M.Tech, CSE (AI and ML)

Semester Wise Course Structure & Detailed Syllabus

1ST SEM							
THEORY							
SL. NO.	PAPER CODE	PAPER NAME	L	T	P	CONTACT HRS./WEEK	CREDIT
01	PGCSPC101	Mathematical Foundation of Computer Science	3	0	0	3	3
02	PGCSPC102	Advanced Data Structure	3	0	0	3	3
03	PGCSRES101	Research Methodology and IPR	3	0	0	3	3
04	PGCSAUD101	Universal Human Values (Audit paper)	3	0	0	3	0
05	PGCSPEC101	A. Machine Learning B. Data Science	3	0	0	3	3
06	PGCSPEC102	A. Artificial Intelligence B. Distributed Database	3	0	0	3	3
SESSIONAL / PRACTICAL							
01	PGCSPCL101	Advanced Data Structure Lab	0	0	3	3	1.5
02	PGCSPECL101	A. Machine Learning Lab B. Data Science Lab	0	0	3	3	1.5
		Total	18	0	6	24	18

L – Lecture (total lecture 36), T – tutorial, P – practical

Name of the Course	**Mathematical Foundation of Computer Science**
Course Code: PGCSPC101	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 mark)

Objective:

1.	To learn the concept of Eigenvalues, Eigenvectors diagonalization of matrices for understanding Engineering problems.
2.	To understand linear spaces its basis and dimension with corresponding applications in the field of computer sciences
3.	To understand Fourier series representation of Periodic signals.
4.	To understand concept of random variable and probability distribution.
5.	To understand counting techniques and combinatorics in the context of discrete probability.
6.	To learn recurrence relations and generating functions.
7.	To understand Algebraic structures and classify Boolean function.

Pre-Requisite

1.	Discrete Mathematics
2.	Engineering Mathematics (UG level)

Detailed Syllabus

Module	Content	Hrs	Marks
1	**Advanced Linear Algebra:** Vector space, Definitions and examples, Subspace, Union and intersection of subspaces, Linear sum of two subspaces, Linear combination, independence and dependence, Linear span, Generators of vector space, Finite dimensional vector space, Replacement Theorem, Extension theorem, Statement of the result that any two bases of a finite dimensional vector space have same number of elements. Dimension of a vector space, Extraction of basis, formation of basis with special emphasis on Rn ($n \leq 3$), Eigen value and eigenvectors of matrices, Caley Hamilton Theorem, Simple properties of eigen values and eigen vectors- for symmetric and general matrices, Diagonalisation.	10	
2	**Counting Techniques:** Pigeon- hole Principle, Principles of inclusion and exclusions; Recurrence relations: Formulation & Modelling of different counting problems in terms of recurrence relations, Solution of linear recurrence relations with constant coefficients(up to second order) by (i) The iterative method (ii) Characteristic roots method (iii) Generating functions method.	4	
3	**Stochastic Process:** Random variable, Distribution function, Interval estimation, Confidence intervals, Test of hypothesis, Markov process with special emphasis on Markov chain.	6	
4	**Integral Transform:** Fourier Series and Transform: Periodic functions, Trigonometric functions, Trigonometric Series, Fourier series, Dirichlet conditions, Euler formula for Fourier coefficients, Even and Odd functions, Half range series expansion, Parseval's formula. Fourier transform, Properties of Fourier transform, Fourier sine and cosine transform, Convolution theorem, First Fourier transform.	8	
5	**Algebraic Structures and Morphism:** Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Permutation Groups, Normal Subgroups, Quotient group, Homomorphism & Isomorphism (Elementary properties only). Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. Boolean algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function	8	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Recognize** the concept of the terms span, linear independence, basis and dimension and apply these concepts to various vector spaces and subspaces.
CO 2	**Solve** problems involving recurrence relations and generating functions & also countingtechniquesandcombinatoricsinthecontextofdiscreteprobability.
CO 3	**Learn** the ideas of probability, random variable and distribution and their application in engineering environment.
CO 4	**Write** periodic function in terms of sine and cosine terms in Fourier series and also to get knowledge in Fourier transforms.

CO 5	**Solve** problems using counting techniques and combinatorics in the context of discrete probability.
CO6	**Classify** the algebraic structure for a given mathematical problem and evaluate Boolean functions and simplify expressions using the properties of Boolean algebra
Learning Resources:	
1.	C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw – Hill.
2.	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI.
3.	Loknath Debnath–Integral transforms and their Applications.
4.	B. Chakraborty and M.K. Sen–Discrete mathematics.
5.	Koshy–Discrete Mathematics and Application
6.	Jyoti Medhi–Stochastic Process.
7.	S.K. Mapa –Abstract and Linear Algebra.
8.	Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw – Hill
9.	Susanna S. Epp, Discrete Mathematics with Applications,4th edition, Wadsworth Publishing Co. Inc.
10.	Douglas Brent West, Introduction to Graph Theory, Prentice Hall.
11.	B. Davies-Integral transforms and their Applications.
12.	Friedberg, Insel, Spence–Linear Algebra
13.	Clark John, Holton Derek Allan, A First Look at Graph Theory, World Scientific.

Name of the Course		**Advanced Data Structure**	
Course Code: PGCSPC102		**Semester: 1st**	
Duration: 6 month		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory Contact Hrs.: 3 hrs./week		**Mid Semester 1 Exam: 15 Marks**	
Tutorial Contact Hrs.: 0 hrs./week		**Mid Semester 2 Exam: 15 Marks**	
Practical : 0 hrs./week		**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**	
Credit point: 3		**End Semester Exam:75 Marks (**To be mapped into 50 mark)	
Objective:			
1.	To understand the concept of time and space complexity		
2.	To implement balanced trees		
3.	To implement various priority queues		
4.	To analyse various advance data structures such as hashing, tries and suffix trees		
Pre-Requisite			
1.	Data Structure, Algorithm		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	Review of Fundamental Data Structures Recap of basic data structures (arrays, linked lists, stacks, queues) Analysis of time and space complexity Big O notation	4	
2	Advanced Tree Structures Binary search trees (BSTs), AVL trees Red-black trees, B-trees and B*-trees for efficient indexing and searching. Van Emde Boas trees for efficient predecessor/successor search operations	10	
3	Heaps and Priority Queues, Min-heaps and max-heaps, Priority queue operations (insert, delete, extract-min/max) Fibonacci heaps	6	
4	Disjoint set data structure, Union find using array, linked list, union by rank, union by rank and path compression	8	
5	Advanced Techniques, Hashing and collision resolution, Tries and Patricia trees, Suffix trees	8	
Course outcomes			
After completion of the course, a student would be able to:			
CO 1	**Compute** complexities of data structures and algorithms for a given problem.		
CO 2	**Implement** various balanced tree data structures.		
CO 3	**Implement** various Priority Queue data structures.		
CO 4	**Apply** disjoint set data structure		
CO 5	**Design** algorithms using Hashing, Tries and Suffix trees.		
Learning Resources:			
1.	"Introduction to Algorithms,3rd edition", T.H.Cormen, C.E. Leiserson, R.L.Rivest and C. Stein , PHI		
2.	Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson, 2005.		
3.	Skiena, Steven S. The algorithm design manual. Vol. 2. New York: springer, 1998.		

