

**ANNA UNIVERSITY, CHENNAI**  
**NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY**  
**M.TECH. INFORMATION TECHNOLOGY**

**REGULATIONS – 2021**  
**CHOICE BASED CREDIT SYSTEM**

**1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

To produce graduates who will be able to:

- I. Provide suitable IT solutions to challenging problems in their profession by applying the best practices.
- II. Apply their knowledge and skills to analyse, design, test and implement various IT support systems and be engaged in life - long learning.
- III. Respond to the technological changes in Information Technologies and to foster related research to meet the needs of the society.
- IV. To work collaboratively on multidisciplinary projects and exhibit high levels of professional and ethical values within the organization and society at large.
- V. Become entrepreneurs and show their leadership and technical skills to develop innovative IT solutions to address the challenges of a sustainable ecosystem.

**2. PROGRAM SPECIFIC OUTCOMES (PSOs) :**

PSO1: Identify, formulate and solve engineering problems by applying mathematical foundations, algorithmic principles and design techniques in IT environment to meet industrial challenges.

PSO2: Analyse and recommend the suitable IT solutions required for the implementation of a software systems

PSO3: Apply the known facts and use modern tools to provide innovative solutions in the domain of Information technology

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**CHOICE BASED CREDIT SYSTEM**  
**I TO IV SEMESTERS CURRICULA AND 1<sup>st</sup> SEMESTER SYLLABI**  
**SEMESTER I**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	MA4108	Applied Probability and Statistical Analysis	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	CP4151	Advanced Data Structures and Algorithms	PCC	3	0	0	3	3
4.	CP4152	Database Practices	PCC	3	0	2	5	4
5.	CP4153	Network Technologies	PCC	3	0	0	3	3
6.	CP4252	Machine Learning	PCC	3	0	2	5	4
7.		Audit Course – I*	AC	2	0	0	2	0
<b>PRACTICALS</b>								
8.	CP4161	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
9.	IF4111	Applied Probability and Statistical Analysis Laboratory	PCC	0	0	2	2	1
<b>TOTAL</b>				<b>19</b>	<b>1</b>	<b>10</b>	<b>30</b>	<b>23</b>

\*Audit course is optional

**SEMESTER II**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	IF4201	Software Industrialization	PCC	3	0	0	3	3
2.	IF4251	Full stack Web Application Development	PCC	3	0	2	5	4
3.	BD4251	Big Data Mining and Analytics	PCC	3	0	0	3	3
4.	CP4251	Internet of Things	PCC	3	0	2	5	4
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
<b>PRACTICALS</b>								
8.	IF4211	Term Paper and seminar	EEC	0	0	2	2	1
<b>TOTAL</b>				<b>20</b>	<b>0</b>	<b>6</b>	<b>26</b>	<b>21</b>

\*Audit course is optional

### SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>THEORY</b>								
1.	IF4301	Information and Network Security	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
<b>PRACTICALS</b>								
5.	IF4311	Project Work I	EEC	0	0	12	12	6
<b>TOTAL</b>				<b>12</b>	<b>0</b>	<b>14</b>	<b>26</b>	<b>19</b>

### SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
<b>PRACTICALS</b>								
1.	IF4411	Project Work II	EEC	0	0	24	24	12
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>24</b>	<b>24</b>	<b>12</b>

TOTAL NO. OF CREDITS: 75

PROGRESS THROUGH KNOWLEDGE

**PROFESSIONAL ELECTIVES**

**SEMESTER II, ELECTIVE I**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MU4251	Digital Image Processing	PEC	3	0	0	3	3
2.	IF4001	Game Development	PEC	3	0	0	3	3
3.	MP4152	Wireless Communications	PEC	3	0	0	3	3
4.	IF4071	Compiler Optimization Techniques	PEC	3	0	0	3	3
5.	IF4002	Multimedia Coding Techniques	PEC	3	0	0	3	3

**SEMESTER II, ELECTIVE II**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IF4072	Computer Vision	PEC	3	0	0	3	3
2.	MP4073	Human Computer Interaction	PEC	3	0	0	3	3
3.	IF4003	Cyber Forensics	PEC	3	0	0	3	3
4.	ML4151	Artificial Intelligence	PEC	3	0	0	3	3
5.	MU4153	Principles of Multimedia	PEC	3	0	0	3	3
6.	NE4072	Wireless Sensor Networks and Protocols	PEC	3	0	0	3	3

