2	1	1	3	3	3	2	3	3	3
CO3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO4	3	3	3	2	2	1	3	3	3	2	2	3	3
CO5	2	3	3	3	1	1	3	3	3	2	2	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Analysis of Algorithm	Algorithms, Analysing Algorithms, Growth of Functions-order Arithmetic, Models of computation, Performance analysis.	08
	2. Elementary data Structures	Stacks and Queues, Lists, Trees, Dictionaries, sets and Graphs.	08
	3. Basic Design Methodologies	Divide and Conquer, Dynamic Programming, Backtracking, Greedy Algorithms, Branch and bound.	08
<b>Unit-2</b>	4.Particular Algorithms	Disjoint set manipulation, Matrix multiplication, Pattern matching, sorting and searching algorithms, combinatorial algorithms, string processing algorithms, Algebraic Algorithms, Graph Algorithms, Comparative study of sorting techniques with their complexities.	12
	5. NP Completeness	Problem classes, NP-Completeness, Deterministic and non-Deterministic polynomial time algorithms, Theory of lower bounds Approximation Algorithms.	12

**Total=48**

**Recommended Books:**

1. Thomas H. Cormen, Charles E. Leiserson, "Introduction to Algorithms", PHI.
2. Alfred V. Aho, John E. Hopcroft, "Design & Analysis of Computer Algorithms", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajasekaran, "Fundamentals of Computer Algorithms", Galgotia Publishers.
4. Donald E. Knuth, "The Art of Programming", Pearson Education.

**Title of the course : Big Data Analytics**

**Subject Code : PECS-812 C**

**Weekly load : 3Hrs**

**LTP 3 0 0**

**Credit : 3**

**Course Outcome: After completion of this course students will be able to**

CO1	Describe big data and use cases from selected business domains
CO2	Explain NoSQL big data management
CO3	Install, configure, and run Hadoop and HDFS
CO4	Perform map-reduce analytics using Hadoop
CO5	Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	2	3	3
CO2	3	2	3	2	1	2	3	3	3	2	3	3	3
CO3	3	3	3	3	1	3	3	3	3	2	2	3	3
CO4	3	3	3	3	1	2	3	3	3	2	1	3	3
CO5	3	2	3	2	1	3	3	3	3	2	1	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Big data, need of big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics	08
	2. NoSQL	Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer-peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.	08
	3. Hadoop	Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures	08
	4. MapReduce	MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats	08

<b>Unit-2</b>	5. Hbase and Cassandra	Hbase, data model and implementations, Hbase clients, Hbase examples, praxis Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration	08
	6. High Level utilities (Pig, Grunt, Hive)	Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts, Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.	08

**Total=48**

### **Recommended Books:**

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging
2. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
3. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
4. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
5. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
6. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
7. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
8. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
9. Alan Gates, "Programming Pig", O'Reilley, 2011.

Title of the course : **Artificial Intelligence Lab**  
 Subject Code : **PCCS-813**  
 Weekly load : **4 Hrs** **L T P 0 0 4**  
 Credit : **2**

**Course Outcome: After completion of this course students will be able to**

CO1	Understanding the basics of AI and Prolog programming.
CO2	Implement DFS, BFS and TSP
CO3	Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing
CO4	Solve complex puzzles
CO5	Understanding the implementation and architecture of Expert System.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
COs	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	3	3	3
CO2	3	3	2	3	1	3	3	3	3	2	1	3	3
CO3	3	3	2	3	2	2	3	3	3	2	2	3	3
CO4	3	3	3	3	1	2	3	3	3	2	3	3	3
CO5	3	3	2	3	1	1	3	3	3	2	1	3	3

Introduction to prolog programming, Implementing DFS, BFS, TSP, simulated annealing, hill climbing, Hanoi problem, 8-puzzle problem and A\* algorithm using Prolog, Implementation of Expert System with forward chaining using JESS/ CLIPS. Implementation Expert System with backward chaining using RVD/PROLOG



Title of the course : **Parallel Computing Lab**

Subject Code : **PECS-813A**

Weekly load : **4 Hrs**

LTP: 0 0 4

Credits : **2**

**Course Outcomes:** At the end of the course, the student will be able to:

CO1	Gain practical skills in development of parallel programs
CO2	Use OpenMP and MPI technologies for development of parallel programs for computing systems with shared and distributed memory
CO3	Run simulation experiments on high-performance computing systems
CO4	Perform parallel calculations efficiency assessment
CO5	Use multithreading programming to implement programs

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	2	2	3	2	2	3	3
CO2	3	3	2	3	1	3	2	2	3	1	2	3	3
CO3	3	3	3	3	1	2	3	2	3	2	3	3	3
CO4	3	3	2	3	1	2	2	2	3	1	2	3	3
CO5	3	3	3	3	1	3	3	2	3	2	3	3	3

### **LIST OF PRACTICALS**

Introduction to OpenMP, Parallelizing a Simple Loop using OpenMP, Creating threads in OpenMP, Demonstrate thread synchronization in OpenMP, Demonstration of the clause used in the data environment, Create a program that computes a simple matrix vector multiplication  $b=Ax$ , in C/C++, Use OpenMP directives to make it run in parallel, Create a program that computes the sum of all the elements in an array A (in C/C++), Use OpenMP directives to make it run in parallel, Create a program that finds the largest number in an array A (in C/C++), Use OpenMP directives to make it run in parallel.

Title of the course : **Data Preparation and Analysis Lab**

Subject Code : **PECS-813B**

Weekly load : **4 Hrs**

LTP 004

Credit : **2**

**Course Outcomes: At the end of the course the student will be able to:**

CO1	Understand various data formats and their transformation
CO2	Association and clustering of data
CO3	Find meaning full visualization of data
CO4	Use hypothesis generation on data
CO5	Implement consistency checking and find missing data

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	3	2	3	3	2	2	3	3
CO2	3	3	3	3	1	1	2	3	3	2	2	3	3
CO3	2	3	3	3	1	2	3	3	3	1	3	3	3
CO4	2	3	3	3	1	2	2	3	3	2	2	3	3
CO5	3	3	3	3	1	1	3	3	3	1	3	3	3

In this lab students are required to implement and understand the various Data Formats and Various Software Tools to transform these data formats, consistency checking, missing data, comparative statistics, Clustering and association of data, hypothesis generation on data and meaning full visualization of data.

Title of the course : **Advance Database System Lab**

Subject Code : **PECS-813 C**

Weekly load : **4Hrs**

LTP 0 0 4

Credit : **2**

**Course Outcomes: At the end of the course, the student will be able to**

CO1	Acquire knowledge of advance database system.
CO2	To learn different software used for advance database system.
CO3	In depth knowledge of different techniques and tools used in advance database system.
CO4	Learn about various formats of databases
CO5	Implement various application based on different databases

Cos	CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):												
	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	3	3	3
CO2	3	2	3	3	1	2	3	3	3	2	1	3	3
CO3	3	3	3	3	1	1	3	3	3	1	1	3	3
CO4	3	2	3	3	1	2	3	3	3	2	2	3	3
CO5	3	2	3	3	2	1	3	3	3	1	2	3	3

In this lab the students are required to implement the applications based on Relational databases, Object-oriented databases and Distributed databases.