Name of the Course	**Research Methodology and IPR**
Course Code: PGCSRES101	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.):20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks(**To be mapped into 50 marks)

Objective:

1.	To learn the features of Research Methodology
2.	To identify the rules of Copy Right, Design and Trade Mark
3.	To analyse Intellectual Property Rights
4.	To apply for a Patent and defend Patent Prosecution

Pre-Requisite

1.	Nil

Detailed Syllabus

Module	Content	Hrs	Marks
1	Course-based degree and research degree, selection of research topic, the role of supervisor, Academic research and developmental research. Keyword based search and citation based search, cite score and impact factor. Literature survey using Web of Science and Scopus. Database search using Science Direct, Springer Link, Research Gate, Academia.edu, Google Scholar etc. Reference Management Software: Jabref, EndNote, Zotero etc.	10	
2	Investigation and generation of data. First principles model and empirical model. Features and constraints of Technical Presentation. Standard table, graph and image. Technical presentation vs journal paper. Unethical activity: data fabrication and plagiarism.	6	
3	Discrete Probability Distribution and Continuous Probability Distribution.Probability Density Function, Mean and Variance of Probability Density Function. Normal Distribution and Central Limit Theorem. Testing of Hypothesis, Errors in decision making.	6	
4	Definition of IPR, types of Intellectual Property, meaning of "right" in IPR, meaning of "property" in IPR, meaning of "intellectual" in IPR, infringement in IPR, IPR and its duration, Invention and patent, rights of patentee. Process for grant of patent: abstract, description, specification, claims for invention. Filing of Application: Self application or application through Patent Agent. Types of Application: Provisional and Complete Application, Convention Application, International Application under Patent Cooperation Treaty (PCT),	8	
5	Copyright, its features and duration, Design Act, its feature, duration and Hague Agreement. Trade Marks Act, its feature and duration, International application for Trade Mark World Intellectual Property Organization (WIPO), European Patent Office (EPO) Database, Berne Convention, International Bureau (IB) of WIPO.	6	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Explain** the techniques Literature Survey
CO 2	**Interpret** Data Modelling and Technical Presentation
CO 3	**Examine** the concept of Design of Experiments
CO 4	**Apply** for a Patent in the context of IPR
CO 5	**Investigate** different Responsible Organizations for IPR and Database

Learning Resources:

1.	Important Guidelines on Research Methodology by R. S. Agarwal, published by B. R. Publishing Corporation
2.	Research Methodology by Suresh Chandra, published by Narosa Publishing House
3.	Research Methodology by A. K. Ohdedar, published by Bengal Library Association
4.	Text Book of Intellectual Property Rights by N. K. Acharya, published by Asia Law House
5.	Law Relating to Intellectual Property Rights by V. K. Ahuja, published by Lexis Nexis

Name of the Course		**Universal Human Values (UHV)**	
Course Code: PGCSAUD101		**Semester: 1st**	
Duration: 6 month		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory Contact Hrs.: 3 hrs./week		**Mid Semester 1 Exam: 15 Marks**	
Tutorial Contact Hrs.: 0 hrs./week		**Mid Semester 2 Exam: 15 Marks**	
Practical : 0 hrs./week		**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**	
Credit Points: 3		**End Semester Exam:75 Marks (**To mapped into 50 marks)	
Objective:			
1.	To create awareness on engineering ethics, human values and value education.		
2.	To understand social responsibilities of an engineer.		
3.	To develop a holistic perceptive based on self-exploration about themselves, family, society, nature, existence.		
4.	To understand or develop clarity of the harmony in the human being, family, society, nature.		
5.	Development of commitment and courage to act.		
6.	To create awareness on engineering ethics, human values and value education.		
Pre-Requisite			
1.	Nil		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	**Introduction:** Introduction to value education, Engineering ethics: Social responsibilities of an engineer.	6	
2	**Harmony in the human being:** Self exploration, needs of the self and body	6	
3	**The basic need of a healthy society to extend the family:** Understanding harmony between family and society, understanding values in human relationships. Trust and Respect as the foundational values	9	
4	**Develop the right understanding of the harmony at all levels:** Understanding harmony in the nature and existence holistic perception of harmony at all levels of existence include practice session to discuss human being as cause of imbalance in nature.	8	
5	**Implication of the above Holistic Understanding of Harmony on Professional Ethics :**The basis of ethical human conduct. Human rights violation and social disparities issues in professional ethics: value based life and profession.	7	
Course outcomes			
After completion of the course, a student would be able to:			
CO 1	**Understand** the significance of value and starts applying them in their life and profession.		
CO 2	**Distinguish** between self and body, intention and competence, happiness and physical facilities.		
CO 3	**Understands** the role of a human being in ensuring harmony in society and nature		
CO 4	**Distinguish** between ethical and unethical practices and start working out the strategy to actualize a harmonious environment wherever they work.		
CO 5	**Understand** the significance of value and starts applying them in their life and profession.		
Learning Resources:			
1.	A.N. Tripathi, new age international publishers: 2003- Human values. Human Society in Ethics 2 polities-Bertrand Russell.		
2.	Small is beautiful – E.F. Schumacher philosophy of humanism: Corliss Layout. Foundation Course in value Education :Gour .R.R./sangal R.		

Name of the Course	**Artificial Intelligence**
Course Code: PGCSPEC102A	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks(**To be mapped into 50 marks)
Objective:	
1.	The main purpose of this course is to provide the most fundamental knowledge to the students so that they can understand what the AI is.
2.	Apply the basic principles, models and algorithms of AI to recognize model and solve problems in the analysis and design of information systems.

3.	Analyse the structures and algorithms of a selection of techniques related to searching, reasoning and language processing.

Pre-Requisite

1.	Strong knowledge of Mathematics.
2.	Good command over programming languages
3.	Design & Analysis of Algorithm

Detailed Syllabus

Module	Content	Hrs	Marks
1	**Introduction of AI and Agents**: Overview of Artificial Intelligence, Problems of AI, AI technique, Nature of Environment, Intelligent Agents, Structure of Agents, goal based agents, utility based agents, learning agents, Problem solving agents. Knowledge Based Agents.	5	
2	**Problem Solving: Problem Space &Search:** Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.	3	
3	**Search Techniques**: Searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Greedy best-first search, A* search, heuristic search, Hill climbing search, simulated annealing search, the minimax search procedure, alpha-beta pruning, constraint satisfaction problems, Games, optimal decisions & strategies in games.	10	
4	**Knowledge &Reasoning and Representing Knowledge using Rules**: Knowledge representation issues, representation & mapping, approaches to knowledge representation, The First Order Predicate Logic, Semantic Nets, Frames and Scripts Formalisms, Resolution in Predicate Logic, Unification, Strategies for Resolution by Refutation, Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge. Automated Reasoning.	7	
5	**Planning and Learning:** Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques, partial order planning, planning graphs, planning with propositional logic. Forms of learning, inductive learning, Learning from observations learning decision trees, learning using relevance information, neural net learning & genetic learning. Reinforcement Learning, Perception,	5	
6.	**Natural Language Processing, Expert Systems and others:** Introduction, Syntactic processing, semantic analysis, discourse & pragmatic processing, expert system shells, knowledge acquisition, Artificial Neural Networks, Human-Computer Interaction, Hidden Markov Models, Rule-based systems, AI-Based Programming Tools.	6	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Analyse** different types of AI techniques and Agents
CO 2	**Estimate** the problems of Space and Search
CO 3	**Apply** different search techniques that play an important role in AI
CO 4	**Determine** the basic issues of knowledge representation and reasoning
CO 5	**Implement** different planning system and Learning System**.**
CO6	**Apply** Natural Language Processing, Expert Systems and AI-Based Programming Tools

Learning Resources:

1.	Introduction to Artificial Intelligence, E. Charniak, et.al., PEARSON
2.	Artificial Intelligence, P. H. Winston, PEARSON
3.	Artificial Intelligence, E. Rich and K. Knight, TMH.
4.	"Artificial Intelligence: A Modern Approach" Stuart Russell, Peter Norvig,2nd Edition, Prentice Hall
5.	Artificial Intelligence and Expert Systems – Dan W. Patterson PHI
6.	Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson
7.	Artificial Neural Networks , B. Yagna Narayana, PHI
8.	The Handbook of Artificial Intelligence, Vol.1,2 and 3, Kaufman Inc.
9.	Logic & Prolog Programming, Saroj Kaushik, New Age International
10.	PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education