**SEMESTER III, ELECTIVE III**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CP4076	Information Retrieval Techniques	PEC	3	0	0	3	3
2.	IF4079	Social Network Analysis	PEC	3	0	0	3	3
3.	IF4077	GPU Computing	PEC	3	0	0	3	3
4.	IF4080	Visualization Techniques	PEC	3	0	0	3	3
5.	IF4074	Design Thinking	PEC	3	0	0	3	3
6.	IF4078	Pattern Recognition	PEC	3	0	0	3	3

**SEMESTER III, ELECTIVE IV**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IF4004	Block Chain and Crypto Currency	PEC	3	0	2	5	4
2.	IF4076	Distributed and Scalable Architecture	PEC	3	0	2	5	4
3.	IF4005	Forecasting and Optimization	PEC	3	0	2	5	4
4.	IF4073	Deep Learning	PEC	3	0	2	5	4
5.	IF4075	DevOps and Microservices	PEC	3	0	2	5	4
6.	MP4252	Mobile Application Development	PEC	3	0	2	5	4
7.	CP4253	Multicore Architecture and Programming	PEC	3	0	2	5	4
8.	BC4251	Ethical Hacking	PEC	3	0	2	5	4
9.	MU4151	Advanced Graphics and Animation	PEC	3	0	2	5	4

**AUDIT COURSES (AC)**

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

PROGRESS THROUGH KNOWLEDGE

**COURSE OBJECTIVES :**

- To provide students with basic concepts of probability theory.
- To gain knowledge about two dimensional random variable and its regression, correlations.
- To decide whether to accept or reject a specific value of the parameters.
- To provide the most appropriate interval estimator of the parameters in statistical inferences.
- To avoid or at least minimize, the problems of estimating the effects of the independent variables by experimental designs.

**UNIT I PROBABILITY AND RANDOM VARIABLES 12**

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

**UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12**

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

**UNIT III TESTING OF HYPOTHESIS 12**

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

**UNIT IV ESTIMATION THEORY 12**

Interval estimation for population mean - Standard deviation - Difference in means, proportion ratio of standard deviations and variances.

**UNIT V DESIGN OF EXPERIMENTS 12**

Completely randomized design – Randomized block design – Latin square design –  $2^2$  Factorial design.

PROGRESS THROUGH KNOWLEDGE

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES :**

After completing this course, students should demonstrate competency in the following topics:

- Basic probability axioms and rules and the moments of discrete and continuous random variables and various standard distributions and their properties.
- Distributions of two dimensional variables, correlation and regression.
- Use statistical tests in testing hypotheses on data.
- Interval estimation for population parameters such as mean and standard deviation.
- List the guidelines for designing experiments and recognize the key historical figures in Design of Experiments.

## REFERENCES :

1. Devore, J. L., "Probability and Statistics for Engineering and Sciences", 8<sup>th</sup> Edition, Cengage Learning, 2014.
2. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", 12<sup>th</sup> Edition, Sultan and Sons, New Delhi, 2020.
3. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9<sup>th</sup> Edition, Pearson Education, Asia, 2016.
4. Rice, J. A., "Mathematical Statistics and Data Analysis", 3<sup>rd</sup> Edition, Cengage Learning, 2015.
5. Ross, S. M., "Introduction to Probability and Statistics for Engineers and Scientists", 5<sup>th</sup> Edition, Elsevier, 2014.

**RM4151**

**RESEARCH METHODOLOGY AND IPR**

**L T P C**

**2 0 0 2**

### **UNIT I RESEARCH DESIGN**

**6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

### **UNIT II DATA COLLECTION AND SOURCES**

**6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

### **UNIT III DATA ANALYSIS AND REPORTING**

**6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

### **UNIT IV INTELLECTUAL PROPERTY RIGHTS**

**6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

### **UNIT V PATENTS**

**6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

**TOTAL: 30 PERIODS**

## REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

**COURSE OBJECTIVES:**

- To understand the usage of algorithms in computing
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications
- To select and design data structures and algorithms that is appropriate for problems
- To study about NP Completeness of problems.

**UNIT I                    ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY                    9**  
**ANALYSIS**

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms- Program performance measurement - Recurrences: The Substitution Method – The Recursion-Tree Method- Data structures and algorithms.