# **SEMESTER-II**

Title of the course : **Machine Learning**

Subject Code : **PCCS-821**

Weekly load : **4 Hrs**

**L T P 3 1 0**

Credit : **4**

**Course Outcome: After completion of this course students will be able to**

CO1	Understand the basics of Machine Learning, Data Preparation and Modelling, Regression and Classification
CO2	Understanding Bayesian Learning
CO3	Understanding Decision tree Learning
CO4	Understanding ANN, Instance based learning and clustering
CO5	Understanding Ensemble Learning Methods

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	3	2	3	2	2	3	3
CO2	2	3	3	3	1	3	3	3	3	2	3	3	3
CO3	2	2	3	3	1	2	3	2	3	2	1	3	3
CO4	3	2	3	3	2	2	2	3	3	2	3	3	3
CO5	3	3	3	3	1	1	2	3	3	2	2	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Motivation, Introduction to machine learning, types of machine learning, Regression and Classification, Exploring Data for modelling, Selection and evaluation of Model, Feature Engineering	07
	2. Decision Tree and Bayesian Learning	Decision Tree representation, appropriate problems for tree learning, Univariate Trees(Classification and Regression), Multivariate Trees, Basic Decision Tree Learning algorithms, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.	10
	3. Bayesian Learning	Bayes theorem and concept learning, Bayes optimal classifier, Gibbs algorithms, Naïve Bayes Classifier, Bayesian belief networks, The EM algorithm	07
<b>Unit-2</b>	4. ANN Learning	Neural Network, Perceptron, Multilayer Neural Network, Back-propagation, Recurrent Network, SVM, Introduction to Deep Learning	08
	5. Instance Based Learning and Clustering	K-Nearest Neighbor Learning, Introduction to clustering, k-means clustering, agglomerative hierarchical clustering	08
	6. Ensemble Learning Methods	Introduction to Ensemble Learning, Bagging, Boosting	08

**Total=48**

**Recommended Books:**

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. SakatDutt, S Chandramouli, Amit Kumar Das :Machine Learning, Pearson , 2018
5. Mitchell T.M , Machine Learning, McGraw Hill , 1997
6. Alpaydin E, Introduction to Machine Learning, MIT Press , 2010
7. Bishop C, Pattern Recognition and Machine Learning, Springer Verlag (2006)

Title of the course : **Advanced Network Principles and Protocols**  
 Subject Code : **PCCS-822**  
 Weekly load : **3Hrs** **L T P 3 0 0**  
 Credit : **3**

**Course Outcomes: At the end of the course the student will be able to:**

CO1	Learn basic understanding of the layered protocol models.
CO2	Get a comprehensive practical knowledge of peer to peer and end to end communication.
CO3	Acquire in depth knowledge of Internetwork routing of data.
CO4	Learn working of various network protocols
CO5	Apply knowledge of networking technologies to design a network as per the organization requirements.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	3	3	3
CO2	3	3	3	2	1	1	3	3	3	2	2	3	3
CO3	2	3	3	3	1	1	3	3	3	3	1	3	3
CO4	2	3	3	2	2	2	3	3	3	2	3	3	3
CO5	3	3	3	2	2	2	3	3	3	1	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Data and Media	Theoretical Basis of Data Communication, Data Rate, Transmission Media, Wireless Transmission, WDM system, Optical LANs, Optical paths and networks	08
	2. Review of Networking Concepts	Reference Models, MAC layer issues, Network Technologies, ARP/RARP, IP addressing and Subnetting, NAT and PAT, Variable Length Subnet Masking, CIDR.	08
	3. Routing of Data	Internetworking, IP protocol, IP header, Internet Multicasting, Mobile IP, IPv6, Routing architecture, Routing Algorithms, Congestion Control Algorithms.	08
<b>Unit-2</b>	4. End to End Protocols	TCP connection establishment and termination, Sliding window concepts, other issues: wraparound, silly window syndrome, Nagle's algorithm, adaptive retransmission, TCP extensions. Congestion and flow control, Queuing theory, Transport protocol for real time (RTP), Quality of service: Integrated Services, Differentiated services, UDP.	12
	5. Shared Communications Protocols and	Domain Name System, Simple Mail Transfer Protocol, File Transfer Protocol, Post Office Protocol, Hyper	06

	Interface	Text Transfer Protocol	
	6. Emerging Trends in Networking	Zigbee Protocol, Wireless Sensor Networks, Internet of Things	06

**Total=48**

**Recommended Books:**

1. Andrew S. Tanenbaum, "Computer Networks", PHI.
2. A. Behrouz Forouzan, "Data Communication and Networking", TMH.
3. William Stalling, "Data and Computer Communication", Pearson Education.



Title of the course : **Cyber Security**

Subject Code : **PCCS-823**

Weekly load : **3Hrs**

**L T P 3 0 0**

Credit : **3**

**Course Outcomes:** At the end of the course, the student will be able to:

CO1	Understand the basic terminologies related to cyber security.
CO2	Acquire knowledge about the type and nature of cyber crimes and as to how report these crimes through the prescribed legal and Government channels.
CO3	Understand the legal framework that exists in India for cyber crimes and penalties and punishments for such crimes.
CO4	Understand the aspects related to personal data privacy and security.
CO5	Get insights into risk-based assessment, requirement of security controls.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):

Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	3	3	3	2	2	3	3	3
CO2	3	3	3	3	2	2	3	2	3	3	2	3	3
CO3	3	3	3	3	1	2	3	2	1	1	3	3	3
CO4	3	3	3	3	1	2	3	3	2	3	1	3	3
CO5	3	3	3	3	2	3	3	3	3	1	1	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	1. Overview of Cyber security	Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies.	10
	2. Cyber crimes	Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cyber-squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake news cyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.	14
	3. Cyber Law	Cyber crime and legal landscape around the world, IT Act,2000 and its amendments and limitation. Cyber crime and punishments, Cyber Laws, Legal and Ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and	08

		Social media, Cyber Laws of other countries, Case Studies.	
<b>Unit-2</b>	4. Data Privacy and Security	Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.	08
	5. Cyber security Management, Compliance and Framework	Cyber security Plan- cyber security policy, cyber crises management plan, Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy. NIST Framework, MITRE Attack TTP's	08

**Total=48**

### **Recommended Books:**

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
5. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1stEdition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning.