Name of the Course	**Distributed Database**
Course Code: PGCSPEC102B	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0hrs/week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:			
1.	To explain the basic principles of distributed database systems and its architectures		
2.	To evaluate the efficiency of distributed database design and the distributed query processing plans		
3.	To handle different concurrency control anomalies and maintain the reliability of distributed transactions.		
4.	To discuss the overall concept of parallel database systems		
Pre-Requisite			
1.	Database Management System		
2.	Computer Network		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	**Introduction to Distributed Database Management Systems (DDBMS):** Basic idea of DDBMS, homogenous, heterogeneous and federated DDBMS, DDBMS fragmentation, replication and allocation concept, global and local schema, key advantages and reliability of DDBMS, different layers of distribution transparency, complications of DDBMS, reference architecture for distributed DBMS- client/server, peer-to-peer, and multidata base systems, global directory issues in distributed DBMS.	6	
2	**DDBMS Design Aspect:** Design issues of DDBMS, non-replicated, non-fragmented, fully replicated, partially replicated DDBMS, top down & bottom up approach of DDBMS design, reasons for data fragmentation, degree of fragmentation, different type of fragmentations- primary and derived horizontal fragmentation, vertical fragmentation mixed or hybrid fragmentation, correctness rules of fragmentation, data fragment allocation and its associated issues, basic idea of view management- views in centralized and distributed database.	6	
3	**DDBMS Query Processing:** Query processing issues in DDBMS, objectives of distributed query processing, different layers of distributed query processing- query decomposition, data localization, global query optimization, distributed query execution, centralized query optimization- main objectives, query processing with translation and optimization steps, concept of distributed query optimization- distributed query processing architecture, mapping global queries into local queries, main issues of distributed query optimization.	6	
4	**Distributed Transaction Management & Reliability Aspects:** Concept of transaction & its properties, serial and parallel schedule, locking based concurrency control- 2PL & strict 2PL, distributed concurrency control algorithms- centralized & distributed 2PL, time stamp-based concurrency control algorithms, deadlock detection & resolution- centralized, hierarchical and distributed deadlock detection, concept of reliability & different types of failures in DDBMS, idea of local recovery manager, distributed reliability protocols- centralized & distributed 2PC, termination protocol for 2PC-coordinator & participant timeout, non-blocking commit protocol, voting protocol.	12	
5	**Parallel Database Systems:** Basic idea, objectives, parallel database system architectures- functional architecture, shared memory, shared disk, shared nothing & hybrid architecture, concept of database cluster & architecture, parallel data placement- round-robin, hash and range based partitioning, parallel query processing- intra & inter operator parallelism.	6	
Course outcomes			
After completion of the course, a student would be able to:			
CO 1	**Explain** the overall concept of distributed database systems and its different associated components		
CO 2	**Choose** suitable design strategies for the distributed database systems in the aspects of data storage and views		
CO 3	**Analyze** different query processing plans applicable for the distributed database systems		
CO 4	**Compare** various concurrency control mechanisms and recovery issues for distributed database systems		
CO 5	**Discuss** the main idea and features of parallel database system in the aspect of performance benefits		
Learning Resources:			
1.	Stefano Ceri, Guiseppe Pelagatti, "Distributed Databases: Principles and Systems", McGraw Hill Education, Indian Edition, 2017.		
2.	M. Tamer Ozsu, Patrick Valduriez, "Principles of Distributed Database Systems", Springer, Third edition, 2011.		
3.	Saeed K. Rahimi, Frank S. Haug, "Distributed Database Management Systems: A Practical Approach", Wiley-IEEE Computer Society, Aug, 2010, Print ISBN:9780470407455, Online ISBN:9780470602379		
4.	Chhanda Ray, "Distributed Database Systems", Pearson Education India, 1st Edition, Kindle Edition, 2009, ISBN- 9788131727188, 8131727181.		
5.	Sachin Deshpande, "Distributed Databases", Dream tech Press, Kindle Edition, 2014, ISBN 13: 9789351197201		

Name of the Course	**Machine Learning**
Course Code: PGCSPEC101A	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:

1.	Develop an appreciation for what is involved in Learning models from data
2.	Understand a wide variety of learning algorithms
3.	Understand how to evaluate models generated from data
4.	Apply the algorithms to a real problem, optimize the models learned and report on the expected

Pre-Requisite

1.	Mathematics

Detailed Syllabus

Module	Content	Hrs	Marks
1	**Introduction:** Prepare the Data for Machine Learning Algorithms, Data Cleaning, Handling Text and Categorical Attributes, Handling Missing Values, Exploration of Data using Visualization, Types of Machine Learning Systems.	5	
2	**Linear Regression:** Linear regression, Gradient Descent Algorithm for Linear Regression Model, Polynomial model, Regularization, Multi-Collinearity.	7	
3	**Classification:** Training a Binary Classifier, Measuring Performance, Logistic Regression, Multiclass Classifier, Multi-label Classification, Multi-output Classification	8	
4	**Some Supervised Machine Learning Algorithms:** k-Nearest Neighbours (KNN), Naive Bayes Classifiers, Decision Trees, Ensembles of Decision Trees: Random Forests, Support Vector Machines, Model Evaluation and Improvement	7	
5	**Dimensionality Reduction:** Dimensionality Reduction, Feature Extraction, and Manifold Learning, Principal Component Analysis (PCA), Kernel PCA, Selecting a Kernel and Tuning Hyper-parameters, Other Dimensionality Reduction Techniques	7	
6	**Unsupervised Learning:** Clustering: K-Means, Image Segmentation using clustering, Creating Product Segments Using Clustering, Finding Optimal Number of Clusters Using Elbow Curve Method, Normalizing the Features, Hierarchical Clustering, Compare the Clusters Created by K-Means and Hierarchical Clustering, Anomaly Detection using Gaussian Mixtures, Assessment Metrics for Clustering Algorithms.	6	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Describe** the concepts of Machine Learning.
CO 2	**Implement** algorithms of Machine Learning.
CO 3	**Develop** Machine Learning models
CO 4	**Apply** Machine Learning Models to classification and recognition problems.
CO 5	**Design** various Machine Learning algorithms for real-world applications for model optimization.

Learning Resources:

1.	Christopher Bishop. Pattern Recognition and Machine Learning. 2e
2.	Machine Learning by Tom Mitchell, McGraw Hill Education
3.	Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
4.	R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000.