**UNIT II                    HIERARCHICAL DATA STRUCTURES                    9**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B - trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

**UNIT III                    GRAPHS                    9**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm

**UNIT IV                    ALGORITHM DESIGN TECHNIQUES                    9**

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

**UNIT V                    NP COMPLETE AND NP HARD                    9**

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

**TOTAL: 45 PERIODS**

**SUGGESTED ACTIVITIES:**

1. Write an algorithm for Towers of Hanoi problem using recursion and analyze the complexity (No of disc-4)
2. Write any one real time application of hierarchical data structure
3. Write a program to implement Make\_Set, Find\_Set and Union functions for Disjoint Set Data Structure for a given undirected graph  $G(V,E)$  using the linked list representation with simple implementation of Union operation
4. Find the minimum cost to reach last cell of the matrix from its first cell
5. Discuss about any NP completeness problem



## **COURSE OUTCOMES:**

**CO1:** Design data structures and algorithms to solve computing problems.

**CO2:** Choose and implement efficient data structures and apply them to solve problems.

**CO3:** Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.

**CO4:** Design one's own algorithm for an unknown problem.

**CO5:** Apply suitable design strategy for problem solving.

## **REFERENCES:**

1. S.Sridhar," Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014.
2. Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, 4th Edition, 2013.
3. T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012.
4. Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition, 2009.
5. E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008.
6. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

**CP4152**

**DATABASE PRACTICES**

**L T P C**

**3 0 2 4**

## **COURSE OBJECTIVES:**

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Understand query processing in a distributed database system
- Understand the basics of XML and create well-formed and valid XML documents.
- Distinguish the different types of NoSQL databases
- To understand the different models involved in database security and their applications in real time world to protect the database and information associated with them.

## **UNIT I RELATIONAL DATA MODEL**

**12**

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

### **Suggested Activities:**

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints
- Creating Views

Data Manipulation Language

- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations

- Nested Queries

Transaction Control Language

- Commit, Rollback and Save Points

## **UNIT II            DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY            12**

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

### **Suggested Activities:**

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers
- Accessing a Relational Database using PHP, Python and R

## **UNIT III            XML DATABASES            12**

Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

### **Suggested Activities:**

- Creating XML Documents, Document Type Definition and XML Schema
- Using a Relational Database to store the XML documents as text
- Using a Relational Database to store the XML documents as data elements
- Creating or publishing customized XML documents from pre-existing relational databases
- Extracting XML Documents from Relational Databases
- XML Querying

## **UNIT IV            NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS            12**

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems – Hbase Data Model – Hbase Crud Operations – Hbase Storage and Distributed System Concepts – NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j – Big Data – MapReduce – Hadoop – YARN.

### **Suggested Activities:**

- Creating Databases using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.
- Writing simple queries to access databases created using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.

## **UNIT V            DATABASE SECURITY            12**

Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security.

**Suggested Activities:**

Implementing Access Control in Relational Databases

**TOTAL: 75 PERIODS****COURSE OUTCOMES:**

At the end of the course, the students will be able to

- Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
- Understand and write well-formed XML documents
- Be able to apply methods and techniques for distributed query processing.
- Design and Implement secure database systems.
- Use the data control, definition, and manipulation languages of the NoSQL databases

**REFERENCES:**

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016.
2. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019.
3. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006
4. Raghu Ramakrishnan, Johannes Gehrke "Database Management Systems", Fourth Edition, McGraw Hill Education, 2015.
5. Harrison, Guy, "Next Generation Databases, NoSQL and Big Data" , First Edition, Apress publishers, 2015
6. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015

**CP4153****NETWORK TECHNOLOGIES****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- To understand the basic concepts of networks
- To explore various technologies in the wireless domain
- To study about 4G and 5G cellular networks
- To learn about Network Function Virtualization
- To understand the paradigm of Software defined networks

**UNIT I****NETWORKING CONCEPTS****9**

Peer To Peer Vs Client-Server Networks. Network Devices. Network Terminology. Network Speeds. Network throughput, delay. Osi Model. Packets, Frames, And Headers. Collision And Broadcast Domains. LAN Vs WAN. Network Adapter. Hub. Switch. Router. Firewall, IP addressing.

**UNIT II****WIRELESS NETWORKS****9**

Wireless access techniques- IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be, QoS – Bluetooth – Protocol Stack – Security – Profiles – zigbee

**UNIT III****MOBILE DATA NETWORKS****9**

4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel

Modelling for 4G – Concepts of 5G – channel access –air interface -Cognitive Radio- spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, mmWave, Introduction to 6G.

