GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
(Deemed to be University)
VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with A^{++} Grade

SYLLABUS

OF

M.Tech. Data Sciences

(w.e.f. 2021-22 admitted batch)

Vision and Mission of university

Vision

To become a global leader in higher education.

Mission

To impart futuristic and comprehensive education of global standards with high sense of discipline and social relevance in a serene and invigorating environment.

Vision and Mission of department

Vision

Excel in computer science and engineering education with international standards for global employment and research.

Mission

- *Create an excellent academic ambience that promotes innovation and research.*
- *Impart quality education through well designed curriculum experiential learning in tune with the changing needs of the industry.*
- *Collaborate with world class academic institutions and software industries for mutual benefit.*
- *Produce competent and socially committed graduates having creative skills and ethical values.*

Program Educational Objectives of M. Tech. Computer Science and Engineering are:

- PEO1: Apply the knowledge gained in the areas of research and development
- PEO2: Develop and use IT tools for the benefit of society
- PEO3: Work effectively as part of a team with strong moral and ethical values

Program Educational Objectives of M. Tech. Data Science are:

- PEO1: Develop competent professionals who can develop novel techniques and tools for data analysis
- PEO2: Enhance their technical skills to be easily absorbed in industry
- PEO3: Produce highly skilled engineers who can work for a sustainable society

Program Educational Objectives of M. Tech. Cyber Forensics and Information Security are:

- PEO1: Develop highly secure and scalable algorithms to provide better security among the various software used.
- PEO2: Promote leadership abilities along with team work for a just and secure technical society
- PEO3: Engage in lifelong learning

Program Outcomes:

At the end of the program a student is expected to have:

1. An understanding of the theoretical foundations and the limits of computing.

2. An ability to adapt existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.

3. An ability to design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.

4. Understanding and ability to use advanced computing techniques and tools.

5. An ability to undertake original research at the cutting edge of computer science & its related areas.

6. An ability to function effectively individually or as a part of a team to accomplish a stated goal.

7. An understanding of professional and ethical responsibility.

8. An ability to communicate effectively with a wide range of audience.

9. An ability to learn independently and engage in life-long learning.

10. An understanding of the impact of IT related solutions in an economic, social and environment context.

Program Specific Outcomes:

Upon successful completion of M.Tech. Computer Science and Engineering Program, student should be able to:

1. identify, formulate and provide efficient solutions to higher engineering problems.
2. design and develop software/hardware solutions for multidisciplinary and transdisciplinary problems.
3. handle research problems.

CSE	DS	CFIS	Course Code	Course Title	Category	L	T	P	C
Semester I(Credits: 21)									
✓	✓	✓	19ECS701	Advanced Data Structures	PC	3	0	2	4
✓			19ECS703	Mathematical Foundations of Computer Science	PC	2	1	0	3
	✓		19EMA110	Statistical Modeling	PC/BS	2	1	0	3
		✓	19ECS707	Number Theory and Cryptography	PC/BS	2	1	0	3
✓	✓	✓	19ECS705	Algorithms and Analysis	PC	3	0	2	4
✓	✓	✓	19ECS7XX	Program Elective I	PE	X	X	X	4
✓	✓	✓	19ECS7XX	Program Elective II	PE	X	X	X	4
✓	✓	✓	19EMC741	Research Methodology and IPR	MC	2	0	0	2
✓	✓	✓	19EAC7XX	Audit Course I	AC	2	0	0	0
Semester II(Credits:24)									
✓	✓		19ECS702	Soft Computing	PC	3	0	2	4
		✓	19ECS704	Pragmatics of Information Security	PC	3	0	2	4
✓	✓	✓	19ECS7XX	Program Elective III	PE	X	X	X	4
✓	✓	✓	19ECS7XX	Program Elective IV	PE	X	X	X	4
✓	✓	✓	19ECS7XX	Program Elective V	PE	X	X	X	4
✓	✓	✓	19EOE7XX	Open Elective	OE	3	0	0	3
✓	✓	✓	19ECS792	Technical Paper Writing	PW	0	0	4	2
✓	✓	✓	HSMCH102	Universal Human Values 2: Understanding Harmony	MC	2	1	0	3
✓	✓	✓	19EAC7XX	Audit Course II	AC	2	0	0	0
Semester III(Credits:13)									
✓	✓	✓	19ECS891	Project Work I	PW	0	0	26	13
Semester IV(Credits:13)									
✓	✓	✓	19ECS892	Project Work II	PW	0	0	26	13
Total Credits: Sem1:21; Sem2:24; Sem3:13; Sem4:13 = 71 Credits									

CSE	DS	CFIS	Course Code	Course Title	Category	L	T	P	C
				Program Elective I					
✓	✓	✓	19ECS741	Machine Learning	PE	3	0	2	4
✓	✓		19ECS753	Data Warehousing and Mining	PE	3	0	2	4
		✓	19ECS764	Secure Coding	PE	3	0	2	4
✓	✓		19ECS776	Cloud computing	PE	3	0	2	4
		✓	19ECS778	Internet Technologies and Cyber Laws		3	0	2	4
✓			19ECS743	Wireless Sensor Networks	PE	3	0	2	4
				Program Elective II					
✓	✓		19ECS751	Data Preparation and Analysis	PE	3	0	2	4
		✓	19ECS757	Malware Analysis and Reverse Engineering	PE	3	0	2	4
✓	✓		19ECS781	Internet of Things	PE	3	0	2	4
		✓	19ECS759	Ethical Hacking	PE	3	0	2	4
✓	✓		19ECS747	Data Science	PE	3	0	2	4
		✓	19ECS761	Data Encryption and Compression	PE	3	0	2	4
✓			19ECS749	Introduction to Intelligent Systems	PE	3	0	2	4
	✓		19ECS763	Recommender Systems	PE	3	0	2	4
✓	✓	✓	19ECS777	Agile Software Development	PE	3	0	2	4
				Program Elective III					
✓	✓		19ECS765	Data Visualization	PE	3	0	2	4
✓	✓		19ECS767	Big Data Analytics	PE	3	0	2	4
✓	✓		19ECS769	Data Storage Technologies and Networks	PE	3	0	2	4
✓	✓		19ECS779	Cyber security	PE	3	0	2	4
		✓	19ECS760	Steganography and Digital Water Marking	PE	3	0	2	4
		✓	19ECS782	Intrusion Detection and Prevention System	PE	3	0	2	4
		✓	19ECS744	Secure Software Design and Enterprise Computing	PE	3	0	2	4
		✓	19ECS780	Web Application Security	PE	3	0	2	4

CSE	DS	CFIS	Course Code	Course Title	Category	L	T	P	C
				Program Elective IV					
✓	✓		19ECS771	Web Analytics and Development	PE	3	0	2	4
✓	✓		19ECS750	GPU Computing	PE	3	0	2	4
✓	✓		19ECS773	Deep Learning	PE	3	0	2	4
✓			19ECS742	Advanced Wireless and Mobile Networks	PE	3	0	2	4
		✓	19ECS766	Biometrics	PE	3	0	2	4
		✓	19ECS752	Digital Forensics	PE	3	0	2	4
		✓	19ECS786	Cloud Security	PE	3	0	2	4
				Program Elective V					
✓	✓		19ECS774	Social Network Analysis	PE	3	0	2	4
✓	✓		19ECS775	Natural Language Processing	PE	3	0	2	4
✓	✓	✓	19ECS772	Data Security and Access Control	PE	3	0	2	4
✓			19ECS754	Mobile Applications and Services	PE	3	0	2	4
✓	✓		19ECS783	Software Project Management	PE	3	0	2	4
	✓	✓	19ECS785	Block Chain Technology	PE	3	0	2	4
		✓	19ECS768	Security Assessment and Risk Analysis	PE	3	0	2	4
		✓	19ECS784	Mobile Application Security	PE	3	0	2	4
				Audit Courses I and II					
✓	✓	✓	19EAC741	English for Research Paper Writing	AC	2	0	0	0
✓	✓	✓	19EAC742	Disaster Management	AC	2	0	0	0
✓	✓	✓	19EAC744	Value Education	AC	2	0	0	0
✓	✓	✓	19EAC745	Constitution of India	AC	2	0	0	0
✓	✓	✓	19EAC746	Pedagogy Studies	AC	2	0	0	0
✓	✓	✓	19EAC747	Stress Management by Yoga	AC	2	0	0	0
✓	✓	✓	19EAC748	Personality Development through life Enlightenment Skills	AC	2	0	0	0
✓	✓	✓	19EAC750	Developing Soft Skills and Personality	AC	2	0	0	0
				Open Elective					
✓	✓	✓	19EOE742	Business Analytics	OE	3	0	0	3
✓	✓	✓	19EOE746	Operations Research	OE	3	0	0	3
✓	✓	✓	19EOE748	Cost Management of Engineering Projects	OE	3	0	0	3

19ECS701: ADVANCED DATA STRUCTURES

L	T	P	C
3	0	2	4

This course provides an overall idea of to design, implement and to perform various operations like search, insert, delete etc., operations on the complex data structures. As a part string matching techniques and text data compression algorithms were also considered

Course objectives:

1. Learn to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
2. Understand the necessary mathematical abstraction to solve problems.
3. Familiarize with advanced paradigms and data structure used to solve algorithmic problems.
4. Analyze efficiency and proof of correctness of various algorithms.

Module I: Dictionaries, Hashing Number of hours(LTP) 9 0 6

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.
Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

Learning Outcomes:
After completion of this Unit the student will be able to

1. define ADT, understand hashing (L1)
2. design and implement a hash function with the above collision resolution techniques(L6)

Module II: Skip Lists Number of hours(LTP) 8 0 4

Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. create and perform operations like insert, delete and search operations on skipped lists (L6)
2. differentiate between singly linked list/ doubly linked list and skip list with respect to space complexity and time complexity to perform search, insert and delete operations**.** (L2)

Module III: Trees Number of hours(LTP) 10 0 7

Trees: Binary Tree, Binary Search Trees, AVL Trees, Red Black Trees, Splay Trees, 2-3 Trees, B-Trees. Distributed trees, -creation, insertion, deletion, rotation

Learning Outcomes:
After completion of this unit, the student will be able to:

1. organize data in a hierarchy form / non linear way (L4)
2. perform search, insert and delete operations in the above data structures**.** (L4)

Module IV: Pattern Matching Algorithms Number of hours(LTP) 9 0 6

Text Processing: String Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth- Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, inverted

index-creation, compression, keyword search, –The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. perform various string handling and string matching algorithms mainly considering similarity and identity in to account. (L6)
2. understand various text data compression techniques (L2)

Module V: Computational Geometry Number of hours(LTP) 9 0 6

Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, constructing a Priority Search Tree, searching a Priority Search Tree, Priority Spatial data-structure: Range Trees, Quad trees, k-D Trees, R trees- indexing, searching, dynamic update

Learning Outcomes:
After completion of this unit, the student will be able to:

1. distinguish between one dimensional range search and two dimensional range search (L2)
2. understand the database management query concepts in this domain(L2).

Text Books(s)

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, 4rd Edition, Pearson, 2014.
2. M T Goodrich, Roberto Tamassia, *Algorithm Design Foundations, Analysis and Internet Examples*, John Wiley, 2014.
3. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Data Structures & Algorithms in Python, Wiley.
4. Suman Saha, and Shailendra Shukla. *Advanced Data Structures: Theory and Applications*. CRC Press, 2019.

Reference Book(s)

1. Peter Brass, *Advanced data structures*. Vol. 193. Cambridge: Cambridge University Press, 2008.

Course Outcomes:

1. understand the implementation of symbol table using hashing techniques(L2).
2. develop and analyze algorithms for red-black trees, b-trees and splay trees(L3).
3. develop algorithms for text processing applications(L5).
4. identify suitable data structures and develop algorithms for computational geometry problems. (L4)

Lab Experiments

1. Develop programs for
   a. HeapSort
   b. MergeSort
   c. Quick sort by taking random element as pivot
   d. Selection
2. Program to perform insertion, deletion and search operations on the following:

   a. Single Linked List b. Doubly Linked List c. Circular Linked List

3. Implement the functions of a dictionary using Hashing.
4. Implement hash tables with linear probing and double hashing.

Demonstration of inserting and deleting elements.

5. Skip list: Implementations and operations.

6. Develop a program to perform insertion, deletion and search operations on the following Trees

    a. Binary Search Tree
    b. B-Trees
    c. AVL Tree
    d. Red Black Trees

7. String matching algorithms.
    1. Brute Force Pattern Matching
    2. Boyer Moore Algorithm
    3. Knuth-Morris-Pratt Algorithm
    4. Text similarity: Longest Common Subsequence Problem

8. Write a program for construct the following trees using a two dimensional data.
    a. KD tree
    b. R tree
    c. Increase the dimension of the data and compare their performance.

19ECS703: Mathematical Foundations of Computer Science

L	T	P	C
2	1	0	3

The purpose of this course is to provide a clear understanding of the concepts that underlying fundamental concepts and tools in mathematics with emphasis on their applications to computer science. It emphasizes mathematical definitions and proofs as well as applicable methods

Course objectives:

- Familiarize the student about the concepts of Probability and Probabilistic Distributions.
- Evaluate principles of Random Sampling and derive the Problems.
- Enable the student to interpret wider range of visual and numerical data and carry out basic inferential procedures.
- Illustrate the knowledge of mathematical modelling.
- Utilize the knowledge of computing and mathematics appropriate to the discipline.
- Be familiar with the concepts of graph theory and using them in solving computer science problems.

Module I: Introduction of Probability — Number of hours(LTP) 8 2 0

Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains

Learning Outcomes:

After completion of this unit, the student will be able to:

- use the axioms of probability, define conditional probability(L2).
- write axioms, and infer meaningful conclusions about the data(L1).
- define conditional probability and understand intuitively about the conditional probability(L1).
- identify the need for central limit theorem(L2).
- use probabilistic inequalities such as Churn off bound, Markov and Chebyshev's inequalities(L2).