Title of the course : **Deep learning**  
 Subject Code : **PECS-821A**  
 Weekly load : **3Hrs** **L T P 3 0 0**  
 Credit : **3**

**Course Outcome: After completion of this course students will be able to**

CO1	Learn the development and application of modern neural networks.
CO2	Be able to build, train and apply fully connected deep neural networks
CO3	Know how to implement efficient (vectorized) neural networks
CO4	Understand the key parameters in a neural network's architecture
CO5	Understand how to build a convolutional neural network, including recent variations such as residual networks.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	3	3	3	2	3	3	3
CO2	3	3	3	3	2	1	3	3	3	3	2	3	3
CO3	3	3	3	3	2	3	3	3	3	3	1	3	3
CO4	3	2	3	3	1	2	3	3	3	2	1	3	3
CO5	3	2	3	3	1	3	3	3	3	1	3	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	What is a neural network? Supervised Learning with Neural Networks, Why is Deep Learning taking off? Neural network Basics: Binary Classification, Logistic Regression, Logistic Regression Cost Function, Gradient Descent, Derivatives, Computation graph, Derivatives with a Computation Graph, Logistic Regression Gradient Descent, Gradient Descent on m Examples Shallow Neural Networks: Neural Networks Overview, Neural Network Representation, Computing a Neural Network's Output, Vectorizing across multiple examples, Explanation for Vectorized Implementation, Activation functions, Why do you need non-linear activation functions?, Derivatives of activation functions, Gradient descent for Neural Networks, Back-propagation algorithm,	08
	2. Deep neural networks	Deep L-layer neural network, Forward Propagation in a Deep Network, Getting your matrix dimensions right, Why deep representations?, Building blocks of deep neural networks, Forward and Backward Propagation, Parameters vs Hyper-parameters. Practical aspects of deep learning: Train/Dev/Test sets, Bias/ Variance, Regularization, Why regularization reduces over fitting?, Dropout Regularization, Understanding Dropout, Other regularization methods, Normalizing inputs, Vanishing / Exploding gradients, Weight Initialization for	08

		Deep Networks, Numerical approximation of gradients, Gradient checking	
	3. Optimization algorithms	Mini-batch gradient descent, Understanding mini-batch gradient descent, Exponentially weighted averages, Understanding exponentially weighted averages, Bias correction in exponentially weighted averages, Gradient descent with momentum, RMSprop, Adam optimization algorithm, Learning rate decay, The problem of local optima	08
<b>Unit-2</b>	4. Hyper parameter tuning, Batch Normalization and Programming Frameworks	Tuning process, Using an appropriate scale to pick hyper parameters, Hyper parameters tuning in practice: Pandas vs. Caviar, Normalizing activations in a network, Fitting Batch Norm into a neural network, Why does Batch Norm work?, Batch Norm at test time, Softmax Regression, Training a softmax classifier, Deep learning frameworks, Tensor-Flow.	08
	5. Convolutional Neural Networks	Foundations of Convolutional Neural Networks: Computer Vision, Edge Detection Example, More Edge Detection, Padding, Strided Convolutions, Convolutions Over Volume, One Layer of a Convolutional Network, Simple Convolutional Network Example, Pooling Layers, CNN Example, Why Convolutions? Deep convolutional models: case studies, Why look at case studies?, Classic Networks, ResNets, Why ResNets Work, Networks in Networks and 1x1 Convolutions, Inception Network Motivation, Inception Network, Transfer Learning, Data Augmentation	08
	6. Sequence Models	Recurrent Neural Networks: Why sequence models, Notation, Recurrent Neural Network Model, Back-propagation through time, Different types of RNNs, Language model and sequence generation, Sampling novel sequences, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU), Long Short Term Memory (LSTM), Bidirectional RNN, Deep RNNs.	08

**Total=48**

**Recommended**

**Books:**

The required textbook for the course is

1. Ian Goodfellow, YoshuaBengio, Aaron Courville. Deep Learning.

Other recommended supplemental textbooks on general machine learning:

2. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification . Wiley-Interscience. 2nd Edition. 2001.
3. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4 . Academic Press, 2008.
4. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.
5. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.
6. Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning, Springer. 2001.
7. Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009.

**Title of the course** : **Software Project Management**  
**Subject Code** : **PECS-821B**  
**Weekly load** : **3Hrs** **L T P 3 0 0**  
**Credit** : **3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Comprehend software project management activities
CO2	Understand various steps required for project planning
CO3	Create an estimation and effective cost benefit evaluation techniques
CO4	Design framework for risk management
CO5	Comprehend resource management

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	3	3	3	2	3	3	3
CO2	2	3	2	3	2	1	3	3	3	2	2	3	3
CO3	3	3	3	3	1	2	3	3	3	3	2	3	3
CO4	2	3	2	3	1	3	3	3	3	3	3	3	3
CO5	2	3	3	3	2	2	3	3	3	2	1	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Introduction to software project management, types of project, project attributes, project constraints, importance of management, problems with software projects, management control, role of project manager, steps in project planning, Programme management, managing resources within Programme,	12
	2. Software Cost and Time Estimation	A system view of project management, stakeholder management, Assessment of projects, Cost-benefit Analysis, Cash flow forecasting, Cost-benefit evaluation techniques, Selection of an appropriate project technology, Choice of process model, developing the project schedule, Estimation Techniques, Problem with over and underestimates, COCOMO Model	12
<b>Unit-2</b>	3. Planning	Objective of Planning, Project Schedule, Activities – Sequencing and Scheduling, Development of Project Network, Time Estimation, Forward and backward Pass, Critical Path and Activities. Introduction to project risk management, Risk categories, identification, assessment, planning, management, Software Configuration Management Process: Version Control, Change Control management, PERT and CPM Models, project implementation	12

	4. Software Project Management	Resources, Nature of Resources, developing the project budget, monitoring and controlling the project, project metrics, Project targets, Management Spectrum, Associating human resource with job, Motivation, Oldham- job Characteristics Model, Decision Making, Leadership, Stress Management, Health and Safety	12
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**Total=48**

**Recommended Books:**

1. Bob Hughes, Mike Cotterell, "Software Project Management", Tata McGraw Hill.
2. Prasanna Chandra, "Projects: Panning, Analysis, Selection, Financing, Implementation and Review", Tata McGraw Hill Publication.
3. Jeffrey K. Pinto, "Project Management", Pearson Publications.