Name of the Course		**Data Science**	
Course Code: PGCSPEC101B		**Semester: 1st**	
Duration: 6 month		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory Contact Hrs.: 3 hrs./week		**Mid Semester 1 Exam: 15 Marks**	
Tutorial Contact Hrs.: 0 hrs./week		**Mid Semester 2 Exam: 15 Marks**	
Practical : 0 hrs./week		**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**	
Credit Points: 3		**End Semester Exam:75 Marks (**To be mapped into 50 marks)	
Objective:			
1.	The course is aimed at Building the fundamentals of data science.		
2.	Imparting design thinking capability to build big-data		
3.	Developing design skills of models for big data problems		
4.	Gaining practical experience in programming tools for data sciences		
5.	Empowering students with tools and techniques used in data science		
Pre-Requisite			
1.	DBMS and e knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	**Introduction:** Big Data and Data Science - Big Data Analytics, Business intelligence vs Big data, big data frameworks, Current landscape of analytics, data visualisation techniques, visualization software.	4	
2	**EDA Exploratory Data Analysis:** Exploratory Data Analysis (EDA), statistical measures, Basic tools (plots, graphs and summary statistics) of EDA, Data Analytics Lifecycle, Discovery	6	
3	**Basic Statistical Inference**: Developing Initial Hypotheses, Identifying Potential Data Sources, EDA case study, testing hypotheses on means, proportions and variances.	6	
4	**Regression models:** Regression models: Simple linear regression, least-squares principle, MLR, Multiple correlation, Partial correlation	6	
5	**Linear Algebra Basics:** Matrices to represent relations between data, Linear algebraic operations on matrices, Matrix decomposition: Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).	6	
	Data Pre-processing and Feature Selection : Data cleaning, Data integration, Data Reduction, Data Transformation and Data Discretization, Feature Generation and Feature Selection, Feature Selection algorithms: Filters, Wrappers, Embedded	7	
	Basic Machine Learning Algorithms: Classifiers, Decision tree, Naive Bayes, k-Nearest Neighbours (KNN), SVM, Ensemble methods, Random Forests, logistic regression, k-means, Association Rule mining	8	
Course outcomes			
After completion of the course, a student would be able to:			
CO 1	**Apply** data visualization in big-data analytics		
CO 2	**Utilise** EDA, inference and regression techniques		
CO 3	**Utilize** Matrix decomposition techniques to perform data analysis		
CO 4	**Apply** data pre-processing techniques		
CO 5	**Apply** Basic Machine Learning Algorithms		
Learning Resources:			
1.	Mining of Massive Datasets. v2.1, Jure Leskovek, Anand Rajaraman and Jefrey Ullman., Cambridge University Press. (2019). (free online)		
2.	Big Data Analytics, paperback 2nd ed., Seema Acharya, Subhasini Chellappan, Wiley (2019)		
3.	Doing Data Science, Straight Talk From The Frontline, Cathy O'Neil and Rachel Schutt, O'Reilly.		
4.	Data Mining: Concepts and Techniques", Third Edition, 2 Jiawei Han, Micheline)		
5.	Kamber and Jian Pei, ISBN 0123814790. Big Data and Business Analytics, Jay Liebowitz, CRC press		
6.	Data mining methods, 24th edition, C. Rajan, Narosa		

Name of the Course	**Advanced data structure lab**
Course Code: PGCSPCL101	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme, Total Marks: 100**
Theory Contact Hrs.: Nil	**Attendance : 10**
Tutorial Contact Hrs.: Nil	**Preparation of Lab Report : 30**
Practical : 3 hrs./week	**Experimental data/ Precision of work done : 30**
Credit Points: 1.5	**Presentation/ analysis of the result : 10**
	Viva Voce: 20

Detailed Syllabus

Module	**Content**	**Hrs**	**Marks**
1	To perform various operations on AVL trees.	3	
2	To perform various operations on B-Trees and B^+ trees	6	
3	To perform various operations on Red Black trees.	3	
4	To implement and compare performance of various priority queues	3	
5	To implement disjoint set data structure and compare the performance based on underlying methodology used.	6	
6.	To implement Hashing and analyse performance of different collision resolution techniques.	6	
7.	To implement Tries and Patricia Tries	6	
8.	To implement Suffix trees	3	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Implement** various balanced search trees
CO 2	**Compare** performance of different priority queue implementations
CO 3	**Implement** Disjoint set data structure
CO 4	**Analyse** hashing techniques
CO 5	**Implement** tries and suffix trees

Name of the Course	**Machine learning lab**
Course Code: PGCSPECL101A	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme, Total Marks: 100**
Theory Contact Hrs.: Nil	**Attendance : 10**
Tutorial Contact Hrs.: Nil	**Preparation of Lab Report : 30**
Practical : 3 hrs./week	**Experimental data/ Precision of work done: 30**
Credit Points: 1.5	**Presentation/ analysis of the result : 10**
	Viva Voce: 20

Detailed Syllabus

Module	**Content**	**Hrs**	**Marks**
1	Implement K-nearest neighbours classification using python.	3	
2	Implement linear regression using python.	3	
3	Implement Naive Bayes theorem to classify the English text using python	6	
4	Implement K-means clustering using python.	3	
5	Write a program to demonstrate the working of decision tree.	3	
6.	Implement K-nearest neighbours classification using python.	3	
7.	Implement linear regression using python.	3	
8.	Implement Naive Bayes theorem to classify the English text using python	6	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Design** and implement machine learning solutions to classification, regression problems.
CO 2	**Apply** appropriate data sets to the Machine Learning algorithms
CO 3	**Identify** and apply Machine Learning algorithms to solve real world problems
CO 4	**Apply** supervised and unsupervised techniques on various data sets.
CO 5	**Evaluate** the machine learning models pre-processed through various feature engineering algorithms by python programming
CO6	**Analyze** the complexity of Machine Learning algorithms and their limitations

Name of the Course	**Data Science lab**
Course Code: PGCSPECL101B	**Semester: 1st**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme, Total Marks: 100**
Theory Contact Hrs.: Nil	**Attendance : 10**
Tutorial Contact Hrs.: Nil	**Preparation of Lab Report : 30**
Practical : 3 hrs./week	**Experimental data/ Precision of work done : 30**
Credit Points: 1.5	**Presentation/ analysis of the result : 10**
	Viva Voce: 20

Detailed Syllabus

Module	Content	Hrs	Marks
1	Introduction to Python – Keywords, identifiers, I/O statements., Sequence and File operations.	6	
2	Functions, loops, Modules, errors and exceptions and Data Manipulation- Basic Functionalities, Merging, Concatenation of data objects, Exploring a Dataset and Analysing a dataset.	3	
3	Data visualization – Graphical and diagrammatical presentation, Descriptive statistical analysis – evaluation, plotting and interpretation	3	
4	Evaluation of probability using various distribution functions	3	
5	Correlation – Simple, Partial and Multiple Correlations for linear and nonlinear data	3	
6.	Regression – Simple, Multiple Regression and linear models	3	
7.	Test for normality and homogeneity of variance-Inferential Statistics for Single through multiple samples	3	
8.	Experimental Design: One way ANOVA- two-way ANOVA- Multiple comparison tests	3	
9.	Time series analysis – White noise, AR, MA, ARMA, ARIMA, ACF and PACF.	3	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**At the end** of the course students will be able to: develop relevant programming techniques of moderate complexity and execute in data science.
CO 2	**Demonstrate** the proficiency in statistical data analysis of inferential methods and interpret the results contextually.
CO 3	**Apply** data science concepts and methods to solve problems in real-world contexts.
CO 4	**Integrate** data from disparate sources and transform in relational databases.

2nd SEM							
THEORY							
SL. NO.	PAPER CODE	PAPER NAME	L	T	P	CONTACT HRS./WEEK	CREDIT
01	PGCSPC203	Deep Learning	3	0	0	3	3
02	PGCSPC204	Advanced Algorithm	3	0	0	3	3
03	PGCSAUD202	Constitution of India (Audit Paper)	3	0	0	3	0
04	PGCSOEC201	A. Soft Computing B. Information Security	3	0	0	3	3
05	PGCSOEC202	A. Advanced Software Engineering B. Big Data Analytics	3	0	0	3	3
SESSIONAL / PRACTICAL							
01	PGCSPCL202	Deep Learning Lab	0	0	3	3	1.5
02	PGCSPCL203	Advanced algorithm Lab	0	0	3	3	1.5
03	PGCSASGN201	Seminar	0	0	6	6	3
		Total	15	0	12	27	18

L – Lecture (total lecture 36), T – tutorial, P – practical

Name of the Course	**Deep Learning**
Course Code: PGCSPC203	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:

1.	Understand the concepts of Tensor Flow, Keras, its main functions, operations and execution.
2.	Implement deep learning algorithms, understand neural networks and traverse the layers of data abstraction which will empower the student to understand data more precisely.
3.	Build deep learning models in Tensor Flow and interpret the results.
4.	Learn topics such as Convolutional neural networks, recurrent neural networks, LSTM, GRU, training deep networks and high-level interfaces.
5.	Understand the Auto encoders, GAN and Reinforcement learning concepts.