Module II: Sampling — Number of hours(LTP) 5 2 0

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood

Learning Outcomes:

After completion of this unit, the student will be able to:

- understand the concepts of estimation theory(L2).
- describe the sampling distribution of a sample proportions(L2).
- calculate probabilities of a sample proportion(L3).

Module III: Statistical Model — Number of hours(LTP) 7 2 0

Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of over-fitting model assessment.

Learning Outcomes:

After completion of this unit, the student will be able to:

- summarize data visually and numerically(L4).
- learn the mathematical and probabilistic foundations of statistical inference(L1).
- reduce the dimensionality of data(L3).
- fit the Regression lines and analyse multivariate data(L1).

Module IV: Graph Number of hours(LTP) 6 3 0

Graph Theory: Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems

Learning Outcomes:

After completion of this unit, the student will be able to:

- apply the basic concepts of graph theory and note the different properties of graphs(L4).
- apply the basic concepts to solve combinatorial problems(L4).
- describe and solve some real time problems using concepts of graph theory(L2).

Module V: Applications Number of hours(LTP) 6 3 0

Computer science and engineering applications Datamining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

Learning Outcomes:

After completion of this unit, the student will be able to:

- Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems. (L4).
- Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics. (L5).
- how machine learning algorithms works(L1).
- why we want to study big data and how to prepare data form a chine learning algorithms(L1).
- acquire strong fundamental knowledge in science, mathematics, fundamentals of computer science, software engineering and multidisciplinary engineering beginning practice as a software engineer (L2).

Text Books(s)

1. John Vince, Foundation Mathematics for Computer Science, Springer, 2015.
2. K. Trivedi , Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley, 2016.
3. Alan Tucker, Applied Combinatorics, 6/e, Wiley, 2012.
4. Reuven Y. Rubinstein, Dirk P. Kroese, Simulation and the Monte Carlo Method, 3/e, Wiley Series, 2016.

Reference Book(s)

1. Nar Singh Deo, Graph Theory with Applications to Engineering and Computer Science, PHI Book 2018, ISBN: 9788120301450, 9788120301450.
2. Ethem Alpaydin, Introduction to Machine Learning, PHI 2016.

Course Outcomes:

After completing this Course, the student should be able to

1. evaluate principles of random sampling and derive the problems(L4).
2. understand the concepts of estimation theory(L2).
3. fit the regression lines and analyze multivariate data(L3).
4. Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems(L4).

19EMA110: STATISTICAL MODELING

L	T	P	C
2	1	0	3

The statistical modelling represents the collection of data and summarize the data for further interpretation. It describes a set of probability distribution, correlation, regression, time series analysis and other statistical analyses which are necessary for analyzing the collected data and information on the basis of statistical tools. The thrust of the course is to prepare students to enter into a promising professional life even after graduation, as also provide to them a platform to convert as a data analyst.

Course objectives:

1. To familiarize the students with the foundations of statistical modelling techniques.
2. To sensitize the students will obtain knowledge about the basic concepts of nonparametric statistical inference.
3. To learn how to perform hypothesis testing for population proportion by the p-value approach.
4. To distinguish ARIMA terms from simultaneously exploring an ACF and PACF
5. To import, review, manipulate and summarize data-sets in R.

Module I: Linear Statistical Models, Estimation and Sufficient Statistic: Number of hours(LTP) 6 3 0

Simple linear regression & correlation, multiple regression & multiple correlation, Analysis of variance (one way, two way with as well as without interaction),Estimation: Point estimation, criteria for good estimates (un-biasedness, consistency), Methods of estimation including maximum likelihood estimation, Sufficient Statistic: Concept & examples, complete sufficiency, their application in estimation.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. use the equation of a linear function to model a data set. (L3).
2. apply their knowledge of linear model to solve real world problems in comparing two measurement data. (L3).
3. approximate the value of a population parameter on the basis of a sample statistic. (L4).
4. learn a formal definition of sufficiency. (L1).
5. learn how to apply the Factorization Theorem to identify a sufficient statistic. (L3).

Module II: Test of hypothesis Number of hours(LTP) 6 3 0

Concept & formulation, Type I and Type II errors, Neyman Pearson lemma, Procedures of testing (single proportion and mean, double proportions and Means for Large Samples, t-test, F-test and Chi-Square tests for Small samples).

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand how to develop Null and Alternative Hypotheses. (L3).
2. understand Type I and Type II Errors. (L2).
3. learn how to perform hypothesis testing for population proportion by the p-value approach. (L4).
4. use confidence interval to draw conclusion about two-sided test. (L5).

Module III: Non-parametric Inference Number of hours(LTP) 6 3 0

Comparison with parametric inference, Use of order statistics. Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test. Spearman's and Kendall's test. Tolerance region.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. find the differences among parametric, nonparametric and semi-parametric inferences. (L2).
2. learn nonparametric procedures for analyzing real data(L4).

3. perform and interpret the Mann Whitney U Test, Run test, Kolmogorov-Smirnov test, Spearman's and Kendall's test(L2).
4. identify the appropriate nonparametric hypothesis testing procedure based on type of outcome variable and number of samples(L4).

Module IV: Basics of Time Series Analysis & Forecasting Number of hours(LTP) 6 3 0
Stationary, ARIMA Models: Identification, Estimation and Forecasting.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify and interpret a non-seasonal ARIMA model. (L4).
2. distinguish ARIMA terms from simultaneously exploring an ACF and PACF. (L5).
3. test that all residual autocorrelations are zero. (L4).
4. convert ARIMA models to infinite order Moving Average models. (L4).
5. forecast with ARIMA models. (L5).

Module V: R statistical programming language Number of hours(LTP) 7 3 0
Introduction to R, Functions, Control flow and Loops, Working with Vectors and Matrices, Reading in Data, Writing Data, Working with Data, Manipulating Data, Simulation, Linear model, Data Frame, Graphics in R.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. motivate for learning a programming language. (L3).
2. access online resources for R and import new function packages into the R workspace. (L4).
3. import, review, manipulate and summarize data-sets in R(L4).
4. explore data-sets to create testable hypotheses and identify appropriate statistical tests using R(L5).
5. create and edit visualizations with R(L4).

Text Books(s)

1. Probability and Statistics for Engineers (4^{th} edition), I. R. Miller, J. E. Freund and R. Johnson.
2. Fundamentals of Statistics (Vol. I & Vol. II), A. Goon, M. Gupta and B. Dasgupta.
3. The Analysis of Time Series: An Introduction, Chris Chatfield.
4. D.C. Montgomery & E. Peck, G. Geoffrey Vining , Introduction to Linear Regression Analysis,5/e, Wiley India Pvt. Ltd,2015.
5. Chris Chatfield, The Analysis of Time Series: Texts in Statistical Science, 6/e, Chapman & Hall/CRC, 2016.
6. Garrett Grolemund, Hands-on Programming with R: write your own functions and simulations, Hadley Wickham, 2014.
7. Jared P. Lander, R for Everyone: Advanced Analytics and Graphics, 2/e, Pearson Education,2018.

Reference Book(s)

1. D.C. Montgomery & E. Peck , Introduction to Linear Regression Analysis,3/e, Wiley India Pvt. Ltd,2006.
2. A.M. Mood, F.A. Graybill & D.C. Boes, Introduction to the Theory of Statistics, 3/e, McGraw Hill Education,1 July 2017.X
3. Garrett Grolemund, Hands-on Programming with R,1/e, O'reilly media,2014.
4. Jared P. Lander, R for Everyone: Advanced Analytics and Graphics, 2/e, Pearson Education, 2018.

Course Outcomes: After completion of the course, the student will be able to

1. use the equation of a linear function to model a data set. (L3).
2. understand how to develop Null and Alternative Hypotheses. (L2).
3. find the differences among parametric and nonparametric inferences. (L2).
4. identify and interpret a non-seasonal ARIMA model. (L4).
5. import, review, manipulate and summarize data-sets in R. (L4).

19ECS707: NUMBER THEORY AND CRYPTOGRAPHY

L	T	P	C
2	1	0	3

The emphasis of the course is on the application of the number theory in the design of cryptographic algorithms. The course also familiarizes students with a few mathematical concepts used in cryptography. As a part of cryptanalysis, the course emphasizes to give a basic understanding of attacks in cryptosystems and how to shield information from attacks. It also deals with message authentication, Digital signatures, elliptic curve cryptography for authentication and Network security

Course objectives:

- Understand the arithmetic topics which have been at the center of interest, especially in cryptography.
- Impart various symmetric cryptographic techniques (L2)
- Learn number theory related to RSA and Diffie-Hellman algorithms (L3)
- Study different hash functions and message authentication techniques (L3)
- Learn Elliptic curve Cryptography and its applications(L3)

Module I: Number of hours(LTP) 6 3 0

Topics in elementary number theory: divisibility and the Euclidean algorithm. Overview of Congruence's: Definitions and properties, linear congruencies, residue classes. Euler's phi function, Fermat's Little Theorem, Testing for Primalirity, Chinese Remainder Theorem(CRT).

Learning Outcomes:

After completion of this unit, the student will be able to:

- Learn basic Algebra and Discrete Mathematics. (L1)
- Know to find the greatest common divisor of two numbers. (L1)
- Understand the Chinese remainder theorem which gives a unique solution to simultaneous linear congruence's. (L2)

Module II: Number of hours(LTP) 6 3 0

Classical encryption techniques: Substitution Ciphers :Caeser cipher, Monoalphabetic cipher, Play fair, Hill Cipher, Poly alphabetic cipher, Transposition ciphers: Railfence and Columnar Transpositions.

Simple Cryptosystems: Enciphering Matrices – Block ciphers Principles –Data Encryption Standard (DES) –The Strength of DES– Differential & Linear Crypt analysis–Block Cipher Design principles.

Learning Outcomes:

After completion of this unit, the student will be able to:

- Understand the classical encryption techniques of cryptography(L2)
- Learn the environment that led to the development of the Data Encryption Standard. (L1)
- Identifying, describing, and explaining the purpose of each stage of the DES algorithm. (L3)
-

Module III: Number of hours(LTP) 6 3 0

Public Key Cryptosystems: The idea of public-key cryptography, RSA Cryptosystem, Security of RSA, ElGamal Encryption, The Diffie–Hellman Key Agreement Protocol.

Learning Outcomes:

After completion of this unit, the student will be able to:

- using the RSA algorithm to encrypt and decrypt data. (L3)
- describing a key exchange algorithm or protocol (e.g. Diffie Hellman). (L2)
- using ElGamal encryption. (L3)

Module IV: Number of hours(LTP) 6 3 0

Cryptographic Hash Functions: Applications of hash Functions, Secure Hash Algorithm SHA-3. MAC and Digital Signatures: Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, HMAC. Digital signatures, Digital Signature Standard (DSS), DSA.

Learning Outcomes:

After completion of this unit, the student will be able to:

- explain and implement simple hash functions (L2)
- discuss message authentication techniques (L2)
- explain Digital Signature Standard and DSA (L2)

Module V: Number of hours(LTP) 6 3 0

Elliptic curve Arithmetic, Elliptic curve cryptography, Elliptic curve cryptography encryption and decryption, Security of Elliptic curve cryptography, PNRG based ECC.

Learning Outcomes:

After completion of this unit, the student will be able to:

- identify the approach to public-key cryptography is based on the algebraic structure of elliptic curves. (L3)
- learn examples of elliptic curves over the field of real numbers. (L1)
- learn about the elliptic curve based PNRG

Text Books(s)

1. William Stallings, Cryptography and Network Security – Principles and Practice, 7/e. Pearson Education, 2017.
2. T M Apostol, Introduction to Number Theory, Springer, 2013

Reference Book(s)

1. Neal Koblitz, A Course in Number Theory and Cryptography, 2/e, Springer,2002.
2. R. P. Feynman, Feynman lectures on computation, 1st Edition, Penguin Books,1996.
3. Gennady P. Berman, Gary D. Doolen, Ronnie Mainiri & ValdmisItri Frinovich, Introduction to quantum computers, 1stEdition, World Scientific, Singapore,1998.
4. Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, Principles and Protocols, 2nd Edition, CRC Press,2014

Course Outcomes:

- illustrate working of classical encryption techniques (L3)
- describe the working of symmetric encryption techniques (L2)
- experiment the working of public key cryptography algorithms such as RSA, Diffie-Hellman (L3)
- apply Hash functions and message authentication techniques (L3)
- summarize Application and transport layers security mechanisms. (L2)

19ECS705: ALGORITHMS AND ANALYSIS

L	T	P	C
3	0	2	4

The course is concentrated on the study and development of algorithms for solving practical problems efficiently, and the theoretical analysis of their behaviour. It involves algorithm design techniques, methods for analysing the performance of corresponding algorithms and improving their efficiency, and to provide performance guarantees.

Course objectives:

1. Introduce the advanced methods of designing and analysing algorithms
2. Identify an appropriate algorithm and implement it for a specific problem.
3. Understand different classes of problems concerning their computation difficulties.
4. Solve problems using dynamic programming, network flow algorithms, graph algorithms and approximation algorithms.
5. Analyse recent developments in the area of algorithmic design.

Module I: Number of hours (LTP) 6 0 6

Sorting: Review of various sorting algorithms, topological sorting

Graph**:** Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge weighted case (Dijkstra's), depth-first search and computation of strongly connected components, emphasis oncorrectness proof of the algorithm and time/space analysis.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe different sorting algorithms and their time complexity(L2)
2. apply various graph traversal algorithms to find shortest paths(L3)
3. outline the difference between BFS and DFS algorithms(L4)
4. review the correctness of algorithm time and space analysis(L2)

Module II: Number of hours (LTP) 8 0 6

Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.

Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. calculate the maximum matching in graph related problems(L3)
2. compute algorithms for maximum weight and maximal independent set. (L3)
3. apply MST for real world problems(L3)
4. discover augmenting paths in graphs using various algorithms(L3)

Module III: Number of hours (LTP) 9 0 6

Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond- Karp maximum-flow algorithm.