Title of the course : **Computer Vision**  
 Subject Code : **PECS-821C**  
 Weekly load : **3Hrs** **L T P 3 0 0**  
 Credit : **3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	To learn the basics of sensor and imaging.
CO2	To study about the signal representation and non linear image processing
CO3	Analyze the feature estimation in image processing techniques.
CO4	To study the image and video compression standards.
CO5	Understand analysis and classification of objects

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Sensor and Imaging: Imaging Optics, Radiometry of Imaging, Illumination sources and techniques, Camera Principles, Color Imaging, Single Sensor Color Imaging and Color Demosaicing, Range Images, 3D Imaging.	6
	2. Signal Representation	Vector Space and Unitary Transforms, Multi-Resolutional Signal Representation, Wavelet Decomposition, Scale space and diffusion, Representation of color, Retinex Processing, Markov Random Field Modellings of Images.	8
	3. Non-linear Image Processing	Median and Order Statistics Filters, Rank-Ordered-Mean Filters and Signal Dependent Rank-Ordered-Mean Filters, Two Dimensional Teager Filters, Applications of nonlinear filters in image enhancement, edge detections, noise removal etc.	8
<b>Unit-2</b>	4. Feature Estimation	Morphological Operations, Edge Detection, Edges in multichannel images, Texture Analysis, Optical flow based motion estimation, Reflectance based shape recovery, Depth from focus, Stereo matching and depth estimation.	6
	5. Image and Video Compression Standards	Lossy and lossless compression schemes: Transform Based, Sub-band Decomposition, Entropy Encoding, JPEG, JPEG2000, MPEG-1, MPEG-4, and MPEG-7.	8
	6. Object Analysis, Classification	Bayesian Classification, Fuzzy Classification, Neural Network Classifiers, Shape Reconstruction from volumetric data, Knowledge-based interpretation of images.	5

**Recommended Books:**

1. Computer Vision: Algorithms and Applications by Richard Szeliski.
2. Deep Learning, by Goodfellow, Bengio, and Courville.
3. Dictionary of Computer Vision and Image Processing, by Fisher et al.

Title of the course : **Cloud Computing**  
 Subject Code : **PECS-822A**  
 Weekly load : **3Hrs** LTP 3 0 0  
 Credit : **3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	To create a brief understanding of cloud computing and other related technologies (Grid/cluster etc.).
CO2	To understand cloud service models, deployment models and service inception through virtualization in cloud.
CO3	To understand various security issues in cloud as well as an overview of the basic architectures of cloud computing.
CO4	To understand the architecture of cloud computing up to an advance stage
CO5	To understand the considerations of cloud delivery models this includes an introduction to data center and working with IaaS, PaaS and SaaS.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	1	3	3
CO2	3	3	2	2	2	1	3	3	3	3	3	3	3
CO3	2	2	3	3	1	3	3	3	3	2	2	3	3
CO4	3	3	3	2	1	2	3	3	3	3	1	3	3
CO5	3	3	3	3	1	1	3	3	3	2	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Understanding Cloud Computing	Origins and Influences: A Brief History, Clustering, Grid Computing, Virtualization, Technology Innovations vs. Enabling Technologies. Basic Concepts and Terminology :Cloud, IT Resource, On-Premise, Cloud Consumers and Cloud Providers, Scaling (Horizontal/Vertical), Cloud Service, Service Consumer Goals and Benefits, Risks and Challenges, Cloud Provider, Cloud Consumer, Cloud Service Owner, Cloud Resource Administrator, Organizational Boundary, Trust Boundary.	06
	2. Service deployment Models and Virtualization	Cloud Characteristics, Cloud Service Delivery Models: IaaS, PaaS, SaaS, Deployment Models: Public Clouds, Community Clouds, Private Clouds, Hybrid Clouds. Virtualization Technology: Hardware Independence, Server Consolidation, Operating System-Based Virtualization, Hardware-Based Virtualization, Virtualization Management.	06
	3. Cloud Security	Basic Terms and Concepts- Confidentiality, Integrity, Authenticity, Availability, Threat, Vulnerability, Risk, Security Controls, Security Mechanisms, Security Policies, Threat Agents- Anonymous Attacker, Malicious Service Agent, Trusted Attacker, Malicious Insider, Cloud Security	06



		Threats- Traffic Eavesdropping, Malicious Intermediary, Denial of Service, Insufficient Authorization, Virtualization Attack.	
	4. Cloud Computing Architecture	Fundamental Cloud Architectures- Architecture of Workload Distribution, Resource Pooling, Dynamic Scalability, Elastic Resource Capacity, Service Load Balancing, Cloud Bursting, Elastic Disk Provisioning, Redundant Storage	06
<b>Unit-2</b>	5. Advance cloud computing architecture	Hypervisor Clustering, Load Balanced Virtual Server Instances, Non-Disruptive Service Relocation, Zero Downtime, Cloud Balancing, Resource Reservation, Dynamic Failure Detection and Recovery, Bare-Metal Provisioning, Rapid Provisioning Architecture, Storage Workload Management	06
	6. Cloud Delivery Model Considerations	Building IaaS Environments, Data Centers, Equipping PaaS Environments, Optimizing SaaS Environments, Cloud Delivery Models: The Cloud Consumer Perspective, Working with IaaS Environments, Working with PaaS Environments, Working with SaaS Services	06
	7. Case study	Case study of a Cloud Management and Virtualization software for example Eucalyptus, VMware etc.	12

**Total=48**

**Recommended Books:**

1. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Prentice Hall.
2. John W. Rittinghouse, James F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press.
3. Alfredo Mendoza, "Utility Computing Technologies, Standards, and Strategies", Artech House INC.
4. Bunker, Darren Thomson, "Delivering Utility Computing", John Wiley and Sons Ltd.
5. George Reese, "Cloud Application Architectures", O'Reilly Publications.

**Title of the course** : **Internet of Things**  
**Subject Code** : **PECS-822B**  
**Weekly load** : **3Hrs** **L T P: 3 0 0**  
**Credit** : **3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Understand the application areas of IOT
CO2	Realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
CO3	Acquire knowledge of characteristics of different types of sensors used in IoT
CO3	Analyze randomized algorithms with respect to expected running time
CO4	Understand building blocks of Internet of Things and characteristics

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	3	1	3	3
CO2	2	3	3	3	3	1	3	3	3	2	2	3	3
CO3	2	3	3	2	2	1	3	3	3	2	2	3	3
CO4	3	3	3	2	2	2	3	3	3	3	1	3	3
CO5	3	3	3	3	1	1	3	3	3	2	1	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT. Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security	08
	2. Sensors	Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications  Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc	08
	3. Characteristics of Sensors	Important Characteristics of Sensors: Determination of the Characteristics: Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality  Impedance Spectroscopy: Equivalent circuit of Sensors and Modeling of Sensors, Importance and Adoption of Smart Sensors.	08

<b>Unit-2</b>	4. Architecture and Design constraints	IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.Real-World Design Constraints- Introduction, Technical Design constraints hardware, Data representation and visualization, Interaction and remote controlArchitecture of Smart Sensors: Important components, their features Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical. Vapor, Anodization, Sol-gel	8
	5. Hardware Platforms and Physical Devices for IOT	Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry , Interface and Programming & IOT Device	8
	6. Recent Trends	Recent trends in smart sensor for day to day life, evolving sensors, their architecture and IOT architecture, Automation in Industrial aspect of IOT	8

**Total=48**

**Recommended Books:**

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications.
3. Wiley. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, WileyDonald E. Knuth, “The Art of Programming”, Pearson Education
5. Mandler, B., Barja, J., MitreCampista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing.