**UNIT IV SOFTWARE DEFINED NETWORKS 9**

SDN Architecture. Characteristics of Software-Defined Networking. SDN- and NFV-Related Standards. SDN Data Plane. Data Plane Functions. Data Plane Protocols. OpenFlow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. OpenFlow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. OpenDaylight. OpenDaylight Architecture. OpenDaylight Helium. SDN Application Plane Architecture. Northbound Interface. Network Services Abstraction Layer. Network Applications. User Interface.

**UNIT V NETWORK FUNCTIONS VIRTUALIZATION 9**

Motivation-Virtual Machines –NFV benefits-requirements – architecture- NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration- NFV Use Cases- NFV and SDN –Network virtualization – VLAN and VPN

**TOTAL: 45 PERIODS**

**SUGGESTED ACTIVITIES:**

- 1: Execute various network utilities such as tracert, pathping, ipconfig
- 2: Implement the Software Defined Networking using Mininet
- 3: Implement routing in Mininet
- 4: Install a virtual machine and study network virtualization
- 5: Simulate various network topologies in Network Simulator

**REFERENCES:**

1. James Bernstein, “Networking made Easy”, 2018. ( UNIT I )
2. HoudaLabiod, Costantino de Santis, HossamAfifi –“Wi-Fi, Bluetooth, Zigbee and WiMax”, Springer 2007 ( UNIT 2 )
3. Erik Dahlman, Stefan Parkvall, Johan Skold, —4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013 ( UNIT 3)
4. Saad Z. Asif – “5G Mobile Communications Concepts and Technologies” CRC press – 2019 (UNIT 3)
5. William Stallings –“Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” 1st Edition, Pearson Education, 2016.( Unit 4 and 5 )
6. Thomas D.Nadeau and Ken Gray, “SDN – Software Defined Networks”, O’Reilly Publishers, 2013.
7. Guy Pujolle, “Software Networks”, Second Edition, Wiley-ISTE, 2020

**CP4252**

**MACHINE LEARNING**

**L T P C**

**3 0 2 4**

**COURSE OBJECTIVES:**

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To outline different aspects of unsupervised learning and reinforcement learning
- To outline the role of probabilistic methods for machine learning

- To understand the basic concepts of neural networks and deep learning

**UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS 9**

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics -Vector Calculus & Optimization -Information theory

**UNIT II SUPERVISED LEARNING 9**

Introduction-Discriminative and Generative Models -Linear Regression -Least Squares -Under fitting / Over-fitting -Cross-Validation – Lasso Regression-Classification -Logistic Regression-Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

**UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9**

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Introduction -Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

**UNIT IV PROBABILISTIC METHODS FOR LEARNING 9**

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

**UNIT V NEURAL NETWORKS AND DEEP LEARNING 9**

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning – introduction – Convolution Neural Networks – Recurrent Neural Networks – LSTM- Use cases

**TOTAL: 45 PERIODS**

**SUGGESTED ACTIVITIES:**

1. Give a new example from our daily life for each type of Machine Learning problem.
2. Study at least 3 open source tools/frameworks available for Machine Learning and discuss the pros and cons of each tool/framework.
3. Take an example of a classification problem. Implement a Random Forest and visualize the individual trees to understand how the model works.
4. Examine the various cross disciplinary use cases of Machine Learning. Eg Machine Learning in Bioinformatics, Climate Science, Economics, etc.
5. Outline 10 machine learning applications in healthcare.
6. Discuss the recent advancements in Reinforcement Learning and why research in Reinforcement Learning is hard.
7. Discuss case studies on the ethical issues that have gained traction in recent years due to bulk collection of data. Eg. Racial profiling, Cambridge Analytica.
8. Give 5 examples where sequential models are suitable.
9. Discuss recent CNN architectures.

## **COURSE OUTCOMES:**

**CO1:** Understand and outline problems for each type of machine learning

**CO2:** Design a Decision tree and Random forest for an application

**CO3:** Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

**CO4:** Use a tool to implement typical Clustering algorithms for different types of applications.

**CO5:** Design and implement an HMM for a Sequence Model type of application.

**CO6:** Identify applications suitable for different types of Machine Learning with suitable justification.

## **PRACTICAL EXERCISES:**

**30 PERIODS**

1. Implement a Linear Regression with a Real Dataset

(<https://www.kaggle.com/harrywang/housing>). Experiment with different features in building a model. Tune the model's hyperparameters.

2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?" (use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.

3. Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset

4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.