Matrix Computations**:** Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. solve network flow problems using network flow algorithms(L3)
2. implement divide and conquer paradigm for matrix multiplication(L3)
3. analyse how efficiency can be achieved by matrix computation algorithms(L4)

Module IV: Number of hours (LTP) 10 0 6

Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming.

Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base- representation and modulo-representation. Application: Interpolation problem.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. practice more examples on dynamic programming(L3)
2. determine shortest paths in a graph using dynamic programming(L5)
3. assess various representations of data(L5)
4. develop algorithms for interpolation problems(L6)

Module V: Number of hours (LTP) 9 0 6

Linear Programming: Geometry of the feasibility region and Simplex algorithm

NP-completeness: Examples, proof of NP-hardness and NP-completeness. One or more of the following topics based on time and interest. Approximation algorithms, Randomized Algorithms, Interior Point Method.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. explain linear programming concepts(L2)
2. examine NP-hardness and NP-completeness problems (L4)
3. illustrate approximation algorithms(L4)
4. analyse randomized algorithms. (L4)

Text Books(s)

1. Dr. Basant Agarwal and Benjamin Baka, “Hands-on Data Structures and Algorithms with Python”, Packt, 2/e, 2018.
2. Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithms", Tata Mcgraw Hill
3. Publishers.
4. Aho, Hopcroft, Ullman, "The Design and Analysis of Computer Algorithms", Pearson Education.
5. Kleinberg and Tardos, "AlgorithmDesign", Pearson Education.

E-books

1. Bhupendra Singh Mandloi,” Design and Analysis of Algorithms”,2018.
2. R. Pannerselvam, “Design and Analysis of Algorithm”, PHI Learning Pvt. Ltd., 2/e, 2016.

Course Outcomes:
After completion of the course, students would be able to:

1. Analyze the complexity/performance of different algorithms. (L4)
2. Determine appropriate algorithm that is suitable for solving a particular set of problems. (L3)
3. Explain more complex algorithms and proofs in written form. (L3)

4. Categorize different problems in various classes according to their complexity. (L4)
5. Design and analyze techniques for algorithms and ways to approach NP-complete problems (L6)
6. Apply techniques to solve new problems that may arise in various applications (L3)

ALGORITHM ANALYSIS LABORATORY

List of Practical Experiments:

1. Implement topological sorting technique and compute its time complexity.

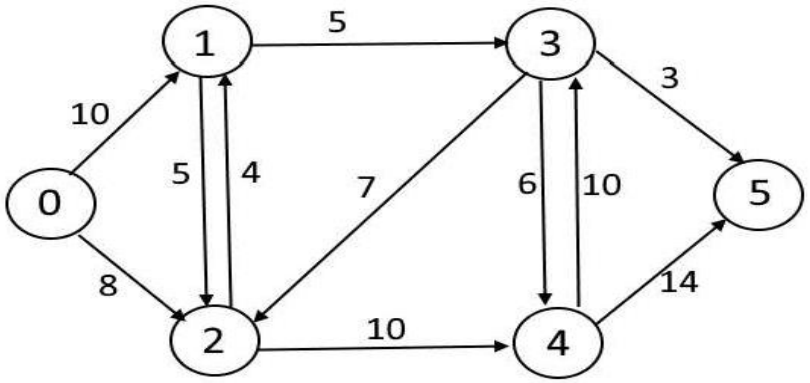
2. Implement Shortest path problem in edge weighted graph (Dijkstra's algorithm).

3. Implement Kosaraju's algorithm to identify strongly connected components in the given directed graph.

4. Implement the algorithm to compute maximum matching.

5. Implement Edmond's Blossom algorithm to compute augmenting path.

6. Consider the given graph which represents a flow network where every edge has a capacity. Also given two vertices *source* 's' and *sink* 't' in the graph.



Implement Ford-Fulkerson algorithm to find the maximum possible flow from s (vertex '0') to t (vertex 5).

7. Implement Strassen's algorithm to perform matrix multiplication.

8. Implement Floyd-Warshall algorithm to find out shortest paths between all pairs of vertices in the given graph using dynamic programming.

19ECS741 Machine Learning

L	T	P	C
3	0	2	4

Machine Learning is the science of making machines think intelligently without being explicitly programmed. Machine learning is pervasive in everyday life today. This course is designed to enable students get in-depth understanding of different machine learning techniques including deep learning and reinforcement learning and apply them on real-life data.

Course objectives:

1. Understand the fundamental concepts of Supervised learning.
2. Explore descriptive problem solving through unsupervised learning strategies.
3. Acquire skills in developing as well as evaluating different machine learning models.
4. Demonstrate the strategies for handling missing data.
5. Gain an understanding of concepts like Reinforcement Learning and Active Learning.

Module I: Number of hours(LTP) 9 0 6

What and why machine learning, applications of machine learning, types of machine learning, Machine learning pipeline. Supervised Learning (Classification): Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naive Bayes, Logistic Regression, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi-class classification. Performance measures and error analysis.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the concept of machine learning and their applications to different real-world datasets. (L2)
2. demonstrate the working of different supervised learning algorithms and assess their suitability to a given problem. (L3)
3. compare the performances of different classification models. (L4)

Module II: Number of hours(LTP) 9 0 6

Supervised Learning (Regression): Linear regression- Simple, Multiple and polynomial regression. Evaluating performance of regression models. Regularized models for regression, dealing with non-linear relationships.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. demonstrate simple and multiple regression on benchmark datasets(L3)
2. apply feature selection using regularized regression(L3)

Module III: Number of hours(LTP) 9 0 6

Unsupervised Learning: Clustering: K-means clustering, hierarchical clustering. Dimensionality Reduction: PCA and kernel PCA.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. demonstrate the working of dimensionality reduction techniques on high-dimensional datasets (L3)
2. illustrate the clustering models for benchmark datasets. (L3)

Module IV: Number of hours(LTP) 9 0 6

Data preprocessing- Dealing with missing data, handling categorical data, data normalization. Model evaluation and hyperparameter tuning- k-fold cross validation, learning and validation curves, fine tuning models using grid search. Ensemble Methods - Bagging, Boosting, Random Forests.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. interpret ensemble models as a function of different weak classifiers. (L3)
2. summarize the data preprocessing techniques(L5)
3. demonstrate model selection techniques(L3)

Module V: Number of hours(LTP) 9 0 6

Scalable Machine Learning -Online and Distributed Learning, Semi-supervised Learning, Active Learning, Reinforcement Learning-Q learning.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. apply reinforcement learning approach to applications like bioinformatics and personalized recommendation. (L3)
2. analyze the working of Active Learning approach on complex data. (L4)

Text Books(s)

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Aurelien Geron, O'REILLY
2. Python Machine Learning : Machine Learning and Deep Learning with Python, ScikitLearn and TensorFlow2, Sebastian Raschka & Vahid Mirjalili
3.

Reference Book(s)

1.

Course Outcomes:

1. Apply classification algorithms to solve real-time machine learning problems. (L4)
2. Develop regression models for predictive tasks. (L5)
3. Analyse and implement unsupervised learning approaches. (L4)
4. Prepare and preprocess datasets for effective model building. (L3)
5. Understand scalable machine learning solutions using advanced learning techniques. (L3)

19ECS753: DATA WAREHOUSING AND MINING

L	T	P	C
3	0	2	4

Due to advent of technology, internet, and advanced applications like social media, huge amount of digital data has been accumulated in data centres/Cloud Databases, which has lead to a situation "we are drowning in data but starving from knowledge". To make use of this various data mining functionalities like Association Analysis, Classification, Clustering, Outlier Analysis and Web mining used to find golden nuggets which are useful for decision making process.

Data warehousing (DW) is an integral part of knowledge discovery process, where DW plays a vital role. DW is an integration of multiple heterogeneous data repositories under a unified schema at a single site. The students will acquire knowledge in Data modelling, design, architecture, Data warehouse implementation and further development of data cube technology.

Course objectives:

1. Review the various components of Data Mining and data warehousing
2. Understand the mechanisms of various clustering algorithms.
3. Explain the advanced classification algorithms.
4. Understand the various aspects of mining the streaming data
5. Discuss key features of Graph and web mining.

Module I: Number of hours(LTP) 8 0 6

What is a Data warehouse, Difference between data warehouse and database, A Multi – Dimensional Data model- Schemas for Multi –Dimensional databases, Concept Hierarchies, OLAP operations, Data warehouse Architecture - A Three tier Data ware Architecture, Types of OLAP servers, Data Mining functionalities- Concept/ Class description, Cluster analysis, Outlier analysis, Classification & Prediction, Frequent Patterns, Data Reduction- Dimensionality reduction, Principal Component Analysis, Numerosity Reduction methods.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand the basic concepts of data mining (L2)
2. Understand various types of data sets and attributes:(L2)
3. Learn the different data pre-processing techniques and apply them on data sets: (L2)
4. Explain the multidimensional data models(L3)

Module II: Number of hours(LTP) 9 0 6

Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods- K-means, K-Medoids, ClARANS - Hierarchical Methods – BIRCH, ROCK algorithms, Density based methods- DBSCAN, OPTICS, DENCLUE algorithms.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Apply different statistical techniques on different types of attributes to find the similarities and dissimilarities (L3)
2. Implement important clustering Algorithms(L2)
3. Analyze issues in Clustering algorithms (L3)
4. Apply Density based methods over different data sets (L3)

Module III: Number of hours(LTP) 9 0 6

Classification: Alternative Techniques - Bayes Theorem, Bayes theorem for classification, Naive Bayes Classifier, Bayes error rate - Artificial Neural Networks, Perceptron, Multilayer Artificial

Neural network, Characteristics of ANN- Ensemble Methods, Bagging, Boosting, Random Forests- Class Imbalance Problem, Alternative metrics, ROC curve, Multiclass problem.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand Bayes theory (L2)
2. Explain the mechanism of neural networks(L2)
3. Discuss the ensemble classification techniques(L3)
4. Apply performance metrics(L3)

Module IV: Number of hours(LTP) 9 0 6

Mining Data Streams, Methodologies for stream data processing and stream data systems, frequent pattern mining in stream data, Classification of dynamic data streams, Mining Time series Data, Trend analysis and Similarity search in Time-series analysis.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Find frequent patterns in streaming data (L2)
2. Describe the streaming data methodologies(L2)
3. Understand the Mining the Time series Data (L2)
4. Explain Similarity search in Time-Series (L1)

Module V: Number of hours(LTP) 10 0 6

Graph Mining, Methods for mining frequent sub-graphs, Mining variants and constrained substructure patterns, applications,- Social Network analysis, Characteristics, Link Mining- Tasks & Challenges, Link Prediction,- Mining the World Wide Web, Mining the Web page Layout structure, Mining the Web Link's structures to identify authoritative web structures, Mining multimedia data on the web.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Explain the Graph Mining techniques (L2)
2. Illustrate the web mining approaches(L2)
3. Discuss Automatic classification of web documents(L4)
4. Understand the taxonomy of Social network analysis(L2)

Text Books(s)

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques, 2012 3rd edition, 2016 kindle edition.
2. Vipin Kumar, Pang-Ning Tan, Michael Steinbach, Introduction to Data Mining, pearson india education services, 2016.

Reference Book(s)

1. Arun K Pujari ,Data Mining Techniques, Universities Press , 3rd Edition.
2. T.V Suresh Kumar, B.Eswara Reddy, Jagadish S Kalimani, Data Mining Principles & Applications, Elsevier.
3. G Dong, J Pei, Sequence Data Mining, Springer, 2007

Course Outcomes:

1. Summarise the various components of data warehousing and data mining (L3)
2. Apply Cluster algorithms on appropriate data sets and applications
3. Simulate the various ensemble classification algorithms (L3)
4. Demonstrate the data mining techniques over streaming data: (L2)
5. Implement prominent Graph and web mining algorithms(L2)

19ECS764: SECURE CODING

L	T	P	C
3	0	2	4

This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

Course objectives:

1. Understand the most frequent programming errors leading to software vulnerabilities.
2. Identify and analyse security problems in software.
3. Understand and protect against security threats and software vulnerabilities.
4. Effectively apply their knowledge to the construction of secure software systems

Module I: Safe Initialization Number of hours(LTP) 9 0 6

Sanitizing the Environment, Restricting Privileges on Windows, Dropping Privileges in set UID Programs, Limiting Risk with Privilege Separation, Managing File Descriptors Safely, creating a Child Process Securely, Executing External Programs Securely, Executing External Programs Securely, Disabling Memory Dumps in the Event of a Crash.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. analyse the security policies and flaws(L4)
2. interpret the security problems occur in software(L2)
3. classify the vulnerabilities(L2)

Module II: Access Control Number of hours(LTP) 9 0 6

Understanding the Unix Access Control Model, Understanding the Windows Access Control Model, Determining Whether a User Has Access to a File on Unix, Determining Whether a Directory Is Secure, Erasing Files Securely ,Accessing File Information Securely, Restricting Access Permissions for New Files on Unix, Locking Files, Synchronizing Resource Access Across Processes on Unix, Synchronizing Resource Access Across Processes on Windows, Creating Files for Temporary Use, Restricting Filesystem Access on Unix, Restricting Filesystem and Network Access on FreeBSD.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. analyse the bugs that can occur in program and try to solve them(L4)
2. able to identify the string errors and rectify them(L3)

Module III: Input Validation Number of hours(LTP) 9 0 6

Understanding Basic Data Validation Techniques, Preventing Attacks on Formatting Functions, Preventing Buffer Overflows, Using the SafeStr Library, Preventing Integer Coercion and Wrap-Around Problems, Using Environment Variables Securely, Validating Filenames and Paths, Evaluating URL Encodings, Validating Email Addresses, Preventing Cross-Site Scripting, Preventing SQL Injection Attacks, Detecting Illegal UTF-8 Characters, Preventing File Descriptor Overflows When Using select( )

Learning Outcomes:
After completion of this unit, the student will be able to:

1. analyse the different vulnerabilities related to inter data(L4)
2. handle the input and validate them(L2