Title of the course : **Bioinformatics**

Subject Code : **PECS-822C**

Weekly load : **3 Hrs**

L T P 3 0 0

Credit : **3**

**Course Outcomes: At the end of the course, the student will be able to**

CO1	Acquire the basic understanding of bioinformatics.
CO2	Understand the role of bioinformatics in real life.
CO3	Comprehensive knowledge of various datasets of bioinformatics.
CO4	Understand the concept of Phylogeny
CO5	In depth knowledge of techniques and tools used in bioinformatics.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	1	3	2	3	3	3
CO2	3	3	3	3	2	3	3	2	3	1	2	3	3
CO3	2	3	3	3	1	2	3	1	3	2	3	3	3
CO4	2	3	3	2	3	1	3	1	3	1	2	3	3
CO5	3	3	3	2	1	1	3	2	3	2	2	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction and Bioinformatics Resources	Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases: <ul style="list-style-type: none"> <li>• Nucleic acid sequence databases-GenBank, EMBL, DDBJ.</li> <li>• Protein sequence databases- SWISS-PROT, TrEMBL, PIR, PDB.</li> <li>• Genome Databases - NCBI, EBI, TIGR, SANGER.</li> <li>• Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources).</li> </ul>	10
	2. Sequence analysis	Various file formats for bio-molecular sequences- genbank, fasta, gcg, msf, nbrf-pir etc. <ul style="list-style-type: none"> <li>• Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues.</li> <li>• Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.</li> <li>• Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST</li> </ul>	10

		and FASTA.	
	3. Pairwise and Multiple sequence alignments	Basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA. Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.	10
<b>Unit-2</b>	4. Phylogeny	Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees: distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method.	10
	5. Current Advancements in Bioinformatics	Introduction to System Biology, Structural Biology, Structural bioinformatics, Chemo-informatics, Immuno-informatics etc.	08

**Total=48**

**Recommended Books:**

1. Introduction to Bioinformatics by Aurther M lesk
2. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck.
3. David W. Mount; Bioinformatics: Sequence and Genome Analysis; CSHL Press; 1st edition, 2001.
4. Andreas D. Baxevanis, Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins. Wiley-Interscience, 3rd edition 2004

Title of the course : **Cloud Computing Lab**

Subject Code : **PECS-823A**

Weekly load : **2 Hrs**

**L T P 0 0 2**

Credit : **1**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Create and run virtual machines
CO2	Implement Infrastructure-as-a-Service and Software-as-a-Service
CO3	Understanding Amazon EC2 and Microsoft Azure services
CO4	Gain in depth knowledge of various cloud services
CO5	Create own cloud

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	2	3	2	3	3	3
CO2	3	3	3	3	1	3	3	3	3	1	2	3	3
CO3	3	2	3	2	1	2	3	2	3	2	3	3	3
CO4	3	2	3	2	2	2	3	2	3	1	2	3	3
CO5	3	3	3	3	1	3	3	3	3	1	3	3	3

The practical lab of Cloud Computing will cover practical use of cloud environment. The aim is to give a general understanding of cloud computing and to give the students a practical understanding of how to create virtual machines on open sources operating systems, use and implementation of Infrastructure-as-a-service and software-as-a-service. Case study of various services such as Amazon EC2, Microsoft Azure etc. Mini project such as creating a cloud like social media for the institute.

**Title of the course : Internet of things Lab**

**Subject Code : PECS-823B**

**Weekly load : 2 Hrs**

**L T P: 0 0 2**

**Credit : 1**

**Course Outcomes: At the end of the course, the student will be able to**

CO1	Able to understand building blocks of Internet of Things and characteristics
CO2	Analyze randomized algorithms with respect to expected running time
CO3	Implement own IoT models in lab
CO4	To gain real working knowledge in the field of IoT.
CO5	Acquire knowledge of using various types of sensors for proper working of IoT

Cos	CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):												
	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	3	3	3	2	3	3	3
CO2	3	3	3	3	3	3	3	3	2	2	1	3	3
CO3	2	3	3	3	1	1	3	3	2	2	3	3	3
CO4	3	3	2	3	1	1	3	3	3	2	2	3	3
CO5	2	3	3	3	2	3	3	3	3	2	3	3	3

The internet of things lab will help the students to acquire skills in using cutting-edge technologies and their working including:

IoT Architecture, IETF IoT Stack/ protocols, IoT hardware platforms and sensor technology, IoT system design and applications for the students to work on real mote platform. A mini project which includes system design (design choices and monitoring & actuation requirements of application) and implementation of real IoT application system (coding/troubleshooting).

**Title of the course : Bioinformatics Lab**

**Subject Code : PECS-823C**

**Weekly load : 2 Hrs**

**L T P 0 0 2**

**Credit : 1**

**Course Outcomes: At the end of the course, the student will be able to**

CO1	Introduction to various bioinformatics techniques.
CO2	Study and usage of various bioinformatics datasets.
CO3	Use various searching techniques for data collection
CO4	Depth knowledge of techniques and tools used in bioinformatics.
CO5	Implement various queries on biological databases

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	1	3	2	3	3	3
CO2	3	2	3	3	1	2	3	2	3	1	1	3	3
CO3	3	2	3	3	2	2	3	1	3	2	3	3	3
CO4	3	2	3	3	2	3	3	1	3	1	1	3	3
CO5	3	3	3	3	1	3	3	2	3	2	3	3	3

In this lab the students are required to implement and understand the biological databases available on world wide web, queries based on biological databases, sequence similarity searching techniques using BLAST (Basic local alignment search tool) and pair-wise sequence alignment of (DNA, RNA, or protein) to identify regions of similarity that may be a consequence of functional, structural, or evolutionary relationships between the sequences.



Title of the course : **Seminar**  
 Subject Code : **PCCS-824**  
 Weekly load : **2 Hrs**  
 Credit : **1**

**L T P 0 0 2**

**Course Outcomes: At the end of the course the student will be able to:**

CO1	Get opportunities to develop skills in presentation and discussion of research topics in a public forum.
CO2	Get a variety of research projects and activities in order to enrich their academic experience.
CO3	Acquire in depth knowledge of various topics
CO4	To set the stage for future recruitment by potential employers.
CO5	Acquire skills in preparing presentations and report writings

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	3	3	3	3	2	3	3	3
CO2	3	3	3	2	1	2	3	3	3	2	3	3	3
CO3	3	3	2	3	2	3	3	3	3	3	2	3	3
CO4	3	3	2	1	2	2	3	3	3	2	2	3	3
CO5	3	3	1	3	2	3	3	3	3	2	3	3	3

Seminar: In this, the student must select an area from emerging technologies and give presentation on the topic. Evaluation criteria will be based on presentation skills and quality/relevance of the topic.