5. Implement the k-means algorithm using <https://archive.ics.uci.edu/ml/datasets/Codon+usage> dataset

6. Implement the Naïve Bayes Classifier using <https://archive.ics.uci.edu/ml/datasets/Gait+Classification> dataset

7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.

**a.** Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.

**b.** You can either pick a project of your own design, or you can choose from the set of pre defined projects.

**c.** You are free to use any third-party ideas or code that you wish as long as it is publicly available.

**d.** You must properly provide references to any work that is not your own in the write-up.

**e.** Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews

2. Stock Prediction

3. Sales Forecasting

4. Music Recommendation

5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

## **HARDWARE/SOFTWARE REQUIREMENTS**

1. Python 3.x
  2. Jupyter Lab
  2. Scientific Computing Libraries: Numpy, JAX, Matplotlib
  3. Machine Learning Libraries: Scikit-Learning, Turi Create
  4. Deep Learning Libraries: Pytorch 1.0, Tensorflow 2.0, TRAX, DyNet
  5. Weka, Wekatorator
  6. Cloud (for Deep Learning): Google Colab, Paperspace Gradient
  7. Intel Core i7 9700K or Ryzen 7 5800X CPU, with minimum 16GB RAM
- Etc.

**TOTAL: 75 PERIODS**

## **COURSE OUTCOMES:**

- CO1: Understand and outline problems for each type of machine learning
- CO2: Design a Decision tree and Random forest for an application
- CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.
- CO4: Use a tool to implement typical Clustering algorithms for different types of applications.
- CO5: Design and implement an HMM for a Sequence Model type of application.
- CO6: Identify applications suitable for different types of Machine Learning with suitable justification.

## **REFERENCES:**

1. Probabilistic Machine Learning: An Introduction by Kevin Murphy, MIT Press 2022. <https://probml.github.io/pml-book/book1.html>
2. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press 2016
3. Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li and Alex J. Smola <https://d2l.ai/>
4. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
5. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
6. Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013
7. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
8. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
9. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
10. Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
11. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2009. (freely available online).
12. Stephen Marsland, "Machine Learning - An Algorithmic Perspective", Chapman and Hall/CRC Press, Second Edition, 2014

**COURSE OBJECTIVES:**

- To acquire the knowledge of using advanced tree structures
- To learn the usage of heap structures
- To understand the usage of graph structures and spanning trees
- To understand the problems such as matrix chain multiplication, activity selection and Huffman coding
- To understand the necessary mathematical abstraction to solve problems.

**LIST OF EXPERIMENTS:**

- 1: Implementation of recursive function for tree traversal and Fibonacci
- 2: Implementation of iteration function for tree traversal and Fibonacci
- 3: Implementation of Merge Sort and Quick Sort
- 4: Implementation of a Binary Search Tree
- 5: Red-Black Tree Implementation
- 6: Heap Implementation
- 7: Fibonacci Heap Implementation
- 8: Graph Traversals
- 9: Spanning Tree Implementation
- 10: Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford Algorithm)
- 11: Implementation of Matrix Chain Multiplication
- 12: Activity Selection and Huffman Coding Implementation

**Hardware/Software Requirements**

- 1: 64-bit Open source Linux or its derivative
- 2: Open Source C++ Programming tool like G++/GCC

**COURSE OUTCOMES:**

- CO1:** Design and implement basic and advanced data structures extensively
- CO2:** Design algorithms using graph structures
- CO3:** Design and develop efficient algorithms with minimum complexity using design techniques
- CO4:** Develop programs using various algorithms.
- CO5:** Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.

**TOTAL: 60 PERIODS****REFERENCES:**

1. Lipschutz Seymour, "Data Structures Schaum's Outlines Series", Tata McGraw Hill, 3rd Edition, 2014.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
3. <http://www.coursera.org/specializations/data-structures-algorithms>
4. [http://www.tutorialspoint.com/data\\_structures\\_algorithms](http://www.tutorialspoint.com/data_structures_algorithms)
5. <http://www.geeksforgeeks.org/data-structures/>



**COURSE OBJECTIVES:**

- Apply key concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.
- Analyze statistical data graphically using frequency distributions and cumulative frequency distributions.
- Analyze statistical data using measures of central tendency, dispersion and location.
- Identify the type of statistical situation to which different distributions can be applied.
- Apply the concepts of interval estimation and confidence intervals.