Module IV: Symmetric Cryptography Fundamentals Number of hours(LTP) 9 0 6

Representing Keys for Use in Cryptographic Algorithms, Generating Random Symmetric Keys, Representing Binary Keys (or Other Raw Data) as Hexadecimal, Turning ASCII Hex Keys (or Other ASCII Hex Data) into Binary, Performing Base64 Encoding, Performing Base64 Decoding, Representing Keys (or Other Binary Data) as English Text, Text Keys to Binary Keys, Using Salts, Nonces, and Initialization Vectors, Deriving Symmetric Keys from a Password, Algorithmically Generating Symmetric Keys from One Base Secret, Encrypting in a Single Reduced Character Set, Managing Key Material Securely, Timing Cryptographic Primitives

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand Memory Forensics and Volatility (L2)
2. find artifacts in Process Memory(L1)

Module V: Anti-Tampering Number of hours(LTP) 9 0 6

Understanding the Problem of Software Protection, Detecting Modification, Obfuscating Code, Performing Bit and Byte Obfuscation, Performing Constant Transforms on Variables, Merging Scalar Variables, Splitting Variables, Disguising Boolean Values, Using Function Pointers, Restructuring Arrays, Hiding Strings, Detecting Debuggers, Detecting Unix Debuggers, Detecting Windows Debuggers, Detecting SoftICE, Countering Disassembly, Using Self-Modifying Code.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. develop web applications and validate them(L3)
2. understand the concept of maintaining session state(L2)

Text Books(s)

1. John Viega and Matt Messier, Secure Programming Cookbook for C and C++, O'Reilly Publication,2003.

Reference Book(s)

1. Robert C. Seacord, Secure Coding in C and C++, Pearson Education, 2013

Course Outcomes:

1. write secure programs and various risk in the software. (L5)
2. describe various possible security attacks(L4)
3. classify various errors that lead to vulnerabilities(L2)
4. real time software and vulnerabilities associated with them. (L6)

19ECS776: Cloud Computing

L	T	P	C
3	0	2	4

This course will help the students to get familiar with Cloud Computing benefits, technology mechanisms, platforms and state-of-the-art security issues in Cloud Computing fundamental issues, technologies, applications and implementations.

Course objectives:

1. To understand the descriptions of common benefits and challenges, services and the virtualization of resources
2. To evaluate the specialized technology mechanisms including scaling, load balancing and storage.
3. To implement modern-day cloud computing platforms and innovations including data centres and descriptions of common cloud security
4. Fundamentals of cloud computing interoperability issues and case study examples.
5. To understand the fundamental cloud enterprise architectural models.

Module I: Number of hours(LTP) 8 0 2

Introduction to Cloud Computing, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Define the cloud benefits, challenges(L-1)
2. Name the cloud computing services. (L-1)
3. Classify the Virtualization of resources. (L-2)

Module II: Number of hours(LTP) 8 0 2

Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage

Learning Outcomes:

After completion of this unit, the student will be able to:

1. List the various Scaling in the cloud(L-1)
2. Illustrate the various capacity planning components(L-2)
3. Apply the load balancer and storage. (L-3)

Module III: Number of hours(LTP) 8 0 2

Multi-tenant Software, Data in Cloud, Database Technology, Content Delivery Network, Security Reference Model, Security Issues, Privacy and Compliance Issues

Learning Outcomes:

After completion of this unit, the student will be able to:

1. List the various cloud enabling technologies. (L-1)
2. Illustrate the various technologies and components. (L-2)
3. Identify the security and privacy issues.(L-3)

Module IV: Number of hours(LTP) 8 0 2

Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Compare the various portability and interoperability issues. (L-2)
2. Build thecloud management model.(L-3)
3. Compare the popular services. (L-4)

Module V: Number of hours(LTP) 8 0 2

Enterprise architecture and SOA, Enterprise Software, Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Categorize the enterprise environments. (L-4)
2. Distinguishbetween the enterprise environments. (L-4)
3. Evaluatethe enterprise cloud computing. (L-5)

Text Books(s)

1. Author(s), Title, Publisher, Edn, Year.
2. Sandeep Bhowmik, “Cloud Computing”, Cambridge University Press, 2017
   GautamShroff, “Enterprise Cloud Computing - Technology, Architecture, Applications”, Cambridge University Press, 2016

Reference Book(s)

1. Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, “Distributed and Cloud Computing From Parallel Processing to the Internet of Things”, Elsevier, 2012.

Course Outcomes:

1. Define the basic concepts related to benefits, services and resource virtualization (L-1)
2. Demonstrate the set of technology mechanisms with cloud computing. (L-2)
3. Identify the building blocks of cloud computing platforms and cloud security issuesL-3)
4. Evaluate the specific interoperability issues and examples (L-4)
5. Elaborate the cloud Enterprise architecture models(L-4)

19ECS778: INTERNET TECHNOLOGIES AND CYBER LAWS

L	T	P	C
3	0	2	4

This course provides an overview of various crimes encountered in the internet era and the laws that prevent the cybercrimes and discusses upon copyright issues, taxation policies and digital signatures to protect the content over the internet.

Course objectives:

Learn about various types of cyber attacks
Understand the concepts related to contracts and IPR in internet
Familiarize about copyright issues, taxation, and their protection
Analyze about digital signature and its needs.

Module I: Number of hours(LTP) 9 0 6

Crimes of this millennium, checks and balances against arbitrary arrests, concept of cybercrime and the IT act, hacking, teenage web vandals, cyber fraud and cyber cheating, virus on the internet, other IT act offences, network service providers, criminal justice in India and implications

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Tabulate various cybercrimes(L1)
2. Infer on criminal justice over cybercrimes(L2)

Module II: Number of hours(LTP) 9 0 6

Contracts in the InfoTech world, click wrap and shrink wrap contracts, contract formation under the Indian context, contract formation on the internet, terms and conditions of the contract, jurisdiction and information technology act, foreign judgments in India, IPR disputes, misuse of the law of jurisdiction, jurisdictional disputes with respect to the internet in USA.

Learning Outcomes:

After completion of this unit, the student will be able to:

Understand the concept and terms in digital contracts(L2)
Analyze IPR and its implications(L4)

Module III: Number of hours(LTP) 9 0 6

Concept of domain name and reply to cyber squatters, meta-tagging, copyright ownership and assignment, license of copyright, copyright term and respect for foreign works, copyright infringement remedies and offences, copyright protection of content on the internet, computers software piracy.

Learning Outcomes:

After completion of this unit, the student will be able to:

Understand the concepts of copyright(L2)
Analyze the implications related to copyright protection(L4)

Module IV: Number of hours(LTP) 9 0 6

Concept of permanent Establishment, PE in cross border E-Commerce, the modeled nations, model tax treaty, law of double taxation avoidance agreements, tax Agents of non-residents under the income tax act and the relevance to E-Commerce, impact of the internet on customs duties, taxation policies in India.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Learn the concept of Permanent Establishment(L1)
2. Understand laws of taxation in ecommerce and its impact(L2)

Module V: Number of hours(LTP) 9 0 6

Digital signatures, digital signature certificate, certifying authorities and liability in the event of digital signature compromise, status of electronic records as evidence, proving digital signatures, proof of electronic agreements, proving electronic messages, goods and services, consumer complaint, defect in goods and deficiency in services, restrictive and unfair trade, practices, reliefs under CPA, consumer forums, jurisdictions and implications on cyber consumers in India.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand the details of digital signatures(L2)
2. Analyze the practices in ecommerce pertaining to agreements, jurisdictions in cyber world(L4)

Text Books(s)

1. Vivek Sood, Cyberlaw Simplified, Tata McGrawHll, 2001.
2. Godbole, Information Systems Security, Wiley, 2008.
3. Merkov, Breithaupt, Information Security, Prentice Hall of India HI, 2005.
4. Yadav, Foundations of Information Technology, 3/e, New Age, 2006.

Course Outcomes:

1. Distinguish various cyber crimes
2. Understand about implementation of digital contracts, copyrights and taxation in ecommerce.
3. Outline about digital signatures, agreements related to cyber consumers

19ECS743: WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	2	4

The course is designed to enable the student to understand the sensor networking concepts. This course lays the foundation both for developing and implementing networking concepts in a real time environment.

Course objectives:

1. Discuss the state-of-the-art in wireless sensor network protocols, architectures and applications.
2. Demonstrate the use of ns-3 for analyzing the performance of popular WSN protocols.
3. Analyze the working of medium access control protocols using Markov chain models.
4. Discuss the key routing protocols for sensor networks and main design issues involved in them.
5. Analyze the issues in and solutions for security in wireless sensor networks.

Module I: Number of hours(LTP) 9 0 6

Introduction to Wireless Sensor Networks: Course Information, Motivations, Applications, Performance metrics, History and Design factors.
Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture
Hardware Platforms: Motes, Hardware parameters

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Understand the basics of wireless sensor networks (L2).
2. List the applications and design factors of sensor networks (l2).
3. Compare and contrast the architecture of WSNs with the traditional layered network architecture. (L2)

Module II: Number of hours(LTP) 9 0 6

Introduction to ns-3: Introduction to Network Simulator 3 (ns-3), Description of the ns-3 core Unit and simulation example.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Understand the working of the network simulator-3 (L2).
2. Demonstrate the working of the ns-3 simulator. (L3)
3. Use this simulator for protocol evaluation (L5).

Module III: Number of hours(LTP) 9 0 6

Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled
Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis
MAC Protocol Analysis: Asynchronous duty-cycled X-MAC Analysis (Markov Chain)

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Understand the medium access control protocol design for WSNs. (L3)
2. Model stochastic processes using Markov chains. (L4)
3. Solve problems of MAC in WSNs using Markov chains. (L3)

Module IV: Number of hours(LTP) 9 0 6

Security: Possible attacks, countermeasures, SPINS, Static and dynamic key distribution
Learning Outcomes:
After completion of this unit, the student will be able to:

1. List the various types of attacks (L2).
2. Apply the SPINS security protocol suite for security in WSNs. (L3).
3. Distinguishing between static and dynamic key distribution (L4)

Module V: Number of hours(LTP) 9 0 6

Routing protocols: Introduction, MANET protocols
Routing protocols for WSN: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast
Opportunistic Routing Analysis: Analysis of opportunistic routing (Markov Chain) Advanced topics in wireless sensor networks.
Advanced Topics: Recent development in WSN standards, software applications.
Learning Outcomes:
After completion of this unit, the student will be able to:

1. Discuss the working of routing protocols in MANETs (L2).
2. Compare and contrast the different routing protocols for sensor networks (L3).
3. Outline the recent developments in WSNs (L1).

Text Books(s)

1. W. Dargie and C. Poellabauer, “Fundamentals of Wireless Sensor Networks –Theory and Practice”,Wiley 2010.
2. KazemSohraby, Daniel Minoli and TaiebZnati, “Wireless sensor networks -Technology, Protocols,and Applications”, Wiley Interscience 2007.

Reference Book(s)

1. Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, Springer 2010.
2. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless. Sensor Networks “John-Wiley, First-Edition-2014.

Course Outcomes:

1. Explain the basics concepts of wireless sensor networks (L2).
2. Use network simulator ns-3 to implement protocols for WSNs and to evaluate their performance(L3).
3. List medium access control and routing protocol design issues for WSNs. L1)
4. Distinguish between different approaches to security in WSNs(L3).
5. Demonstrate knowledge of the state of the art in WSNs (L2).

19ECS751: DATA PREPARATION AND ANALYSIS

L	T	P	C
3	0	2	4

This course provides an overview of techniques to explore, analyze, and leverage data. The goal of data preparation is to create the data and provide insight into methods for analysis and processing of the data generated by modern information systems.

Course Objectives

1. To learn gather data from data sources and clean the data.
2. To prepare data marts and transform data for statistical analysis.
3. To perform exploratory data analysis and apply statistical methods to data for further refining
4. To develop meaningful Data Visualizations.
5. To create visualizations by using summary statistics and visualization methods for data exploration

Module I: Number of hours(LTP) 9 0 6

Data Gathering and Preparation: Introduction to Big data, Terminology, Big data life cycle, Process for Making Sense of Data, Describing Data, Data sources, Data understanding, Data preparation

Learning Outcomes:

After completion of this unit the student will be able to

1. outline the different characteristics of data(L2)
2. summarize the process of preparing the data(L4)
3. collect the data from different sources(L2)
4. classify and describe the data types of raw data(L2)

Module II: Number of hours(LTP) 9 0 6

Data Cleaning: Data Tables, Graphs, Understanding Relationships, Visualizing Relationships between Variables, Calculating Metrics about Relationships, Data Visualization

Learning Outcomes:

After completion of this unit the student will be able to

1. examine the data formats in the tables(L4)
2. identify the relationships and their measures of data variables(L4)
3. modify the relationships for analysis purpose(L6)
4. construct visualizations to find the relationships. (L6)

Module III: Number of hours(LTP) 8 0 6

Exploratory Analysis: Descriptive statistics, inferential statistics, comparative statistics, Clustering and association.