Pre-Requisite

1.	Machine learning

Detailed Syllabus

Module	Content	Hrs	Marks
1	Artificial Neural Networks (ANNs), Perceptron, Multi-Layer Perceptron (MLP), Back propagation, Hyper-parameter selection, Activation functions.	10	
2	Training Deep Neural Networks, Vanishing Gradients Problems, Batch Normalization, Optimizers: Ada Grad, RMS Prop, Adam Optimization, Regularization.	6	
3	Convolutional Neural Networks (CNNs), Convolutional Layers, Filters, Pooling strategies, CNN Architectures, Reutilizing Pretrained Layers	6	
4	Recurrent Neural Networks (RNNs), Recurrent Neurons, Training RNNs, LSTM, GRU.	5	
5	Auto encoders and Generative Adversarial Networks (GAN)	4	
6	Reinforcement Learning, Introduction to Open AI Gym, Markov Decision Processes, Q-Learning.	5	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Describe** the concepts of Tensor Flow, Keras, its main functions, operations and execution.
CO 2	**Explain** deep learning algorithms and neural networks.
CO 3	**Develop** models of convolutional neural networks (CNN), recurrent neural networks (RNN), LSTM, GRU, training deep networks and high-level interfaces.
CO 4	**Apply** Deep Learning Models to realise the concepts of Auto encoders and GAN.
CO 5	**Design** Deep Learning algorithms for Reinforcement learning.

Learning Resources:

1.	Christopher Bishop. Pattern Recognition and Machine Learning. 2e
2.	Machine Learning by Tom Mitchell, McGraw Hill Education
3.	Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
4.	R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000.
5.	Good fellow, I., Bengio, Y., and Courville, A., Deep Learning, MIT Press, 2016
6.	Christopher Bishop. Pattern Recognition and Machine Learning. 2e

Name of the Course	**Advanced Algorithm**
Course Code: PGCSPC204	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:

1.	To understand the concept of randomized algorithms and NP completeness
2.	To implement graph theory algorithms

3.	To able to use parametric algorithms in real life practical problems.
4.	To understand the concept of approximate algorithms
Pre-Requisite	
1.	Algorithm

Detailed Syllabus

Module	Content	Hrs	Marks
1	Amortized Analysis	3	
2	NP Completeness: The Class P, Examples of problems in P, The Class NP, Examples of problems in NP, P versus NP, , Polynomial time reducibility, NP-completeness, The Cook–Levin Theorem.	5	
3	Network Flows, Ford-Fulkerson Algorithm, Edmond-Karp Algorithm .Max-Flow Min-Cut Theorem, Bipartite Matching, stable matching	12	
4	Probabilistic Analysis and Randomized algorithms, The hiring Problem, Indicator random variables, Randomized algorithms.	8	
5	Approximate Algorithms, The vertex cover problem, The Travelling Salesman Problem, The set covering Problem,	8	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Analyze** Randomized algorithms for a given problem.
CO 2	**Analyze** problems to decide NP completeness
CO 3	**Apply** graph algorithms to real life problems
CO 4	**Apply** Amortized analysis to various algorithms
CO 5	**Design** approximate algorithms for problems.
Learning Resources:	
1.	"Introduction to Algorithms, 3rd edition", T.H.Cormen, C.E. Leiserson, R.L.Rivest and C. Stein , PHI
2.	Randomized •algorithms, Rajeev Motwani, PrabhakarRaghavan, Cambridge University Press
3.	Skiena, Steven S. The algorithm design manual. Vol. 2. New York: springer, 1998.
4.	Approximation Algorithms, Vazirani, Vijay V, 2003, Springer.

Name of the Course	**Constitution of India**
Course Code: PGCSAUD202	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 0	**End Semester Exam:75 Marks (**To be mapped into 50 marks)
Objective:	
1.	Resolve to proclaim India as an Independent sovereign republic.
2.	To learn about the Nature-Specialty and Proposal of Indian Constitution.
3.	To establish a democratic Union with an equal level of self government for all the constituent parts
4.	All power and authority of the union government and governments of the constituent parts are derived from the people.
5.	To gain knowledge about the Indian Jurisdiction and conceptualization of social reforms that lead to revolution in India.
Pre-Requisite	
1.	Constitution of India

Detailed Syllabus

Module	Content	Hrs	Marks
1	**History of Making of the Indian Constitution:** Sources and constitutional history, Drafting Committee, Features: Citizenship, Preamble and Proposal of Indian Constitution.	3	
2	**Contours of Constitutional Rights& Duties**: Fundamental Rights, Right On: Equality, Freedom, Against Exploitation, Freedom of Religion, Cultural and Educational Rights, Constitutional Remedies. Directive Principles of State Policy. Fundamental Duties.	4	
3	**Union government and its administration:** Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, Rajya Sabha. State government and its administration: Governor: Role and Position, CM and Council of ministers, State Secretariat: Organization, Structure and Functions.	6	

4	**Local Administration**: District's Administration: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative. Block level: Organizational Hierarchy (Different departments). Panchayati raj: Introduction, Importance and role.	3	
5	**Election Commission**: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	3	
6	**Jurisdiction:** Supreme court: Organization of supreme court, procedure, jurisdiction and power of the supreme court. High court: Organization of high court, procedure, jurisdiction and power of high court. Subordinate courts: constitutional provision, structure and jurisdiction. National legal services authority, gram nyayalays. Public interest litigation (PIL): meaning of PIL, features, scope, principle, guidelines for admitting PIL.	5	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Have** general knowledge and legal literacy about Indian Constitution and thereby it helps to take up competitive examinations & to manage/face complex societal issues in society.
CO 2	**Explain** about different features of Indian constitution. Fundamental Rights & their duties
CO 3	**Identify** the power and functioning of Union, state and local self-government. Understand state and central policies (Union and State Executive).
CO 4	**Understand** Electoral Process and special provisions in Constitution. Explain about jurisdiction and function of Indian Judiciary. Using the basics of PIL and guideline for admission of PIL along with the functioning of local administration starting from block to municipal Corporation.
CO 5	**Applying** the authority to redress a problem in the profession and in the society. Demonstrate the intellectual origins of the framework of argument that informed the conceptualization of social

Learning Resources:	
1.	Indian polity, M, Laxmikanth, MC Graw Hill education, 5th Edition.
2.	Indian Constitution, M P Jain,8th Edition.
3.	Indian Constitution and Administration, LatikaShekhar.
4.	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.
5.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
6.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice – Hall EEE, 19th / 20th Edn., (Latest Edition) or 2008.
7.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.
8.	M.V. Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
9.	Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi.