# **SEMESTER-III**

**Title of the course : Dissertation (Part-1)**

**Subject Code : PCCS-921**

**Weekly load : 20 Hrs**

**L T P 0 0 20**

**Credit : 10**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Synthesize and apply prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints
CO2	Design and Develop the software with software engineering practices and standards
CO3	Learn effectively presentation and writing skills
CO4	Analyze Database, Network and Application Design methods
CO5	Evaluate the various validation and verification methods

Cos	CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):												
	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	2	2	3	3
CO3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	3	2	1	3	3
CO5	3	3	3	3	1	3	3	3	3	3	3	3	3

Dissertation (Part-1): In this, the student must select an area from emerging technologies and specify the objectives to be achieved. Evaluation criteria will be based on objectives stated and achieved.

**Title of the course : Optimization Techniques**

**Subject Code : PECS-911A**

**Weekly load : 3Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Describe clearly a problem, identify its parts and analyze the individual functions. Feasibility study for solving an optimization problem.
CO2	Becoming a mathematical translation of the verbal formulation of an optimization problem.
CO3	To design algorithms, the repetitive use of which will lead reliably to finding an approximate solution.
CO4	Evaluate and measure the performance of an algorithm. Discovery, study and solve optimization problems.
CO5	Investigate study, develop, organize and promote innovative solutions for various applications.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	3	3	3	2	3	3	3
CO2	3	3	3	3	1	2	3	3	3	2	1	3	3
CO3	3	3	3	3	2	2	3	3	3	2	3	3	3
CO4	3	3	3	3	2	2	3	3	3	2	1	3	3
CO5	3	3	3	3	1	3	3	3	3	2	1	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	7. Linear programming models	Introduction to optimization, two variable LP model, graphical LP solution, LP problems, convex set, LP model in equation form, transition from graphical to algebraic solution, the simplex method, generalized simplex tableau in matrix form, revised simplex method, artificial starting solution, special cases in the simplex method	13
	8. Dual problems	Definition of dual problem, duality, primal-dual relationships, additional simplex algorithms (dual simplex method, generalized simplex algorithm), post optimal analysis, definition of transportation problem, the transportation algorithm, the assignment model	12
	9. Multi objective optimization	Goal programming formulation, algorithms: the weights method and the preemptive method	05
<b>Unit-2</b>	4. Integer programming problems	Formulation of IP problem, branch and bound method for solving IPP	05

	5. Nonlinear programming problems	Unconstrained problems, convex and concave functions, elimination methods: direct search method, gradient of a function, descent methods: steepest descent method, Karush-Kuhn-Tucker (KKT) conditions, quadratic programming	08
	6. Nontraditional optimization techniques	Drawbacks of the classical techniques, introduction to nontraditional optimization techniques	05

**Total=48**

**Recommended Books:**

1. HA Taha, Operations Research: An Introduction, Pearson Education, 9th Edition, 2011
2. CB Gupta, Optimization in Operations Research, 2nd Edition, IK International, New Delhi, 2012
3. JC Pant, Introduction to Optimization: Operations Research, Jain Brothers, New, 6th Edition, 2004
4. WL Winston, Operations Research: Applications and Algorithms, Thomson Learning, 4th Edition, 2004

**Title of the course : Pattern Recognition**

**Subject Code : PECS-911B**

**Weekly load : 3Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Study the fundamental algorithms for pattern recognition
CO2	Investigate the various classification techniques
CO3	Originate the various structural pattern recognition and feature extraction techniques
CO4	Acquire knowledge of parameter estimation
CO5	Study the clustering concepts and algorithms

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	3	3	3	3	2	1	3	3
CO2	3	3	3	2	1	1	3	3	3	2	1	3	3
CO3	2	3	3	2	1	1	3	3	3	1	3	3	3
CO4	2	3	3	3	3	3	3	3	3	1	3	3	3
CO5	3	3	3	3	2	1	3	3	3	1	1	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	Introduction to Pattern Recognition System, The sub-problems of pattern recognition, The basic structure of a pattern recognition system, Comparing classifiers.	04
	2. Bayes Decision Theory	Bays Decision Theory: continuous and discrete features, Classifiers, Discriminant functions and decision surfaces, Error bounds, Missing and Noisy features, Bayesian Belief networks.	04
	3. Maximum Likelihood And Bayesian Parameter Estimation	Maximum Likelyhood estimation, Bayeseian Estimation and Parameter Estimation, Component Analysis and Discriminants, Expectation-Maximization, Hidden Markov Models.	08
	4. Nonparametric Techniques	Introduction, Density Estimation, Parzen Windows, K-nearest neighbour estimation, The nearest neighbour rule, Metrics and Nearest Neighbor classification, fuzzy classification	06
<b>Unit-2</b>	5. Linear Discriminant Functions	Introduction, Linear Discriminant functions and Decision Surfaces, Generalized Linear Discriminant functions, Two-category Linearly separable case, Relaxation procedures,	06

		Minimum Squared Error procedures, Linear Programming Algorithms, Support Vector Machines, Multicategory Generalizations.	
6.	Multilayer Neural Networks ,Stochastic Methods, Non Metric Methods	Feedforward operation and classification, Backpropagation Algorithm, Additional network and training methods. Simulated Annealing and Boltzman machine. Tree Methods, Recognition with strings, Rule based methods, Grammatical Methods	06
7.	Unsupervised Learning and Clustering	Mixture Densities and Identifiability, Maximum Likelyhood Estimates, application to normal mixtures, Unsupervised Bayesian Learning, Similarity measures, Criterion functions for clustering, Hierarchical clustering, On-line clustering, Graph-Theoretic Methods, Component Analysis, Low-Dimensional Representations and Multidimensional Scaling (MDS)	08
8.	Applications of PR	Speech and speaker recognition, Character recognition, Scene analysis.	06

**Total=48**

**Recommended Books:**

1. Richard O.Duda, "Pattern Classification", Wiley Publication.
2. Theodoridis, Koutroumbas, "Pattern Recognition", Academic Press.
3. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer

Title of the course : **Data Sciences**  
 Subject Code : **PECS-911 C**  
 Weekly load : **3Hrs** **L T P 3 0 0**  
 Credit : **3**

**Course Outcomes:** At the end of the course, the student will be able to:

CO1	Explain how data is collected, managed and stored for data science
CO2	Understand the key concepts in data science
CO3	Acquire knowledge of real-world applications and the toolkit used by data scientists
CO4	Get in depth knowledge of data science applications
CO5	Implement data collection and management scripts using MongoDB