Learning Outcomes:

After completion of this unit the student will be able to

1. understand different statistical methods used to prepare data(L2)
2. apply statistical methods on data for further analysis(L4)
3. use hypothesis tests to re-verify the data(L3)
4. develop clusters and associations for the data(L5)

Module IV: Number of hours(LTP) 8 0 6

Visualization: Designing visualizations, Time series, Geo-located data

Learning Outcomes:

After completion of this unit the student will be able to

1. use various time series in visualization(L3)
2. distinguish various forms of visualizations(L4)
3. design data visualizations for complex datasets(L6)
4. generate visualizations for geo located data(L6)

Module V: Number of hours(LTP) 8 0 6

Correlations and connections, Hierarchies and networks, interactivity

Learning Outcomes:

After completion of this unit the student will be able to

1. understand the concept of correlations and connections.(L2)
2. explain how interactivity can be used for visualization. (L4)
3. imagine the basic hierarchies in a network for interactivity.(L5)

Text Book(s):

1. Glenn J. Myatt, Making sense of Data I: A practical Guide to Exploratory Data Analysis and Data Mining, 1/e,2/e, A John Wiley & Sons, Inc., Publication, 2014.
2. Ben Fry, Visualizing Data: Exploring and Explaining Data with the pre-processing Environment, O'REILLY MEDIA,2018.
3. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung: Time Series Analysis: Forecasting and Control, 5/e,Wiley publications**,**2015**.**
4. Tamraparni Dasu, Exploratory Data Mining and Data Cleaning, A John Wiley & Sons, Inc, 2003.(no updated edition)

Course Outcomes:

After completing this Course, the student should be able to

1. familiarize in converting data into valuable information. (L1)
2. develop strategies for dealing with imperfect data. (L5)
3. distinguish clustering and association and apply them in solving statistical problems. (L2)
4. design visualizations for exploratory analysis. (L3)
5. review the concept of correlations and connections for geo located data. (L3)
6. visualize the basic hierarchies in a network for interactivity. (L2)

19ECS757: MALWARE ANALYSIS AND REVERSE ENGINEERING

L	T	P	C
3	0	2	4

The course will provide an overview of malware research, intelligence gathering related to malware, and provide basic skills required to analyse and dis-assemble malicious programs. Students will explore the tools required to analysis and do reverse engineering of malicious code, learn malware Forensics techniques, how malware functions, and will perform live analysis and reverse engineering exercises.

Course objectives:

1. Learn fundamentals and Classification of Malware
2. Introduce Tools and Techniques of malware analysis
3. Enable to Identify malware through behavioural and Code analysis
4. Describe Malware Forensics

Module I: Number of hours(LTP) 9 0 6

Introduction: CISC/RISC and Programming Basics, Assembly languages, Becoming familiar with x86 (IA-32 and x64), Exploring ARM assembly, Basics of MIPS, Covering the SuperH assembly, Working with SPARC

Diving Deep into Windows Malware: Basic Static and Dynamic Analysis for x86/x64, Static and dynamic linking, Using PE header information for static analysis, PE loading and process creation, Dynamic analysis with OllyDbg/immunity debugger, Debugging malicious services

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand goals of malware analysis(L1)
2. compare dynamic analysis and static analysis(L2)
3. learn malware analysis. (L1)

Module II: Number of hours(LTP) 9 0 6

Unpacking, Decryption, and De-obfuscation: Exploring packers, Identifying a packed sample, Automatically unpacking packed samples, Manual unpacking using OllyDbg,Dumping the unpacked sample and fixing the import table, Identifying different encryption algorithms and functions, String search detection techniques for simple algorithms, Identifying the RC4 encryption algorithm, Standard symmetric and asymmetric encryption algorithms, Cryptography API next generation (CNG), Using IDA for decryption and unpacking

Learning Outcomes:

After completion of this unit, the student will be able to:

1. review unpacking, decrypting and de-obfuscation (L2)
2. compare symmetric and asymmetric encryption algorithms. (L2)
3. understand how IDA is used for decryption and unpacking(L6)

Module III: Number of hours(LTP) 9 0 6

Inspecting Process Injection and API Hooking :Understanding process injection, DLL injection, Working with process injection, Dynamic analysis of code injection, Memory forensics techniques for process injection, Understanding API hooking, Working with API hooking, Exploring IAT hooking

Learning Outcomes:

After completion of this unit, the student will be able to:

1. develop code for process injection(L3)
2. Explore IAT Hooking (L2)

Module IV: Number of hours(LTP) 9 0 6

Examining Cross-Platform Malware: Handling Exploits and Shellcode, Cracking the shellcode, Exploring bypasses for exploit mitigation technologies, Analyzing Microsoft Office exploits, Studying malicious PDFs

Learning Outcomes:

After completion of this unit, the student will be able to:

1. record the experience of malware behaviour in Microsoft office(L1)
2. evaluate exploit mitigation technologies. (L5)

Module V: Number of hours(LTP) 9 0 6

Dissecting Linux and IoT Malware :Exploring common behavioral patterns, Static and dynamic analysis of x86 (32- and 64-bit) samples, Learning Mirai, its clones, and more, Static and dynamic analysis of RISC samples, Handling other architectures

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify common behavioural patterns (L1)
2. explain Static and dynamic analysis of x86. (L4)
3. understand how tohandling other architectures(L2)

Text Books(s)

1. Alexey Kleymenov, Amr Thabet ,Mastering Malware Analysis : The complete malware analyst's guide to combating malicious software, APT, cybercrime, and IoT attacks , Packt Publications,2019

Reference Book(s)

1. Michael Sikorski, Andrew Honig, Practical Malware Analysis: The Hands On Guide to Dissecting Malicious Software, William Pollock, 2012
2. Monnappa K A, Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware,Packt Publications,2018

Course Outcomes:

1. apply malware analysis methodology and technology (L3)
2. implement advanced static and dynamic malware analysis(L3)
3. make Process injection and API Hooking (L3)
4. analyse Office exploits and malicious PDFs (L1)
5. apply Linux and IoT Malware Dissection(L3)

19ECS781: Internet of Things

L	T	P	C
3	0	2	4

The Internet of Things (IoT) is a network of a wide variety of devices like vehicles, humans, soil etc. These devices gather data using sensors, which will be useful for monitoring and control. This course is an introduction to the embedded devices, communication protocols and APIs used in IoT.

Course objectives:

1. Introduce the fundamental concepts of IoT and physical computing
2. Expose the student to a variety of embedded boards and IoT Platforms
3. Create a basic understanding of the communication protocols in IoT communications.
4. Familiarize the student with application program interfaces for IoT.
5. Enable students to create simple IoT applications in virtual environment

Module I: Number of hours(LTP) 9 0 6

Overview of IoT: The Internet of Things - An Overview, The Flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?, Design Principles for Connected Devices, Calm and Ambient Technology, Privacy, Keeping Secrets, Whose Data Is It Anyway?, Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens On The Internet, Graceful Degradation, Affordances.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the technology for IoT architecture(L2)
2. interpret the design principles that govern connected devices(L2)
3. summarize the roles of various organizations for IoT(L2)

Module II: Number of hours(LTP) 9 0 6

Embedded Devices - I: Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, Developing on the Arduino, Some Notes on the Hardware, Openness.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the basics of microcontrollers(L2)
2. outline the architecture of Arduino(L2)
3. develop simple applications using Arduino(L3)

Module III: Number of hours(LTP) 8 0 6

Embedded Devices – II: Raspberry Pi , Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness, BeagleBone Black, Developing of Electric Imp,Other notable platforms, Mobile phones and tablets, Plug
Computing: Always-on Internet of Things.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. outline the architecture of Raspberry Pi(L2)
2. develop simple applications using Raspberry Pi(L3)
3. select a platform for a particular embedded computing application(L3)

Module IV: Number of hours(LTP) 8 0 6

Communication in the IoT: Internet Principles, Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP), UDP, IP Addresses, DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, An Example: HTTP Ports, Other Common Ports, Application Layer Protocols- HTTP, HTTPS: Encrypted HTTP, Other Application Layer Protocols.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. interpret different protocols and compare them(L2)
2. select which protocol can be used for a specific application(L3)
3. Utilize the Internet communication protocols for IoT applications(L3)

Module V: Number of hours(LTP) 8 0 6

Prototyping Online Components: Getting Started with an API, Mashing Up APIs, Scraping, Legalities, Writing a New API, Clockodillo, Security, Implementing the API, Using Curl to Test, Going Further, Real Time Reactions, Polling, Comet, Other Protocols, MQ Telemetry Transport, Extensible Messaging and Presence Protocol, Constrained Application Protocol.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. select IoT APIs for an application(L3)
2. design and develop a solution for a given application using APIs(L6)
3. test for errors in the application(L4)
4. judge the security issues in Real time applications(L5)

Text Books(s)

1. Adrian McEwen, Hakim Cassimally - Designing the Internet of Thing Wiley Publications, 2014, ISBN : 978 - 1118430620

Reference Book(s)

1. ArshdeepBahga, Vijay Madisetti - Internet of Things: A Hands-On Approach, Universities Press, 2014, ISBN: 978 - 0996025515
2. Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling technologies anduse cases –CRC Press 2017, ISBN : 978 - 1498761284

Course Outcomes:

After completion of this course, the student will be able to

1. choose the sensors and actuators for an IoT application(L1)
2. select protocols for a specific IoT application(L2)
3. utilize the cloud platform and APIs for IoT application(L3)
4. experiment with embedded boards for creating IoT prototypes(L3)
5. design a solution for a given IoT application(L6)

19ECS759: Ethical Hacking

L	T	P	C
3	0	2	4

This course provides an overall idea of various ethical hacking techniques. It also provides various reverse engineering technique. Exploitation techniques for Linux and windows operating systems are also provided

Course objectives:

1. Learn the grey hat way of hacking.
2. Understand the red team and purple team operations.
3. Familiarize with Linux exploitation techniques.
4. Implement windows exploitation techniques.

Module I: Number of hours(LTP) 8 0 6

Introduction to grey hat hacking: Know your Enemy, the grey hat way, Evolution of cyber law, C Programming Language, computer memory, Assembly language basics, Debugging with gdb
Introduction to reverse engineering: Code Annotation, Collaborative Analysis, Dynamic Analysis

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand Grey hat hacking (L1)
2. design and implement reverse engineering techniques(L6)

Module II: Number of hours(LTP) 10 0 6

Red team Operations: Objectives, Scope, Time, Audience, Overcoming Limitations, Understanding Threads, Attack frameworks, Testing Environment, Adaptive testing.
Purple Teaming: Introduction, Blue team operations, Purple team operations, Purple team optimization.
Bug Bounty Programs: History of Vulnerability Disclosure, Bug crowd, earning a living finding bugs, incident response, Gaining Access - Capturing Password Hashes, Using Win exe, Using WMI, Win RM

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Explain various red team and purple team operation (L4)
2. Identify bug bounty programs (L3)

Module III: Number of hours(LTP) 8 0 6

Linux Exploits: Stack operations and function-calling procedures, Buffer Overflows, Local Buffer overflow Exploits, Exploit Development process. Format String Exploits, Memory protection schemes.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand Linux exploitation techniques (L1)
2. use buffer overflow attack techniques(L3)

Module IV: Number of hours(LTP) 8 0 6

Windows Exploits: Compiling and debugging windows programs, Writing Windows, Exploits, understanding structured Exception handling, Understanding and bypassing windows memory protections.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Implement windows memory protection bypass techniques(L4)
2. use windows exploitation techniques (L3)

Module V: Number of hours(LTP) 8 0 6

Web application exploitation: The Evolution of cross site scripting, Framework Vulnerabilities Malware analysis: Dissecting Mobile Malware, The android platform, The IOS Platform. Dissecting ransom ware. Dissecting ransom lock, Wanna Cry, introduction to honey pots.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. design and implement Web application exploitation (L6)
2. understand malware analysis (L1)

Text Book(s)

1. Allen Harper, Gray Hat Hacking: The Ethical Hacker's Handbook, Mc Graw Hill Education ,5th Edition.

Course Outcomes:

1. understand Grey hat hacking techniques. (L2)
2. Differentiate red team and purple team operations. (L4)
3. implement Linux and Windows exploitation. (L6)
4. Implement malware analysis on various platforms (L6)

Laboratory experiments

1. To learn about hacking tools and skills
2. To study about "Footprinting and Reconnaissance".Domain Name Information, Finding IP Address, Finding Hosting Company, IP Address Ranges.
3. To study about Fingerprinting.
   Port Scanning, Ping Sweep, DNS Enumeration
4. To study about system Hacking.
   TCP/IP Hijacking, Trojan Attacks, Trojan Information, Email Hijacking, Social Engineering, Inserting Viruses in a User System, Password Hacking, Dictionary Attack, Hybrid Dictionary Attack, Brute-Force Attack, Rainbow Tables
5. To study about Wireless Hacking.
   Kismet, NetStumbler, Wired Equivalent Privacy, WEPcrack, Aircracking, Wireless DoS Attacks.
6. To learn about Sniffing tools.
7. To study about Mobile Hacking.
8. To study about performing DOS Attacks on Cloud Network.
9. To study various cryptography tools.
10. To study Web Application Hacking

19ECS747: DATA SCIENCE

L	T	P	C
3	0	2	4

The purpose of this course is to provide a clear understanding about various data analytic techniques available to solve real world business problems, communicate findings, and effectively present the results using data visualization techniques. The knowledge gained helps in applying the data science concepts and methods to solve problems in real-world contexts.

Course objectives:

1. Familiarize the student about the concepts of data visualization and formal inference procedures.
2. Enable the student to interpret wider range of visual and numerical data
3. Train the student on basic machine learning algorithms
4. Demonstrate the Applications of Data Science, Technologies for visualization
5. Handling of variables using Python

Module I: Introduction to core concepts and technologies — Number of hours(LTP) 9 0 6

Benefits and uses of data science and big data, Data science Process, data science toolkit, Types of data Example applications. Introduction to Data Science, Terminologies: Artificial Intelligence, Machine Learning, Statistics, Business Analytics

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand the basic concepts of data science(L2)
2. identify the types of data(L2)

Module II: Data collection and management — Number of hours(LTP) 9 0 6

Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand about how to collect the data, manage the data, explore the data, store the data(L2)

Module III: Data analysis — Number of hours(LTP) 8 0 6

Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes. Bayesian Classifier, K-Nearest Neighbors, Decision trees, Logistic Regression

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand the basic measures of central tendency. (L2)
2. classify the data using svm and navie Bayesian. (L2)
3. understand about Decision trees and Logistic Regression (L2)

Module IV: Data visualization — Number of hours(LTP) 8 0 6

Introduction, Types of data visualization, Data for visualization: Data types, Data encodings Retinal variables, mapping variables to encodings, Visual encodings.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. familiarize about the visualization of data. (L4)
2. apply coding techniques to data for securing the data. (L4)

Module V: Artificial Neural Network Number of hours(LTP) 8 0 6

Perceptron, multi-layer perceptron, CNN, RNN, GAN, Auto Encoder , Applications of Data Science , Case study using Kaggle

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the various concepts of data science and can be able to handle simple application of data science using python.(L2)

Text Books(s)

1. Cathy O'Neil, Rachel Schutt, Doing Data Science, Straight Talk from the Frontline. O'Reilly, 2013.
2. Jure Leskovek, Anand Rajaraman, Jeffrey Ullman, Mining of Massive Datasets. v 2.1 Cambridge University Press, 2014.