**ACTIVITIES:**

- 1: Scrape the LivingSocial/Groupon sites for the daily deals and develop a prediction of how successful the deal will be based on location/price/type of deal. You could use either the RCurl R package or the XML R package to scrape the data.
- 2: Does social media presence or influence affect the performance of an employee?
- 3: Determine the best number of clusters from Crime Dataset.
- 4: Download data on state of the union speeches from here (<http://stateoftheunion.onetwothree.net/texts/index.html>) and use the tm package in R to analyze the patterns of word use over time
- 5: Analysis of all the factors that contribute to low productivity in employees.

**COURSE OUTCOMES:**

- CO1: Translate real-world problems into probability models.  
CO2: Derive the probability density function of transformation of random variables.  
CO3: Use Poisson, exponential distributions to solve statistical problems..  
CO4: How to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions.  
CO5: How to translate real-world problems into probability models.

**TOTAL PERIODS: 30**

**AUDIT COURSES**

**AX4091**

**ENGLISH FOR RESEARCH PAPER WRITING**

**L T P C  
2 0 0 0**

**COURSE OBJECTIVES:**

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

**UNIT I INTRODUCTION TO RESEARCH PAPER WRITING**

**6**

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

**UNIT II PRESENTATION SKILLS 6**  
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

**UNIT III TITLE WRITING SKILLS 6**  
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

**UNIT IV RESULT WRITING SKILLS 6**  
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT V VERIFICATION SKILLS 6**  
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

CO1 –Understand that how to improve your writing skills and level of readability

CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title

CO4 – Understand the skills needed when writing the Conclusion

CO5 – Ensure the good quality of paper at very first-time submission

**REFERENCES:**

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

**AX4092**

**DISASTER MANAGEMENT**

**L T P C  
2 0 0 0**

**COURSE OBJECTIVES:**

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

**UNIT I INTRODUCTION 6**  
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6**

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

**UNIT III DISASTER PRONE AREAS IN INDIA 6**

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

**UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6**

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

**UNIT V RISK ASSESSMENT 6**

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

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

**REFERENCES:**

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

**AX4093**

**CONSTITUTION OF INDIA**

**L T P C  
2 0 0 0**

**COURSE OBJECTIVES:**

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in

the early years of Indian nationalism.

- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

#### **UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION**

History, Drafting Committee, (Composition & Working)

#### **UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION**

Preamble, Salient Features

#### **UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**

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

#### **UNIT IV ORGANS OF GOVERNANCE**

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

#### **UNIT V LOCAL ADMINISTRATION**

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

#### **UNIT VI ELECTION COMMISSION**

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

**TOTAL: 30 PERIODS**

#### **COURSE OUTCOMES:**

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

#### **SUGGESTED READING**

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

<b>UNIT I</b>	<b>சங்க இலக்கியம்</b>	<b>6</b>
	<ol style="list-style-type: none"> <li>1. தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள்</li> <li>2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்</li> <li>3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி</li> <li>4. புறநானூறு (95,195) - போரை நிறுத்திய ஔவையார்</li> </ol>	
<b>UNIT II</b>	<b>அறநெறித் தமிழ்</b>	<b>6</b>
	<ol style="list-style-type: none"> <li>1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்</li> <li>2. பிற அறநூல்கள் - இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)</li> </ol>	
<b>UNIT III</b>	<b>இரட்டைக் காப்பியங்கள்</b>	<b>6</b>
	<ol style="list-style-type: none"> <li>1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை</li> <li>2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை</li> </ol>	
<b>UNIT IV</b>	<b>அருள்நெறித் தமிழ்</b>	<b>6</b>
	<ol style="list-style-type: none"> <li>1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்</li> <li>2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு</li> <li>3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள்</li> <li>4. தர்மச்சாலையை நிறுவிய வள்ளலார்</li> <li>5. புறநானூறு - சிறுவனே வள்ளலானான்</li> <li>6. அகநானூறு (4) - வண்டு நற்றிணை (11) - நண்டு கலித்தொகை (11) - யானை, புறா ஐந்திணை 50 (27) - மான் ஆகியவை பற்றிய செய்திகள்</li> </ol>	

1. உரைநடைத் தமிழ்,
  - தமிழின் முதல் புதினம்,
  - தமிழின் முதல் சிறுகதை,
  - கட்டுரை இலக்கியம்,
  - பயண இலக்கியம்,
  - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
  - [www.tamilvu.org](http://www.tamilvu.org)
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
  - <https://ta.wikipedia.org>
3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம்
  - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
  - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
  - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

PROGRESS THROUGH KNOWLEDGE