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	1	3	3	3	2	3	3	3
CO2	3	3	3	3	3	1	3	3	3	1	2	3	3
CO3	3	2	3	3	2	1	3	3	3	1	2	3	3
CO4	3	2	3	2	1	2	3	3	3	2	3	3	3
CO5	3	2	3	2	1	2	3	3	3	1	1	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction to Core Concepts and Technologies	Introduction, Terminology, Data Science Process, Data Science Toolkit, Types of Data, Example Applications.	06
	2. Data Collection and Management	Introduction, Sources of Data, Data Collection and APIs, Exploring and Fixing Data, Data Storage and Management, Using Multiple Data Sources.	07
	3. Data Analysis	Introduction, Terminology and Concepts, Introduction to Statistics, Central Tendencies and Distributions, Variance, Distribution Properties and Arithmetic, Samples/CLT, Basic Machine Learning Algorithms, Linear Regression, SVM, Naive Bayes.	10
<b>Unit-2</b>	4. Data Visualisation	Introduction, Types of Data Visualisation, Data for Visualisation: Data Types, Data Encodings, Retinal Variables, Mapping Variables to Encodings, Visual Encodings.	11
	5. Applications	Applications of Data Science, Technologies for Visualisation, Bokeh (Python)	07
	6. Recent Trends	Recent Trends in Various Data Collection and Analysis Techniques, Various Visualization Techniques, Application Development Methods of Use in Data Science.	07

**Total=48**



**Recommended Books:**

1. Cathy O'Neil, Rachel Schutt, Doing Data Science, Straight Talk From The Frontline, O'Reilly.
2. Jure Leskovek, AnandRajaraman, Jeffrey Ullman, Mining of Massive Datasets, v2.1, Cambridge University Press.

**Title of the course : Internet of Things**  
**Subject Code : OECS-911B**  
**Weekly load : 3Hrs** **L T P: 3 0 0**  
**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Understand the application areas of IOT
CO2	Realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
CO3	Acquire knowledge of various types of sensors used in IoT
CO4	Analyze randomized algorithms with respect to expected running time
CO5	Understand building blocks of Internet of Things and characteristics

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	1	3	3	3	2	3	3	3
CO2	3	3	3	2	2	3	3	3	3	1	2	3	3
CO3	3	3	3	2	3	1	3	3	3	2	3	3	3
CO4	3	3	3	3	1	3	3	3	3	1	1	3	3
CO5	3	3	3	2	1	1	3	3	3	1	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	2. Introduction	Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT. Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security	08
	2. Sensors	Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications  Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc	08
	3. Characteristics of Sensors	Important Characteristics of Sensors: Determination of the Characteristics: Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality  Impedance Spectroscopy: Equivalent circuit of Sensors and Modeling of Sensors, Importance and Adoption of Smart Sensors.	08

<b>Unit-2</b>	4. Architecture and Design constraints	IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.Real-World Design Constraints- Introduction, Technical Design constraintshardware, Data representation and visualization, Interaction and remote controlArchitecture of Smart Sensors: Important components, their features Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical. Vapor, Anodization, Sol-gel	8
	5. Hardware Platforms and Physical Devices for IOT	Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry, Interface and Programming & IOT Device	8
	6. Recent Trends	Recent trends in smart sensor for day to day life, evolving sensors, their architecture and IOT architecture, Automation in Industrial aspect of IOT	8

**Total=48**

**Recommended Books:**

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications.
3. Wiley. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, WileyDonald E. Knuth, “The Art of Programming”, Pearson Education
5. Mandler, B., Barja, J., MitreCampista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing.

**Title of the course : Deep learning**

**Subject Code : OECS-911C**

**Weekly load : 3Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcome: After completion of this course students will be able to**

CO1	This course is an introduction to deep learning, a branch of machine learning concerned with the development and application of modern neural networks.
CO2	Be able to build, train and apply fully connected deep neural networks
CO3	Know how to implement efficient (vectorized) neural networks
CO4	Understand the key parameters in a neural network's architecture
CO5	Understand how to build a convolutional neural network, including recent variations such as residual networks.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	1	3	3	3	2	3	3	3
CO2	3	3	3	3	2	2	3	3	3	3	1	3	3
CO3	3	3	3	3	2	2	3	3	3	2	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	2	3	3	3	2	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Introduction	What is a neural network? Supervised Learning with Neural Networks, Why is Deep Learning taking off? Neural network Basics: Binary Classification, Logistic Regression, Logistic Regression Cost Function, Gradient Descent, Derivatives, Computation graph, Derivatives with a Computation Graph, Logistic Regression Gradient Descent, Gradient Descent on m Examples Shallow Neural Networks: Neural Networks Overview, Neural Network Representation, Computing a Neural Network's Output, Vectorizing across multiple examples, Explanation for Vectorized Implementation, Activation functions, Why do you need non-linear activation functions?, Derivatives of activation functions, Gradient descent for Neural Networks, Back-propagation algorithm,	08
	2. Deep neural networks	Deep L-layer neural network, Forward Propagation in a Deep Network, Getting your matrix dimensions right, Why deep representations?, Building blocks of deep neural networks, Forward and Backward Propagation, Parameters vs Hyper-parameters. Practical aspects of deep learning: Train/Dev/Test sets, Bias/ Variance, Regularization, Why regularization reduces over fitting?, Dropout Regularization, Understanding Dropout, Other regularization methods, Normalizing inputs, Vanishing / Exploding gradients, Weight Initialization for Deep Networks, Numerical approximation of gradients,	08

		Gradient checking	
	3. Optimization algorithms	Mini-batch gradient descent, Understanding mini-batch gradient descent, Exponentially weighted averages, Understanding exponentially weighted averages, Bias correction in exponentially weighted averages, Gradient descent with momentum, RMSprop, Adam optimization algorithm, Learning rate decay, The problem of local optima	08
Unit-2	4. Hyper parameter tuning, Batch Normalization and Programming Frameworks	Tuning process, Using an appropriate scale to pick hyper parameters, Hyper parameters tuning in practice: Pandas vs. Caviar, Normalizing activations in a network, Fitting Batch Norm into a neural network, Why does Batch Norm work?, Batch Norm at test time, Softmax Regression, Training a softmax classifier, Deep learning frameworks, TensorFlow.	08
	5. Convolutional Neural Networks	Foundations of Convolutional Neural Networks: Computer Vision, Edge Detection Example, More Edge Detection, Padding, Strided Convolutions, Convolutions Over Volume, One Layer of a Convolutional Network, Simple Convolutional Network Example, Pooling Layers, CNN Example, Why Convolutions? Deep convolutional models: case studies, Why look at case studies?, Classic Networks, ResNets, Why ResNets Work, Networks in Networks and 1x1 Convolutions, Inception Network Motivation, Inception Network, Transfer Learning, Data Augmentation	08
	6. Sequence Models	Recurrent Neural Networks: Why sequence models, Notation, Recurrent Neural Network Model, Back-propagation through time, Different types of RNNs, Language model and sequence generation, Sampling novel sequences, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU), Long Short Term Memory (LSTM), Bidirectional RNN, Deep RNNs.	08

**Total=48**

### Recommended Books:

The required textbook for the course is

1. Ian Goodfellow, YoshuaBengio, Aaron Courville. Deep Learning.

Other recommended supplemental textbooks on general machine learning:

2. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification . Wiley-Interscience. 2nd Edition. 2001.
3. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition Academic Press, 2008.
4. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.
5. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.
6. Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning, Springer. 2001.
7. Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009.