Reference Book(s)

1. The Visual display of quantitative information by Edward R. Tufte, 2nd ediion
2. Cathy O'Neil and Rachel Schutt , "Doing Data Science", O'Reilly, 2015.

Course Outcomes:

1 identify the types of data (L1).
2. understand about how to collect the data, manage the data (L2).
3. classify the data using svm and navie bayesian (L3)
4. apply coding techniques to data for securing the data (L4)

19ECS761: DATA ENCRYPTION AND COMPRESSION

L	T	P	C
3	0	2	4

The emphasis of the course is the processing of encryption and compression in the design of cryptographic algorithms. The course will start with encryption, which is the process of encoding messages or information so that only authorized parties can read it. Moreover, compression, source coding, or bit-rate reduction involves encoding information using fewer bits than the original representation. As a part of cryptanalysis, we will study several attacks on these algorithms and their remedies. We will also study recent developments in Entropy encoding and differential encoding techniques

Course objectives:

1. This course aims to introduce to the students the fundamentals of data compression, data encryption, and data security.
2. Students will distinguish among various types of Data Compression and Encryption techniques/algorithms for text, images.
3. Enable the student to learn basic knowledge in various cryptographic algorithms.
4. Demonstrate the handling of various threats during the transmission of information over the network and overcome them.
5. Describe and apply various techniques for text compression and evaluate the performance of the coding techniques.

Module I: Introduction to Security Number of hours(LTP) 9 0 6

Need for security, Security approaches, Principles of security, types of attacks. Encryption Techniques: Plaintext, Ciphertext, Substitution & Transposition techniques, Encryption & Decryption, Types of attacks, Key range & Size.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. learn why networks need security and their approaches. (L1)
2. learn to protect a computer system from security threats and ethical issues related to computer and network security. (L1)
3. finding differentiates between substitution and transposition techniques and different types of cryptography. (L2)

Module II: Symmetric & Asymmetric Key Cryptography Number of hours(LTP) 9 0 6

Algorithm types & Modes, DES, IDEA, Differential & Linear Cryptanalysis, RSA, Symmetric & Asymmetric key together, Digital signature, Knapsack algorithm. User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate-based & Biometric authentication, Firewall.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. learn the environment that led to the development of the Data Encryption Standard (DES). (L6)
2. identifying, describing, and explaining the purpose of each stage of the DES algorithm. (L3)
3. enumerating the weaknesses of the DES algorithm. (L4)

4. finding methods that provide the goals of integrity, authentication, and non-repudiation. (L1)

Module III: Case Studies of Cryptography Number of hours(LTP) 9 0 6

Denial of service attacks, IP spoofing attacks, Secure inter-branch payment transactions, Conventional Encryption, Message Confidentiality, Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.

Public Key Cryptography and Message Authentication: Approaches to Message Authentication, SHA-1, MD5, Public-Key Cryptography Principles, RSA, Digital, Signatures, Key Management.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. learn the requirement in public-key cryptography is a secure algorithm. (L1)
2. know the MD5 sum collection in the presence of witnesses. (L1)
3. practices and procedures to be followed in carrying out technical and administrative aspects of key management, both automated and manual. (L3)

Module IV: Introduction to data compression Number of hours(LTP) 9 0 6

Need for data compression, Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression, Classification.
Methods of Data Compression: Data compression - Lossless & Lossy.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe and apply various techniques for text compression and evaluate the performance of the coding techniques. (L2)
2. define and classify compression and explain its performance parameters. (L1)

Module V: Encoding Number of hours(LTP) 9 0 6

Entropy encoding: Repetitive character encoding, Run-length encoding, Zero/Blank encoding.

Statistical encoding: Huffman, Arithmetic & Lempel-Ziv coding; Source encoding - Vector quantization (Simple vector quantization & with error term).

Differential encoding: Predictive coding, Differential pulse code modulation, Delta modulation, Adaptive differential pulse code modulation.

Transform based coding: Discrete cosine transform & JPEG standards, Fractal compression.
Recent trends in encryption and data compression techniques.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand the need for text compression, types of redundancies, and their model to apply to code. (L2)
2. examine the given situation to choose the appropriate compression technique by evaluating the performance. (L4)

3. conclude on encoded outputs using entropy technique with given the different probability sets. (L5)
4. draw and explain different image compression standards. (L2)

Text Books(s)

1. BehrouzForouzen, Cryptography, and Network Security, Tata McGraw-Hill Education 2011.
2. Mark Nelson, Jean-Loup Gailly,The Data Compression Book, 2nd edition, BPB Publications
3. Atul Kahate, Cryptography & Network Security, TMH

Reference Book(s)

1. Khalid Sayood, Introduction to Data Compression, 2nd Edition Morgan Kaufmann.
2. William Stallings, Cryptography and Network Security Principles and Practices 5th Edition, Pearson Education.
3. David Saloman, Data Compression: The complete reference, Springer publication.
4. Berard Menezes, Network Security, and Cryptography, learning publication Cengage.

Course Outcomes:

1. provide security of the data over the network. (L4)
2. research the emerging areas of cryptography and network security. (L6)
3. implement various networking protocols. (L3)
4. protect any network from the threats in the world.(L5)

19ECS749: INTRODUCTION TO INTELLIGENT SYSTEMS

L	T	P	C
3	0	2	4

The purpose of this course is to familiarize you with the basic techniques of artificial intelligence/intelligent systems. An introduction to the theories and algorithms used to create intelligent systems. Topics include search algorithms, logic, planning, knowledge representation, machine learning, and applications from areas such as computer vision, robotics, natural language processing, and expert systems.

Course objectives:

1. Introduces students to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach.
2. Explores the essential theory behind methodologies for developing systems that demonstrate intelligent behaviour including dealing with uncertainty, learning from experience and following problem solving strategies found in nature
3. Understand the process of design of Intelligent systems
4. Develop prototype Intelligent system by adopting the natural inspired strategies
5. Acquire the Knowledge of parametric and non-parametric techniques

Module I: Foundations to intelligent systems I Number of hours(LTP) 9 0 6
Artificial neural networks, Hidden layer, Multilayer Perceptron, Back- propagation networks, Radial basis function networks, and recurrent networks (Chapter 12, Chapter 13 of Text Book 1)

Learning Outcomes:
After completion of this unit, the student will be able to:

1. acquire a basic understanding of the Intelligent systems (L2)
2. have the understanding of the Neural Networks. (L2)
3. explain back propagation in naturally existed organism (L2)
4. analyse the neural network problems (L4)
5. illustrate machine perception (L2)

Module II: Foundations to intelligent systems II Number of hours (LTP) 6 0 4
Genetic Algorithms, basic GA, Selection, Elitism, Gray code, Genetic Programming (Chapter GA and optimization of Text book 2),Swarm Intelligence (Chapter 16 of text book 1)
Learning Outcomes:
After completion of this unit, the student will be able to:

1. experiment with genetic algorithms. (L3)
2. make use of the Inference Techniques. (L3)
3. outline knowledge representation (L2)
4. understand fuzzy logic foundations (L2)
5. make use of fuzzy logic for real time problems (L3)

Module III: Search Methods Number of hours (LTP) 8 0 6
Search Methods Basic concepts of graph and tree search. Three simple search methods: breadth-first search, depth-first search, iterative deepening search. Heuristic search methods: best-first search, admissible evaluation functions, hill- climbing search. Optimization and search such as stochastic annealing and genetic algorithm (Chapters 2,3,5 of text book 1)

Learning Outcomes:
After completion of this unit, the student will be able to:

- understand annealing optimization technique (L2)
- visualize real time problems as graph and tree search algorithms (L3)
- experiment heuristic search (L3)
- apply basic search methods in the design of intelligent systems (L3)
- define hill climbing search mechanism (L1)

Module IV: Knowledge Representation (if any) Number of hours(LTP) 9 0 6
Knowledge representation and logical inference Issues in knowledge representation. Structured representation, such as frames, and scripts, semantic networks and conceptual graphs. Formal logic and logical inference. Knowledge-based systems structures, its basic components. Ideas of Black board architectures (Chapters 3,4,5 of text book 2)

Learning Outcomes:
After completion of this unit, the student will be able to:

1. apply formal logic for knowledge representation. (L3)
2. understand black board architectures. (L2)
3. illustrate formal logic and logical inferences (L2)
4. distinguish inferencing issues (L2)
5. explain about how to choose attributes for knowledge-based systems structures (L2)

Module V: Reasoning under uncertainty Number of hours (LTP) 10 0 6
Quantifying uncertainty, Probabilistic Reasoning, Probabilistic reasoning over time (Chapters 13, 14, 15 of text book 3)
Learning Outcomes:
After completion of this unit, the student will be able to:

1. have a basic understanding of reasoning under uncertainty. (L2)
2. have the understanding Dempster-Shafer theory. (L2)
3. infer Probabilistic reasoning over time algorithms (L2)
4. understanding Kalman filters (L2)
5. make use of hidden Markov models (L3)

Text Books(s)

1. Crina Grosan Ajith Abraham, Intelligent Systems, Springer, 2011
2. Adrian A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2016
3. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 2016

Reference Book(s)

1. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson.
2. T. J. M. Bench-Capon, Knowledge Representation: An Approach to Artificial Intelligence, Academic Press, 2014
3. Dr.Nilakshi Jain, Artificial Intelligence : Making a System Intelligent, Wiley Publications,1st Edition,2019

Course Outcomes:

1. describe the attributes of various search techniques and the situations to which they are well-suited. (L2)
2. describe and apply various techniques for logic programming and machine learning. (L2)
3. Implement standard AI algorithms. (L6)
4. discuss the history and implications of artificial intelligence research. (L2)
5. Design and construct a intelligent system

19ECS763: RECOMMENDER SYSTEMS

L	T	P	C
3	0	2	4

The aim of this course to cover the foundations of recommender systems, domain-areas and applications of Recommender systems such as business, content and media, Social Networking, Intrusion and attacks and so on. Also this course covers basic and advanced concepts of Recommender Systems that includes personalization algorithms, evaluation tools, and user experiences.

Course objectives:

1. Understand the foundations of Recommender Systems
2. Understand and Apply different Filtering Methods of Recommender Systems: Content-Based and Collaborative Based RSs
3. Understand and apply Mathematical Foundations for Recommender Systems.
4. Understand and apply different Recommender Systems such as Context-Aware, Knowledge-Based, Ensemble-Based, Hybrid Approaches and Group-Based Recommender Systems
5. Identify and Analyze a recommender system for real-time case studies such as Business, Content, Media, and Social Networking and so on.

Module I: Introduction to Recommender Systems Number of hours(LTP) 9 0 6
Introduction to Recommender System, Taxonomy of Recommender Systems, Traditional, Personalized and Non-Personalized Recommender Systems, Data and Knowledge Sources of Recommender Systems. Goals of Recommender Systems, Issues and Challenges of Recommender Systems, Applications of Recommender Systems

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Analyze the Taxonomy of Recommender Systems(L4)
2. Discuss various types of Recommender Systems(L6)
3. List the Goals of Recommender Systems(L4)
4. Elaborate the issues and challenges of Recommender Systems(L6)
5. List various applications of Recommender Systems(L4)

Module II: Content-Based Recommender Systems Number of hours(LTP) 8 0 6
Introduction, Basic Components of Content-based Recommended Systems, Advantages and Disadvantages of Content-Based Recommender Systems, Pre-processing and Feature Extraction, Item representation Methods for learning user profiles and Filtering, Similarity Based and Classification methods

Learning Outcomes:
After completion of this unit, the student will be able to:

1. List the components of Content-Based Recommender Systems(L4)
2. Discuss about various Pre-Processing mechanisms and Feature Engineering(L6)
3. List the learning user profiles and Filtering(L4)
4. Explain about Similarity-based methods(L6)
5. Discuss various classification techniques in Content-Based Recommender Systems(L6)

Module III: Collaborative Filtering Number of hours(LTP) 8 0 6
Introduction to Collaborative Filtering, Neighbourhood-based Collaborative Filtering: Introduction, Key Properties of Rating Matrices, User-based Neighbourhood models, Item-based Neighbourhood models, Comparison of User-based and Item-based models, Strengths and Weakness of

Neighbourhood-Based models, Components of Neighbourhood methods, Matrix Factorization and Dimensionality Reduction for Neighbourhood based models, Graph Models for Neighbourhood based methods, Latent factor models, Introduction to tensors and their applications

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Discuss Different types of Collaborative Filtering(L6)
2. List Strengths and Weakness of Collaborative Filtering(L4)
3. Apply various Matrix Factorization Methods for Feature engineering(L6)
4. Discuss Graph-Based methods for Recommender Systems(L6)
5. List Tensor models and their applications in Collaborative Filtering(L4)

Module IV: Ensemble and Hybrid-Based Approaches Number of hours(LTP) 8 0 6
Knowledge-Based Recommender Systems: Introduction, Constraint-Based Recommender Systems: Introduction, Case-Based Recommender Systems: Introduction.
Ensemble-Based and Hybrid Recommender Systems: Introduction, Ensemble methods for classification Perspective, Weighted Hybrids, Switching Hybrids, Cascade Hybrids, Feature Augmentation and Feature Combination Hybrids, Mixed Hybrids, Limitations of Hybrid Models and Applications.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Explain Constraint-based and Case-based Recommender Systems(L4)
2. Discuss Ensemble-Based Recommender Systems(L6)
3. List the Opportunities of Hybrid Systems(L4)
4. Explain different types of Hybrid Systems and its Perspectives(L6)
5. Interpret the Limitations of Hybrid Systems (L5)

Module V: Advanced Recommender Systems Number of hours(LTP) 8 0 6
Evaluating Recommender Systems: Introduction, Evaluation Paradigms and General Goals of Evaluation Design, Design Issues and Challenges.
Context-Aware Recommender Systems: Introduction, Contexts in Recommender Systems, Paradigms, Multidimensional Approach, Design Issues and Challenges.
Group-Based Recommender Systems: Introduction, Characteristics, Recommendation Algorithms

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Interpret different Evaluating Design Issues and Paradigms (L5)
2. Explain Context-Aware Recommender Systems and multidimensional Approach (L5)
3. Discuss about Group-Based Recommender Systems (L6)
4. Elaborate various applications of Recommender Systems(L6)
5. Discuss the limitations and merits of Recommender Systems(L6)

Text Books(s)

1. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. Jannach D., Zanker M., Fel Fering A., Recommender Systems: An Introduction, 1/e, Cambridge University Press, 2011.
3. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer, 2011.