Name of the Course	**Soft Computing**
Course Code: PGCSOEC201A	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:	
1.	To understand basic soft computing techniques
2.	To learn how to use soft computing technique for a particular problem
3.	To implement hybrid soft computing techniques
Pre-Requisite	
1.	Discrete Mathematics
2.	Design and Analysis of Algorithm

Detailed Syllabus

Module	**Content**	**Hrs**	**Marks**
1	**Introduction:** Concept of computing systems, Characteristics of Soft computing, some applications of Soft computing techniques, Different learning methods: Supervised, Unsupervised & reinforced; Simple Clustering algorithm, k-means & k-medoid based algorithm.	4	
2	**Artificial Neural Network:** Basic concept of neural networks, Mathematical model, Typical architectures: single layer, multilayer, Common activation functions; basic models, Perceptron, Multilayer feed forward network, Back propagation, ADALINE, MADALINE, Different issues regarding convergence of Multilayer Perceptron, Self-Organizing Feature Maps.	8	

3	**Fuzzy Logic:** Fuzzy Sets, Basic Definitions and Terminology, membership function, Set-theoretic operation. Fuzzy union, intersection and complement, various T-norm and T-conorm operators, Fuzzy Relations. Fuzzy Logic, Approximate Reasoning, Compositional Rule of Inference.	5	
4	**Evolutionary Algorithms:** Genetic Algorithms: Simple GA, Encoding Techniques, Crossover, mutation, inversion and deletion, Multi-objective Genetic Algorithm (MOGA). Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering Algorithm. Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).	12	
5	**Hybrid Soft Computing Techniques:** Neuro-fuzzy hybrid algorithm, genetic neuro hybrid algorithm, fuzzy-genetic hybrid algorithm, genetic-fuzzy hybrid algorithm, GA-PSO hybrid algorithm.	7	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Understand** the concept of soft computing
CO 2	**Explain** fuzzy sets and represent these sets by membership functions
CO 3	**Compare** the relation between real brains and simple artificial neural network models
CO 4	**Analyze** Evolutionary algorithms for single and multiple objective optimization problem
CO 5	**Design** Neuro fuzzy and other hybrid approaches of soft computing techniques for problem solving
Learning Resources:	
1.	"Neuro-Fuzzy and Soft computing", Jang, Sun, Mizutani, PHI
2.	"Neural Networks: A Comprehensive Foundation", Simon Haykin, Prentice Hall.
3.	"Genetic Algorithms in search, Optimization & Machine Learning", David E. Goldberg, Pearson/PHI
4.	"Fuzzy Sets and Fuzzy Logic: Theory and Applications", George J. Klir and Bo Yuan, Prentice Hall
5.	S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI
6.	Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley and Sons.
7.	D. Ruan, Intelligent Hybrid Systems, Kluwer Academic Publisher, 1997.

Name of the Course	**Information Security**
Course Code: PGCSOEC201B	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:	
1.	To realize the importance of data security practices in the aspect of critical data transmission
2.	To explain some of the common cryptographic and data hiding solutions with their effectiveness
3.	To illustrate a practical approach of authentication in the aspect of secret image sharing
4.	To plan some of the security solutions for user authentication and sensitive data validation
Pre-Requisite	
1.	Computer Network

Detailed Syllabus

Module	Content	Hrs	Marks
1	**Introductory Concepts on Information Security:** Need for information security, security models, major principles of security- authentication, confidentiality, integrity, non-repudiation, access control and availability, classification of different attacks- application-level and network-level attacks, malicious software based attacks, packet sniffing, packet spoofing	6	
2	**Symmetric Key Cryptographic Concepts:** plaintext & cipher text, issues of key ranges and sizes, Diffie-Helman Key exchange algorithm, man in the middle attack, idea of cryptanalysis, cipher text formation with substitution & transposition techniques, idea of stream & block cipher, symmetric key encryption algorithm- DES, double & triple DES, AES	10	
3	**Asymmetric Key Cryptographic Concepts:** Basic idea, comparison of both symmetric and asymmetric key cryptography, asymmetric key encryption with RSA, concept of digital signature with message digest or hashing, combining both symmetric and asymmetric key encryption concept for secure data transmission.	6	
4	**Data Hiding Concepts for Security:** Basic idea, use of steganography, combining cryptographic and stenographic concepts for	8	

	security, stenographic techniques- spatial and transform domain with their comparisons and examples, concept of watermarking and their classifications, idea of multi-watermarking, attacks related to watermarking, data hiding quality matrices- PSNR, MSE, Image Fidelity, CC etc.		
5	**User Authentication Mechanism:** password based authentication and its related issues, random challenge based authentication, certificate based authentication, idea of visual cryptography- share generation concept in visual cryptography, use of visual cryptographic concept with image steganography for digital signature implementation	6	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Understand** the scope of information security in the context of various attacks
CO 2	**Use** Symmetric Key cryptography for secret data communication
CO 3	**Explain** the role of asymmetric key cryptography for secure and trusted data communication
CO 4	**Illustrate** data hiding mechanism for authentication and secure data transmission
CO 5	**Outline** some data security solutions in the context of both user and document validations
Learning Resources:	
1.	William Stallings, Cryptography and Network Security Principles and Practices, 5th Edition, Prentice Hall
2.	C. Kaufman, R. Perlman and M. Speciner, Network Security: Private communication, 2nd Edition, Pearson Education
3.	Atul Kahate, Cryptography & Network Security, 3rd Edition, McGraw Hill Education (India) Private Limited
4.	Merike Kaeo, Designing Network Security, 2nd Edition, Pearson Books
5.	Information Hiding: Steganography and Watermarking: attacks and countermeasures, Neil F. Johnson, Zoran Duric, Sushil Jajodia, Springer Science & Business Media, 2001
6.	Digital Watermarking and Steganography: Fundamentals and Techniques, Frank Y. Shih, Second Edition, CRC Press, 2017

Name of the Course	**Advanced Software Engineering**
Course Code: PGCSOEC202A	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:	
1.	To learn the different models for the development of a software product
2.	To explore the designing, coding and testing to develop software product
3.	To asses quality of software product to sustain in the market
Pre-Requisite	
1.	Fundamentals of Programming knowledge, C, C++ etc.

Detailed Syllabus

Module	**Content**	**Hrs**	**Marks**
1	**Software Development Process Models:** Waterfall, Spiral, Prototyping, RAD, Evolutionary, Software Requirement and Feasibility Analysis, Cost- Benefit Analysis, etc.	5	
2	**Software Design:** Context Diagram, DFD, Data Dictionary, ER diagram, Decision Tree, Decision Table, Structured Chart, Structured English, Top-Down and Bottom-Up design, Modular Programming, Module Relationship- Coupling, Cohesion, Functional vs. Object-Oriented approach, Design for Mobility, Pattern Based Design.	5	
3	**Object Oriented Software Designing with UML:** Basic idea of Object Oriented Modelling & its purpose, Primary goals of UML, static, dynamic and functional aspects of UML, purpose of different diagrams in UML- class, object and interface diagram, class association, dependencies, multiplicity of association, aggregation, brief idea of use case diagram, sequence diagram, collaboration diagram, state chart and transition diagram, activity and deployment diagram, concept of packages,	7	
4	**Software Quality:** Quality Attributes, Total Quality Management, Software Quality Assurance and Quality Control, Reliability, Reliability Models, SEI CMM and ISO 9001. PSP and Six Sigma. Clean room Technique. Software reuse, Software Maintenance.	6	
5	**Software Testing:** Software Testing Strategy, Unit Testing, Integration Testing, System Testing, Debugging, White-Box Testing, Basis Path Testing, Control Structure Testing, Black-Box Testing, Verification, Validation, Cyclomatic Complexity.	5	

6	**Software Project Management& Software Configuration Management:** Software Project Management Concepts, Software Project Management Plan, Tools for Project Plan – WBS, PERT, GANTT, Project Scheduling & Monitoring, Staffing, Cost Estimation, COCOMO, Software Reengineering Process model, Software Configuration Management (SCM), SCM Repository.	8	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Differentiate** among different types of SDLC models.
CO 2	**Assess** the quality of software
CO 3	**Examine** various testing techniques
CO 4	**Review** the activity of software project management with CASE study
Learning Resources:	
1.	Software Engineering: A practitioner's approach– Pressman (TMH)
2.	Software Engineering: Pankaj Jalote (Wiley-India)
3.	Software Engineering: Rajib Mall (PHI)
4.	Software Engineering: Agarwal and Agarwal, (PHI)
5.	Software Engineering: Sommerville, Pearson
6.	Fundamentals of Software Engineering – C. Ghezzi, M. Jazayeri, D. Mandrioli
7.	Software Engineering Martin L. Shooman,– TMH