**Title of the course : Cloud Computing**

**Subject Code : OECS-911D**

**Weekly load : 3Hrs**

**L T P 3 0 0**

**Credit : 3**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	To create a brief understanding of cloud computing and other related technologies (Grid/cluster etc.).
CO2	To understand cloud service models, deployment models and service inception through virtualization in cloud.
CO3	To understand various security issues in cloud as well as an overview of the basic architectures of cloud computing.
CO4	To understand the architecture of cloud computing up to an advance stage
CO5	To understand the considerations of cloud delivery models which includes an introduction to data center and working with IaaS, PaaS and SaaS.

Cos	CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):												
	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	2	1	3	3
CO2	3	3	2	2	2	1	3	3	3	3	3	3	3
CO3	2	2	3	3	1	3	3	3	3	2	2	3	3
CO4	3	3	3	2	1	2	3	3	3	3	1	3	3
CO5	3	3	3	3	1	1	3	3	3	2	3	3	3

**Theory**

Unit	Main Topics	Course outlines	Lecture(s)
<b>Unit-1</b>	1. Understanding Cloud Computing	Origins and Influences: A Brief History, Clustering, Grid Computing, Virtualization, Technology Innovations vs. Enabling Technologies. Basic Concepts and Terminology: Cloud, IT Resource, On-Premise, Cloud Consumers and Cloud Providers, Scaling (Horizontal/Vertical), Cloud Service, Service Consumer Goals and Benefits, Risks and Challenges, Cloud Provider, Cloud Consumer, Cloud Service Owner, Cloud Resource Administrator, Organizational Boundary, Trust Boundary.	06
	2. Service deployment Models and Virtualization	Cloud Characteristics, Cloud Service Delivery Models: IaaS, PaaS, SaaS, Deployment Models: Public Clouds, Community Clouds, Private Clouds, Hybrid Clouds. Virtualization Technology: Hardware Independence, Server Consolidation, Operating System-Based Virtualization, Hardware-Based Virtualization, Virtualization Management.	06
	3. Cloud Security	Basic Terms and Concepts- Confidentiality, Integrity, Authenticity, Availability, Threat, Vulnerability, Risk, Security Controls, Security Mechanisms, Security Policies, Threat Agents- Anonymous Attacker, Malicious Service Agent, Trusted Attacker, Malicious Insider, Cloud Security	06

		Threats- Traffic Eavesdropping, Malicious Intermediary, Denial of Service, Insufficient Authorization, Virtualization Attack.	
	4. Cloud Computing Architecture	Fundamental Cloud Architectures- Architecture of Workload Distribution, Resource Pooling, Dynamic Scalability, Elastic Resource Capacity, Service Load Balancing, Cloud Bursting, Elastic Disk Provisioning, Redundant Storage	06
<b>Unit-2</b>	5. Advance cloud computing architecture	Hypervisor Clustering, Load Balanced Virtual Server Instances, Non-Disruptive Service Relocation, Zero Downtime, Cloud Balancing, Resource Reservation, Dynamic Failure Detection and Recovery, Bare-Metal Provisioning, Rapid Provisioning Architecture, Storage Workload Management	06
	6. Cloud Delivery Model Considerations	Building IaaS Environments, Data Centers, Equipping PaaS Environments, Optimizing SaaS Environments, Cloud Delivery Models: The Cloud Consumer Perspective, Working with IaaS Environments, Working with PaaS Environments, Working with SaaS Services	06
	7. Case study	Case study of a Cloud Management and Virtualization software for example Eucalyptus, VMware etc.	12

**Total=48**

**Recommended Books:**

1. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Prentice Hall.
2. John W. Rittinghouse, James F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press.
3. Alfredo Mendoza, "Utility Computing Technologies, Standards, and Strategies", Artech House INC.
4. Bunker, Darren Thomson, "Delivering Utility Computing", John Wiley and Sons Ltd.
5. George Reese, "Cloud Application Architectures", O'reilly Publications.

Title of the course : **Cyber Security**  
 Subject Code : **OECS-911E**  
 Weekly load : **3Hrs** **L T P 3 0 0**  
 Credit : **3**

**Course Outcomes:** At the end of the course, the student will be able to:

CO1	Understand the basic terminologies related to cyber security.
CO2	Acquire knowledge about the type and nature of cyber crimes and as to how report these crimes through the prescribed legal and Government channels.
CO3	Understand the legal framework that exists in India for cyber crimes and penalties and punishments for such crimes.
CO4	Understand the aspects related to personal data privacy and security.
CO5	Get insights into risk-based assessment, requirement of security controls.

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	3	3	3	2	2	3	3	3
CO2	3	3	3	3	2	2	3	2	3	3	2	3	3
CO3	3	3	3	3	1	2	3	2	1	1	3	3	3
CO4	3	3	3	3	1	2	3	3	2	3	1	3	3
CO5	3	3	3	3	2	3	3	3	3	1	1	3	3

### Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	1. Overview of Cyber security	Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies.	10
	2. Cyber crimes	Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cyber-squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake news cyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.	14
	3. Cyber Law	Cyber crime and legal landscape around the world, IT Act,2000 and its amendments and limitation. Cyber crime and punishments, Cyber Laws, Legal and Ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and	08



		Social media, Cyber Laws of other countries, Case Studies.	
<b>Unit-2</b>	4. Data Privacy and Security	Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.	08
	5. Cyber security Management, Compliance and Framework	Cyber security Plan- cyber security policy, cyber crises management plan, Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy. NIST Framework, MITRE Attack TTP's	08

**Total=48**

### **Recommended Books:**

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
5. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1stEdition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning.

# **SEMESTER-IV**

**Title of the course : Dissertation (Part-2)**

**Subject Code : PCCS-921**

**Weekly load : 32 Hrs**

**L T P 0 0 32**

**Credit : 16**

**Course Outcomes: At the end of the course, the student will be able to:**

CO1	Synthesize and apply prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints
CO2	Design and Develop the software with software engineering practices and standards
CO3	Learn effectively presentation and writing skills
CO4	Analyze Database, Network and Application Design methods
CO5	Evaluate the various validation and verification methods

CO/PO Mapping : (Strong(3)/Medium(2)/Weak(1) indicates strength of correlation):													
Cos	Program Outcomes (PO's)/ Program Specific Outcomes (PSO's)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	2	2	3	3
CO3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	3	2	1	3	3
CO5	3	3	3	3	1	3	3	3	3	3	3	3	3

Dissertation (Part-2): In this, the student must select an area from emerging technologies and specify the objectives to be achieved. Evaluation criteria will be based on objectives stated and achieved.