Reference Book(s)

4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer, 2013.

5. Alexander Felfernig, Ludovico Boratto, Martin Stettinger and Marko Tkalcic, Group Recommender Systems: An Introduction, Springer.

Course Outcomes:

1. Interpret different challenges and issues with Recommender Systems(L5)
2. Experiment with content-based Recommender systems(L3)
3. Apply Different strategies and methods of Collaborative Filtering (L5)
4. Discuss and Interpret Knowledge-Based, Ensemble and Hybrid Approaches (L5)
5. Explain Advanced Recommender Systems: Evaluating, Context-Aware and Group-Based Recommender Systems(L5).

19ECS777: AGILE SOFTWARE DEVELOPMENT

L	T	P	C
3	0	2	4

agile software development practices enable customer centric software development with collaborative teamwork centred around people. This course elaborates agile development principles and techniques covering the entire software development process from problem conception through development, testing and deployment to equip the learner with practical software development methodology.

Course objectives:

1. Understand the agile concepts and its importance in software development
2. Acquire knowledge on Scrum, Xtreme programming, FDD
3. Practice agile methods through projects
4. Understand Continuous Integration, Test Driven Development
5. Relate Devops to Agile Processes

Module I: Number of hours(LTP) 9 0 6

Introduction: The Agile manifesto, Agile methods, XP: Extreme Programming, DSDM, SCRUM, feature- Driven Development, Test Driven Development, modelling misconceptions, agile modelling, tools of misconceptions, updating agile models.

Lab: Case study analysis and user stories/features identification (Jira, Github, any IDE can be used as Tools for the Lab)

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand the origins and motivations of the Agile Manifesto (L1)
2. Distinguish different agile methods for software development(L2)
3. Describe different Agile Methods (L3)
4. Analyse requirements to prepare features and user stories (L4)
5. Develop roadmap for the Epics and user stories (Jira/any other Tool)(L5)

Module II: Number of hours(LTP) 9 0 6

Extreme Programming: Introduction, core XP values, the twelve XP practices, extreme programming, planning XP projects, test first coding, pair programming.

Agile Modelling and XP: Introduction, the fit, common practices, modelling specific practices, XP objections to agile modelling, agile modelling and planning XP projects, XP implementation phase.

Lab: plan and initiate pair programming for the case study

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Define core XP values(L1)
2. Explain the twelve XP practices(L2)
3. Identify different XP projects(L4)
4. Construct test first coding and pair programming(L5)
5. Manage Sprints (L5)

Module III: Number of hours(LTP) 9 0 6

Scrum Framework, Agile Principles, Sprints, Requirements and User Stories, Product backlogs, Estimation and Velocity, Roles, Planning, Multi-level Planning, Release Planning, Sprint planning

Lab: Plan for the application based on case study using Scrum
Learning Outcomes:
After completion of this unit, the student will be able to:

1. Understand Scrum enables developers to develop customized software(L1)
2. DemonstrateScrum practices (L3)
3. Develop user stories (L4)
4. Develop scrum process for implementation of case study (L4)
5. Identify tools for Agile Development (L3)

Module IV: Number of hours(LTP) 9 0 6

Feature-Driven Development: Introduction, incremental software development, Regaining Control, motivation behind FDD, planning an iterative project, architecture centric, FDD and XP.
Test Driven Development: Unit Tests, Integration Tests, End-to-End Tests, Customer Tests

Lab: Identify Features in the application for incremental development using FDD and TDD and implement initial version

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Define Feature-Driven Development(L1)
2. Demonstrate incremental software development(L2)
3. Apply regaining control techniques(L3)
4. Develop application using TDD(L4)
5. Track Backlogs and run reports (L5)

Module V: Number of hours(LTP) 9 0 6

Release Management - Version Control, Continuous Integration.
DevOps: What is DevOps, DevOps Capabilities, Principles of flow, feedback, continuous learning, Technical Practices of Flow, Feedback, Continuous Learning, DevOps Tools.
DevOps using Cloud, Using DevOps to solve New Challenges

Lab: Plan and implement version control and releases for the application using DevOps. (Jenkins/ Microsoft Azure platform can be used)
Learning Outcomes:
After completion of this unit, the student will be able to:

1. Explain DevOps relation to Software Development Process (L2)
2. Understand DevOps practices (L1)
3. Identify tools to for enabling DevOps(L3)
4. Develop Application using DevOps principles(L4)
5. Set up version Control, builds, unit testing, code coverage, packaging for the application(L5)

Text Books(s)

1. John Hunt, Agile Software Construction, 1st Edition, Springer,2005
2. Craig Larman, Agile and Iterative Development: A Manager's Guide, Addison-Wesley, Pearson Education,2004.
3. Pearson, Robert C. Martin, Juli, James Shore, The Art Of Agile Development, O'Reilly Media, 2013
4. Elisabeth Hendrickson, Agile Testing, Quality Tree Software Inc. 2008.
5. Kenneth S. Rubin, Essential Scrum, Addison-Wesley, 2013 (Module IV)
6. Jene Kim, Jez Humble, Patrick Debois, John Willis, The Devops Handbook, 1st edition, IT

Revolution Press, 2016 (Module V)

7. Sanjeev Sharma, Bernie Coyne, DevOps for Dummies, Oreilly, 2nd IBM limited edition, 2015

Reference Book(s)

1. Andrew Stellman, Jenifer Greene, Head First Agile, Oreilly, 2017
2. Peggy Gregory, Casper Lassenius, Xiaofeng Wang Philippe Kruchten (Eds.), Agile Processes in Software Engineering and Extreme Programming, 22nd International Conference on Agile Software Development, XP 2021 Virtual Event, June 14–18, 2021, Proceedings, Springer
3. Peggy Gregory, Philippe Kruchten (Eds.), Agile Processes in Software Engineering and Extreme Programming – Workshops XP 2021 Workshops Virtual Event, June 14–18, 2021 Revised Selected Papers, 2021
4. Digital.ai-Periodic-Table-of-DevOps-Tools-4.2
5. Ian Somerville, Software Engineering, 10th edition, Pearson, 2016

Course Outcomes:

1. Use agile methods in various development environments
2. Apply Xtreme programming in XP projects confidently.
3. Design and develop applications in Scrum environments.
4. Develop abilities on Feature Driven Development
5. Develop abilities on DevOps Tools

19EMC741: RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

Please This course introduces the student, to the fundamentals of research, research process, technical writing and intellectual property rights. Students will be able to use this knowledge to gain interest in their subject area and pursue their career in research.

Course objectives:

1. To familiarize the meaning, objectives and sources of research
2. To acquaint the student with the importance and methods of literature review/research ethics
3. To impart the knowledge of technical writing for preparing reports, presentations, research proposals, conference/journal publications
4. To introduce the terminology and process of obtaining intellectual property rights
5. To expose the intricacies in the process of obtaining patent right

Module I: Number of hours(LTP) 6 0 0

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the meaning of a research problem. (L1)
2. list the different sources of research problem. (L1)
3. enumerate the different criteria of good research and list the different errors in selecting research problem. (L5)
4. contrast the different approaches of research. (L2)
5. compare the different methods for data collection and analysis. (L2)

Module II: Number of hours(LTP) 6 0 0

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list and elaborate the different steps of the research process. (L1)
2. explain the importance of carrying out an effective literature review. (L3)
3. identify the research gaps from literature review. (L1)
4. describe the ethical principles to be following during research process and authorship
5. define the terminology and list the methods to avoid being accused of plagiarism. (L1)
6. list the different types of research misconduct. (L1)

Module III: Number of hours(LTP) 6 0 0

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list the attributes, reasons and guidelines for effective technical writing. (L1)
2. contrast between conference paper, technical presentation and journal paper . (L2)
3. choose a particular research contribution for patenting or journal publication. (L1)
4. define the terminology related to citation, citation index, h-index etc.(L1

Module IV: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the codes and standards in building intellectual property rights. (L3)
2. list the subject, importance and requirements for of patentability. (L1)
3. explain the process of patenting and commercialization in academia. (L3)
4. enumerate the procedure for application preparation, filing and grant of Patents. (L2)
5. define the terminology related to citation, citation index, h-index etc.(L1)

Module V: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the scope of patent rights. (L3)
2. describe the process for licensing and transfer of technology. (L2)
3. identify the sources of patent information and databases. (L1)
4. elaborate the administration of patent system. (L2)
5. describe the new developments in IPR in computer software, biological systems etc.(L2)

Text Books(s)

1. Vinayak Bairagi, Mousami v. Munot, “Research Methodology: A Practical and Scientific Approach”, CRC press, 2019.
2. Dolores Modic, Nadja Damij, “Towards Intellectual Property Rights Management: Back-office and FrontOffice Perspectives “, Palgrave macmillan, 201

Course Outcomes:

1. define the meaning, sources, approaches for research problems. (L2)
2. explain the guidelines for carrying out effective literature review and identify research gaps. (L4)
3. describe effective guidelines for preparing technical reports, research publications, presentations and research proposals. (L5)
4. describe the codes, standards and process of obtaining intellectual property rights. (L5)
5. enumerate the new developments of IPR in engineering systems. (L6

19EAC741: ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	0

This course introduces the student, to the different aspects of research paper writing including planning, preparation, layout, literature review write-up etc. Specifically, the perspective and style of writing in different sections of a research paper is highlighted. Students will have exposed to English language skills relevant to research paper writing.

Course objectives:

1. To write clearly, concisely and carefully by keeping the structure of the paper in mind.
2. To use standard phrases in English and further improve his command over it.
3. To write with no redundancy, no ambiguity and increase the readability of the paper.
4. To plan and organize his paper by following a logical build-up towards a proper conclusion.
5. To decide what to include in various parts of the paper.
6. To write a suitable title and an abstract in order to attract the attention of the reader.
7. To identify the correct style and correct tense.
8. To retain the scientific value of the paper by using minimum number of words.

Module I: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. To know the expectations of various journals and referees (L2)
2. To know the typical structure of a paper (L3)
3. Learn to put words in a sentence in the correct order (L4)
4. To write short and clear sentences from the very beginning of the paper (L4)
5. To increase the readability of the paper by making it easy to read and 100% clear (L4)
6. Learn to be concise without losing any important content (L4)
7. To avoid some typical grammar mistakes made in research papers (L4)

Module II: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Learn to make useful contribution worth recommending for publication (L4)
2. Learn good use of language to make readers notice the key findings (L4)
3. Learn to anticipate or predict possible objections to the claims made in the paper(L5)
4. To understand what is plagiarism, and how to paraphrase other people's work (L4)
5. Learn to attract the right kind of readers with a suitable title(L3)
6. Learn to sell the abstract to potential readers by attracting their curiosity (L2)

Module III: Number of hours(LTP) 6 0 0

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. 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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. have a deep knowledge about everything that has been previously written on the topic and decide what is important to know in Introduction. (L3)
2. learn to provide the right amount of literature regarding the sequence of events leading up to the current situation in the Literature review(L4)

Module IV: Number of hours(LTP) 6 0 0

Writing Skills: 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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Learn to describe the materials used in experiments and/or the methods used to carry out the research (L2)
2. The key skill is in reporting the results simply and clearly (L3)
3. Learn to structure the Discussion and satisfy the typical requirements of the referees L4)
4. Learn to provide a clear and high-impact take-home message in the conclusion (L5)

Module V: Number of hours(LTP) 6 0 0

Good Paper Writing: Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Learn various lists of frequently used phrases that have a general acceptance in all disciplines and use in specific sections of the paper (L3)
2. Learn various kinds of things one should look for when doing the final check (L3)

Text Books(s)

1. Goldbort R, Writing for Science, Yale University Press, 2006
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM, Highman, 1998

Reference Book(s)

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Outcomes:

1. Frame the structure of the paper precisely. (L2).
2. Improve his command over English by using standard phrases. (L3).
3. Avoid repetition and mistakes in the paper and increase its readability. (L3).
4. Organize the paper logically towards a proper conclusion. (L4).
5. Decide on the content to be included in various parts of the paper. (L5).
6. Identify whether to use personal or impersonal style in the paper. (L5).
7. Express the content in a clear and concise way. (L6).
8. Attract the attention of the reader by providing a suitable title and an appropriate abstract. (L6)

19EAC742: DISASTER MANAGEMENT

L	T	P	C
2	0	0	0

This course is intended to provide fundamental understanding of different aspects of Disaster Management. It will expose the students to the concept and functions of Disaster Management and to build competencies of Disaster Management professionals and development practitioners for effective supporting environment as put by the government in legislative manner. It would also provide basic knowledge, skills pertaining to Planning, Organizing and Decision-making process for Disaster Risk Reduction.