Name of the Course	**Big Data Analytics**
Course Code: PGCSOEC202B	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)

Objective:	
1.	To study the basic technologies that forms the foundations of Big Data Analytics
2.	Provide an overview of Apache Hadoop, HDFS Concepts and Interfacing with HDFS
3.	To understand the specialized aspects of big data including big data application, and big data analytics.
4.	Increasing operational efficiency by understanding where bottlenecks are and how to fix them.
Pre-Requisite	
1.	Strong knowledge of DBMS
2.	Good command over programming languages
3.	Basic Mathematics and Statistics

Detailed Syllabus

Module	Content	Hrs	Marks
1	**Introduction to Big Data**: History of big data, Elements of big data, why big data, Unstructured data, Data Storage and Analysis, Characteristics of Big Data, Using big data in businesses, Challenges in Big Data Analytics.	5	
2	**Technologies for handling Big Data:** History and overview of Hadoop, Functioning of Hadoop, limitations of RDBMS, RDBMS versus Hadoop, Cloud Computing for big data, Distributed computing challenges, Analyzing Data with Hadoop, Hadoop Streaming, Use case of Hadoop, Processing data with Hadoop, Managing resources and applications with Hadoop YARN (Yet another Resource Negotiator).	3	
3	**HDFS(Hadoop Distributed File System)**: Hadoop distributors, the Design of HDFS, HDFS Concepts, Command Line Interface, Apache Hadoop, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O (Compression, Serialization, Avro and File-Based Data structures).	10	
4	**Map Reduce**: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	7	
5	**Hadoop Eco System: Pig**(Introduction to Pig, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators), **Hive** (Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions) **Hbase** (H Basics, Concepts, Clients, Example, Hbase Versus RDBMS) **Big SQL** (Introduction), Interacting with Hadoop Ecosystem.	5	
6	**Apache Spark:** The basic usage of Spark and examples, how to use Spark and its different components.	6	

7	**Data Analytics with R:** Machine Learning (Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering) Big Data Analytics with R, Integrating R and Hadoop.		

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Understand** Big Data and its analytics in the real world
CO 2	**Analyze** the Big Data framework like Hadoop and NOSQL to efficiently store and process Big Data to generate analytics
CO 3	**Design** of Algorithms to solve Data Intensive Problems using Map Reduce Paradigm
CO 4	**Design and Implementation** of Big Data Analytics using pig and spark to solve data intensive problems and to generate analytics
CO 5	**Implemen**t Big Data Activities using Hive
CO 6	**Apply** Machine Learning Techniques using R.

Learning Resources:	
1.	V.K. Jain, Big Data and Hadoop, Khanna Publishing House, New Delhi(2017).
2.	V.K. Jain, Data Analysis, Khanna Publishing House, New Delhi (2019).
3.	Tom White "Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
4.	Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
5.	Bahga, Arshdeep and Vijay Madisetti, Big data science & analytics: A hands-on approach,(1e),VPT,2016.
6.	EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data,(1e),John Wiley & Sons, 2015.
7.	Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
8.	Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
9.	Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.
10.	Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007
11.	Pete Warden, "Big Data Glossary", O'Reily, 2011.
12.	Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.
13.	Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", MC Press, 2012

Name of the Course	**Deep learning lab**
Course Code: PGCSPCL202	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme, Total Marks: 100**
Theory Contact Hrs.: Nil	**Attendance : 10**
Tutorial Contact Hrs.: Nil	**Preparation of Lab Report : 30**
Practical : 3 hrs./week	**Experimental data/ Precision of work done : 30**
Credit Points: 1.5	**Presentation/ analysis of the result : 10**
	Viva Voce: 20

Detailed Syllabus

Module	**Content**	**Hrs**	**Marks**
1	Implementing Feedforward neural networks with Keras and Tensor Flow.	3	
2	Building Image classification model with CNN architectures	6	
3	Object detection using Transfer Learning of CNN architectures	6	
4	Using Auto encoder to implement anomaly detection.	3	
5	Regression using Deep Neural network.	6	
6.	Classification using Deep neural network.	6	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Learn** the Fundamental Principles of Deep Learning.
CO 2	**Identify** the Deep Learning Algorithms for Various Types of Learning Tasks in various domains.
CO 3	**Implement** Deep Learning Algorithms and Solve Real-world problems.
CO 4	**Understand** the basic concepts of deep neural network model and design the same.
CO 5	**Apply** basic data pre-processing and tuning techniques. (Cognitive Knowledge Level

Name of the Course	**Advanced Algorithm lab**
Course Code: PGCSPCL203	**Semester: 2nd**
Duration: 6 month	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme, Total Marks: 100**
Theory Contact Hrs.: Nil	**Attendance : 10**
Tutorial Contact Hrs.: Nil	**Preparation of Lab Report : 30**
Practical : 3 hrs./week	**Experimental data/ Precision of work done : 30**
Credit Points: 1.5	**Presentation/ analysis of the result : 10**
	Viva Voce: 20

Detailed Syllabus

Module	**Content**	**Hrs**	**Marks**
1	Implement median order statistics using random partition function and compare the performance with classical partition function.	3	
2	Execute randomized quick sort and compare performance with fixed pivot quicksort.	3	
3	Implement network flow algorithms	3	
4	Implement matching algorithms	3	
5	Design approximate algorithms for problems	3	
6.	Use reduction to solve unknown problems using algorithms for known problems	3	

Course outcomes

After completion of the course, a student would be able to:

CO 1	**Implement** randomized algorithms
CO 2	**Analyze** network flow algorithms
CO 3	**Implement** Matching algorithms
CO 4	**Apply** reductions to solve problems
CO 5	**Design** Approximate algorithms for problems

3rd SEM							
THEORY							
SL. NO.	PAPER CODE	PAPER NAME	L	T	P	CONTACT HRS./WEEK	CREDIT
01	PGCSPEC303	A. Robotics B. Natural Language Processing C. Internet of Things	3	0	0	3	3
SESSIONAL / PRACTICAL							
01	PGCSPRJ301	Dissertation-I	0	0	26	26	13
		Total	3	0	26	29	16

L – Lecture (total lecture 36), T – tutorial, P – practical

Name of the Course	**Robotics**		
Course Code: PGCSPEC303A	**Semester: 3rd**		
Duration: 6 month	**Maximum Marks: 100**		
Teaching Scheme	**Examination Scheme**		
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**		
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**		
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**		
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)		
Objective:			
1.	Building the fundamentals of Robotics		
2.	Imparting design thinking capability to build Robot		
3.	For modelling create a useful mathematical representation of a physical system		
4.	Gaining practical experience in programming tools and techniques used in Robotics for Robotics		
5.	Empowering students with the knowledge of different tools used in robotics		
6.	Develop control logics to make the system follow a given trajectory and react to unexpected obstacles.		
Pre-Requisite			
1.	Basic Mathematics and knowledge of Programming		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	**ROBOT BASICS** Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations: Cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot.	5	
2	**ROBOT ELEMENTS** End effectors-Classification, Types of Mechanical (Hydraulic and Pneumatic) actuation, Basic concepts of Gripper design, Robot drive system Types, Position and velocity feedback devices, Robot joints and links, Motion interpolation.	7	
3	**ROBOT KINEMATICS AND CONTROL** Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming	7	
4	**SYSTEM MODELLING AND STABILTY ANALYSIS** Introduction to system modelling, application of Laplace Transform, Block diagrams, Time response of first and second order system, analysis of stability of a system, introduction to controllers	6	
5	**ROBOT SENSORS** Sensors in robot – Touch sensors-Tactile sensor, Proximity and range sensors. Force sensor, Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.	6	
6	**ROBOT APPLICATIONS** Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defence, Disaster management. Applications, Micro and Nan robots, Future Applications	5	
Course outcomes			
After completion of the course, a student would be able to:			
CO 1	**Explain** the basic elements of industrial robots		
CO 2	**Analyze** robot kinematics and robotic control methods.		

CO 3	**Develop** the concept of system modelling and stability.
CO 4	**Classify** the various sensors used in robots.
CO 5	**Summarize** various industrial and non-industrial applications of robots
Learning Resources:	
1.	Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, "Industrial Robotics Technology, Programming and Applications", Tata –McGraw Hill Pub. Co., 2008.
2.	Deb. S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
3.	Klafter. R.D, Chmielewski. T.A, and Noggin's., "Robot Engineering: An Integrated Approach"', Prentice Hall of India Pvt. Ltd., 1994.
4.	Fu. K.S, Gonzalez. R.C & Lee. C.S.G, "Robotics control, sensing, vision and intelligence", Tata- McGraw Hill Pub. Co., 2008.
5.	Yu. "Industrial Robotics", MIR Publishers Moscow, 1985.
6.	Peter Corke, Robotics, Vision and Control, Springer, 2011
7.	Kelly, A, Mobile Robotics: Mathematics, Models, and Methods, Cambridge
8.	Roland Siegwart, Illah R. Nourbakhsh and Davide Scaramuzza, Introduction to Autonomous Mobile Robots, Second Edition, MIT Press 2011

Name of the Course	**Natural language processing**		
Course Code: PGCSPEC303B	**Semester: 3rd**		
Duration: 6 month	**Maximum Marks: 100**		
Teaching Scheme	**Examination Scheme**		
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**		
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**		
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**		
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)		
Objective:			
1.	To get an overall idea of the characteristics of natural languages and the phases in NLP.		
2.	To understand the issues in representation of texts in a computer, and the standards.		
3.	To understand how words are formed in a natural language, and how to analyse words for NLP.		
4.	To understand how the role of words or groups of words in a sentence have to be determined so as to recognise the syntactic structures of sentences.		
Pre-Requisite			
1.	Machine Learning		
2.	Python		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	**Overview of Natural Language Processing:** Text Analytics and NLP; Different NLP Steps; Tokenization; PoS Tagging; Stop Word Removal; Text Normalization; Spelling Correction; Lemmatization; Stemming; Named Entity Recognition (NER); Word Sense Disambiguation; Sentence Boundary Detection.	5	
2	**Approaches for Feature Extraction:** Data Categorization, Text Cleaning and Tokenization, extracting n-grams, Tokenizing Text, Regexp Stemmer, The Porter Stemmer, and Other Tokenizers Lemmatization, Singularization and Pluralization of Words, Language Translation, Removal of Stop Words from Text, Bag of Words (BoW), Creating a Bag of Words, Zipf's Law, Feature Extraction from Texts. Other Visualizations: Term Frequency-Inverse Document Frequency (TF-IDF), Feature Engineering, Word Clouds Dependency Parse Trees and Named Entities.	6	
3	**Creating a Classifier for Text:** Building a Text Classifier, Extracting Features, Engineering Features, Eliminating Correlated .Features, Eliminating Highly Correlated Features (Tokens), Finding the RMSE and MAPE of a Dataset, assessing a Model's Performance, and Carrying Out Dimensionality Reduction Using Principal Component Analysis.	5	
4	**Topic Modelling**: Topic exploration, converting unstructured to organized data, Algorithms for Topic-Modelling, The Operation of Latent Semantic Analysis (LSA) Using Latent Semantic Analysis to Examine Wikipedia World Cup Articles Latent Dirichlet Allocation (LDA): An Overview of Its Operation, Dirichlet Process and Distribution Using the LDA Model to Find Topics.	5	
5	Creation of Text, Summarization, and Vector representation: Vector, Document Vectors, Uses of Document Vectors, Converting News Headlines to Document Vectors, Finding Similar News Articles Using Document Vectors, Generating Text using Markov Chains, Text Summarization.	5	

6	**Large Language Models** (LLM), Concepts behind LLMs, Transformers: Transformer architecture, the encoder and the decoder, Computing the output of the self-attention layer, Embedding layers in the Transformer, Residuals and normalization. ChatGPT and Google BARD, GPT Models	5	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Describe** the concepts of Natural Language Processing.
CO 2	**Demonstrate** understanding of Approaches for Feature Extraction.
CO 3	**Create** a Classifier for Text
CO 4	**Develop** systems for Using APIs and Web Scraping to Gather Text Data.
CO 5	**Describe** Topic Modelling
Learning Resources:	
1.	Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009
2.	Siddiqui T., Tiwary U. S.. Natural language processing and Information retrieval, OUP, 2008

Name of the Course	**Internet of Things**		
Course Code: PGCSPEC303C	**Semester: 3rd**		
Duration: 6 month	**Maximum Marks: 100**		
Teaching Scheme	**Examination Scheme**		
Theory Contact Hrs.: 3 hrs./week	**Mid Semester 1 Exam: 15 Marks**		
Tutorial Contact Hrs.: 0 hrs./week	**Mid Semester 2 Exam: 15 Marks**		
Practical : 0 hrs./week	**Other Assessment tools (Assignment, Quiz etc.): 20 Marks**		
Credit Points: 3	**End Semester Exam:75 Marks (**To be mapped into 50 marks)		
Objective:			
1.	To understand the application areas of IOT .		
2.	To realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.		
3.	To understand building blocks of Internet of Things and characteristics.		
Pre-Requisite			
1.	Computer Networks		
Detailed Syllabus			
Module	**Content**	**Hrs**	**Marks**
1	**Introduction:** What is IoT, Genesis of IoT, IoT Impact, Convergence of IT and oT, IoT Challenges, IoT Network Architecture and Design, Physical design of IoT, Logical design of IoT, A simplified IoT Architecture.	9	
2	**Major components of IoT:** IoT enabling Technologies, Sources of IoT, M2M Communication, M2M Architecture, Difference between M2M and IoT, Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology.	8	
3	**Smart Objects: The "Things" in IoT:** Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart objects, Working Principles of sensors, Introduction to Arduino Uno, and Raspberry PI, Features and application of arduino uno.	6	
4	**Securing Internet of Things :** Security Requirements in IoT Architecture - Security Concerns in IoT Applications. Cryptographic primitives and its role in Digital Signatures and light weight cryptography, Cryptographic controls built into IoT messaging and communication protocols.	8	
5	**Recent trends in smart sensor for day to day life:** Real world applications for IoT: IoT based home automation with security features, Smart farming: IoT based system for smart agriculture, IoT application to improvise industrial automation, – Smart Healthcare systems etc.	5	

Course outcomes	
After completion of the course, a student would be able to:	
CO 1	**Explain** general concepts of Internet of Things (IoT).
CO 2	**Construct** various M2M and IoT architectures.
CO 3	**Analyze** the deployment of smart objects and the technologies to connect them to network.
CO 4	**Evaluate** security principles and methodologies using Cryptography for Internet of Things.
CO 5	**Design** different real world applications.
Learning Resources:	
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things".

2.	Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017 .
3.	Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing.
4.	Jeeva Jose, Internet of Things, Khanna Publishing House
5.	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014. (ISBN: 978-8173719547)
6.	Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill

4Th SEM							
SL. NO.	PAPER CODE	PAPER NAME	L	T	P	CONTACT HRS./WEEK	CREDIT
SESSIONAL / PRACTICAL							
01	PGCSPRJ402	Dissertation-II	0	0	32	32	16
02	PGCSASGN402	Comprehensive Viva-Voce	0	0	0	0	2
		Total	0	0	32	32	18