Course objectives:

1. to provide students an exposure to disasters, their significance, types & Comprehensive understanding on the concurrence of Disasters and its management.
2. to ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention, risk reduction and the basic understanding of the research methodology for risk reduction measures.
3. equipped with knowledge, concepts, and principles, skills pertaining to Planning, Organizing, Decision-making and Problem solving methods for Disaster Management.
4. to develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Module I: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the meaning, list the factors and mention the significance of disaster (L1)
2. distinguish between hazard and disaster (L3)
3. compare manmade and natural disaster (L3)
4. list the types of disaster and describe their magnitude (L2)

Module II: Number of hours(LTP) 6 0 0

Repercussions of Disasters and Hazards: 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.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list the different repercussions of disasters and hazards(L1)
2. describe the characteristics of natural disasters and the magnitude of their losses(L2)
3. describe the characteristics of man-made disasters and the magnitude of their losses(L2)
4. elaborate the outbreaks of diseases and epidemics after disasters (L3)

Module III: Number of hours(LTP) 6 0 0

Disaster Prone Areas in India 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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe the seismic zones and their characteristics(L2)
2. identify the areas prone to floods and droughts(L1)
3. distinguish between landslides and avalanches(L3)
4. identify areas prone to cyclonic and costal hazards(L4)
5. enumerate the post disaster diseases and epidemics(L2)

Module IV: Number of hours(LTP) 6 0 0

Disaster Preparedness and Management 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

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe the monitoring of phenomena triggering a disaster/hazard(L2) e
2. evaluate the risk with the use of remote sensing and meteorological data(L5)
3. list the governmental and community measures for disaster preparedness(L2)

Module V: Number of hours(LTP) 6 0 0

Risk Assessment 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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. define and list the elements of disaster risk(L1)
2. enumerate the measures for risk reduction(L2)
3. apply the techniques of risk assessment (L4)
4. identify the means of people's participation in risk assessment(L2)

Text Books(s)

1. R. Nishith, Singh A.K., Disaster Management in India: Perspectives, issues and strategies, New Royal Book Company., 2008.
2. Sahni, Pardeep, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi., 2012
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep and Deep Publication, 2007

Course Outcomes:

1. Identify management activities in pre, during and post phases of Disasters. (L1)
2. Plan disaster management activities and specify measure for risk reduction(L4)
3. apply risk assessment techniques in real life disaster scenarios(L4)

19EAC744: VALUE EDUCATION

L	T	P	C
2	0	0	0

This course is intended to expose the student to the need for human values and methods to cultivate them for leading an ethical life with good moral conduct. Students taking this course will be able to experience a change in personal and professional behavior with these ethical principles guiding him throughout life.

Course objectives:

1. to expose the student to need for values, ethics, self-development and standards
2. to make the student understand the meaning of different values including duty, devotion, self-reliance etc.
3. to imbibe the different behavioral competencies in students for leading an ethical and happy life
4. to expose the student to different characteristic attributes and competencies for leading a successful, ethical and happy profession life.

Module I: Number of hours(LTP) 8 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the social values and individual attitudes for self development(L1)
2. describe the Indian vision of humanism(L2)
3. distinguish between moral and non-moral acts(L3)
4. list the standards and value principles for moral conduct (L2)

Module II: Number of hours(LTP) 8 0 0

Importance of cultivation of values. Sense of duty. Devotion, self-reliance. Confidence, concentration. Truthfulness, cleanliness. Honesty, humanity. Power of faith, national unity. Patriotism, love for nature, discipline.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the importance of cultivating values(L2)
2. list the different traits of self-developed individual(L1)
3. explain the need for loving nature/country/humanity(L2

Module III: Number of hours(LTP) 8 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the benefits of positive thinking, integrity and discipline(L2)
2. list the different methods for avoiding fault finding, anger(L1)
3. explain the methods to overcome suffering, religious intolerance, self-destructive habits(L2)

Module IV: Number of hours(LTP) 8 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the science of reincarnation(L2)
2. explain the relation between self-management and good health(L1)
3. elaborate the role of different religions in reaching the common goal(L3)
4. list the different techniques for mind-control to improve personality and studies(L1)

Text Books(s)

Chakroborty S.K., "Values and ethics for organizations: Theory and Practice", Oxford University Press, 1998.

Course Outcomes:

1. describe the need for human values and methods for self-development (L2)
2. elaborate the different traits and benefits of a self-developed individual (L1)
3. list the different attributes of self-developed individual (L1)
4. elaborate the role and scope of books/faith/health/religions in character building and competence development(L3)

19EAC745: CONSTITUTION OF INDIA

L	T	P	C
2	0	0	0

This course is intended to expose the student to the philosophy of Indian constitution. Students will be able to understand their fundamental rights/duties and governance structure. Students also appreciate the role of election commission in establishing a democratic society.

Course objectives:

1. to familiarize the student about the need for a constitution
2. to make the student understand the role of constitution in a democratic society
3. to acquaint the student with key constitutional features and fundamental rights of a citizen
4. to impart the organs of governance and local administration hierarchy and their responsibilities
5. to familiarize the student with the role, responsibilities and administration hierarchy of election commission

Module I: Number of hours(LTP) 6 0 0

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working). Philosophy of the Indian Constitution: Preamble, Salient Features.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. list the outline of drafting committee and their roles in the making of Indian constitution (L1)
2. describe the need and role of a constitution in a democratic society(L2)
3. elaborate the salient features of Indian constitution(L3)

Module II: Number of hours(LTP) 6 0 0

Contours of Constitutional Rights & 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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. list the fundamental rights of a citizen(L1)
2. explain the intricacies in the different rights(L2)
3. elaborate the fundamental duties of a citizen(L3)
4. describe the principles of state policy(L2)

Module III: Number of hours(LTP) 6 0 0

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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. present the hierarchy of governance (L2)
2. list the role/responsibilities/powers of different organs of governance(L1)
3. elaborate the guidelines for appointment/transfer of judges(L2)

Module IV: Number of hours(LTP) 6 0 0

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and

role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe the administrative organizational hierarchy of municipalities and panchayats(L2)
2. appreciate the role/responsibilities/powers of mayor, CEO, elected officials(L3)
3. appreciate the importance of grass root democracy(L3)

Module V: Number of hours(LTP) 6 0 0

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.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe the administrative hierarchy of election commission(L2)
2. elaborate the roles/responsibilities/powers of election commissioners at different levels of hierarchy(L3)
3. outline the welfare activities of SC/ST/OBC/Women by different bodies(L3)

Text Books(s)
The Constitution of India, 1950 (Bare Act), Government Publication.

1. S. N. Busi, Dr. B. R. Ambedkar, Framing of Indian Constitution, 1/e, 2015.
2. M. P. Jain, Indian Constitution Law, 7/e, Lexis Nexis, 2014.
3. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

1. describe the philosophy and salient features of Indian constitution(L2)
2. list the constitutional rights and duties of a citizen(L1)
3. elaborate the central and local administrative hierarchy and their roles(L2)
4. describe the roles/responsibilities/powers of different governing and administrative bodies(L2)
5. explain the structure/functioning and power of election commission(L2)

19EAC746: PEDAGOGY STUDIES

L	T	P	C
2	0	0	0

This course is aimed to familiarizing the student with pedagogical principles, practices and methodologies. This course is intended for students interested in pursuing a career in teaching and research.

Course objectives:

1. to familiarize the student about the need for pedagogy studies, background and conceptual framework
2. to expose the student to pedagogical practices in formal/informal classrooms
3. to acquaint the student with type of curriculum and guidance materials for effective pedagogy
4. to familiarize the student with classroom practices and curriculum assessment procedures
5. to make the student understand the effect of undertaking research on teaching quality

Module I: Number of hours(LTP) 6 0 0

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the aim and rationale behind teacher education(L1)
2. classify the different theories of learning (L1)
3. elaborate the need and role of curriculum, teacher education (L1)

Module II: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the different pedagogical practices used by teachers in formal and informal classrooms(L1) explain the pedagogical practices employed in developing countries (L1)
2. enumerate the duties of faculty in terms of teaching, research, consultancy, administration (L1)

Module III: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list the measures for effective pedagogy(L1)
2. identify the different documentation required to formalize curriculum implementation and quality assessment(L1)
3. describe the teachers attitudes and beliefs in pedagogic strategies(L2)

Module IV: Number of hours(LTP) 6 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the organizational hierarchy in a school administration system(L1)
2. list the different barriers to learning(L3)
3. enumerate the methods to overcome limited resources and handle large class sizes(L3)
4. describe the follow-up support and peer-support in classroom practices(L2)

Module V: Number of hours(LTP) 6 0 0

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the need for and role of research in teaching profession(L2)
2. list the different research activities to be taken up by teachers(L1)
3. describe the impact of research on teaching quality and learning process(L2)

Text Books(s)

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

Course Outcomes:

1. describe the theories of learning and conceptual framework of pedagogy(L2)
2. explain the pedagogical practices used by teachers in formal and informal classrooms(L2)
3. visualize the administrative hierarchy of schools and colleges and define the role(L3)
4. appreciate the need for research and define the future direction of teaching career(L3)
5. describe the impact of curriculum and assessment on the teaching learning process of a student(L3)

19EAC747: STRESS MANAGEMENT BY YOGA

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with basic principles of yoga and different physical/mental practices for managing mind and body. This course helps the student in managing stress during education, home and workplace. Further, principles learnt in this course help in building overall personality for a stress-free, happy and independent life.

Course objectives:

1. to familiarize the student about eight parts of yoga and their significance
2. to expose the student to the importance and meaning of Yam and Niyam
3. to make the student understand the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc
4. to introduce the different yogic poses with a knowledge of their benefits for mind and body
5. to familiarize the effect of different types of breathing techniques in concept and in activity

Module I: Number of hours(LTP) 9 0 0

Definitions of Eight parts of yoga (Ashtanga).

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list the eight parts of yoga (L1)
2. describe the effects of different parts of yoga on mind and body(L2)
3. elaborate the importance of yoga in stress management and personality development(L3)

Module II: Number of hours(LTP) 9 0 0

Yam and Niyam.

Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. elaborate the importance of Yam and Niyam(L2)
2. describe the meaning and significance of Ahinsa, satya, astheya etc(L2)
3. explain the need for shaucha, santosh, tapa, swadhyay in leading a healthy and fruitful life(L3)

Module III: Number of hours(LTP) 9 0 0

Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii) ii) Regularization of breathing techniques and its Effects-Types of pranayam.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. demonstrate the different physical asanas and explain their physical and psychological effects(L4)
2. demonstrate the different breathing techniques and describe their physical and mental effects (L4)
3. distinguish between different types of pranayamam(L5)

Text Books(s)

1. Janardan, Yogic Asanas for Group Tarining-Part-I, Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, “Rajayoga or conquering the Internal Nature”, Advaita Ashrama, Kolkata.

Course Outcomes:

1. describe the eight parts of yoga and their significance(L1)
2. explain the the importance and meaning of Yam and Niyam(L2)
3. define the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc.,(L1)
4. demonstrate the different yogic poses and explain their benefits for mind and body(L4)
5. demonstrate the different types of breathing techniques and explain their physical and mental benefits(L5)

19EAC748: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with life enlightenment skills for personality development. This course helps the student in building his holistic personality through human values, ethics and spiritual attributes.

Course objectives:

1. to familiarize the student to good personality traits through moral stories
2. to make the student understand the goal of human life and importance of good personality in reaching the goal
3. to expose the student to the study of Shrimad-Bhagwad-Geeta for developing his/her personality and achieve the highest goal in life
4. to familiarize the student to leadership skills for driving nation and mankind to peace and prosperity
5. to expose the role of Neetishatakam for developing versatile personality of students.

Module I: Number of hours(LTP) 9 0 0

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

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe the moral stories illustrating the traits of good personality(L2)
2. define the meaning and importance of wisdom, pride, heroism, virtue etc(L1)
3. identify do and don't's in life from the foundations of human morals/ethics(L5)

Module II: Number of hours(LTP) 9 0 0

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

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe the characteristics and principles of bhakti yogam, jnana yogam and karma yogam (L1)
2. identify the use of different yogic characteristics in different activities of daily life/duties(L4)
3. apply the use of yogic principles for leading a stress-free, happy and fruitful life with good developed personality(L4)

Module III: Number of hours(LTP) 9 0 0

Statements of basic knowledge.
Shrimad BhagwadGeeta:
Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18
Personality of Role model.

Shrimad BhagwadGeeta:
Chapter2-Verses 17,
Chapter 3-Verses 36,37,42,
Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

Learning Outcomes:
After completion of this unit, the student will be able to:

1. list the characteristics of role model proposed by verses of bhagavad gita(L1)
2. explain the methods for obtaining life enlightenment through the practice of four yoga appropriately (L2)
3. describe the characteristics of karma yogi/jnana yogi for developing leadership personality (L2)

Text Books(s)

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

Course Outcomes:
List the different parables of neethisathakam and identify their morals(L1)

1. enumerate the different traits of human personality for life enlightenment(L2)
2. describe the leadership attributes for driving nation and mankind to peace and prosperity(L2)
3. explain the applicability of different types of yoga to day-to-day work and duties resulting in responsible personality (L2)

19EAC750: DEVELOPING SOFT SKILLS AND PERSONALITY

L	T	P	C
2	0	0	0

Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The course aims to cause a basic awareness within the students about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality.

Course objectives:

1. to familiarize the student to the criteria for self-assessment and significance of self-discipline
2. to expose the student to attitudes, mind sets, values and beliefs
3. to acquaint the student to plan career and goals through constructive thinking
4. to enable the student to overcome barriers for active listening and persuasive speaking
5. to familiarize the skill of conducting meetings, writing minutes and involving in active group discussions

Module I: Number of hours(LTP) 8 0 0

Self-Assessment; Identifying Strength & Limitations; Habits, Will-Power and Drives; Developing Self-Esteem and Building Self-Confidence, Significance of Self-Discipline

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify strengths & limitations through self-assessment(L3)
2. list the attributes of personalities will good will-power and self-drives(L1)
3. describe the reasons for building self-esteem and self-confidence(L2)
4. explain the significance of self discipline(L2)

Module II: Number of hours(LTP) 8 0 0

Understanding Perceptions, Attitudes, and Personality Types: Mind-Set: Growth and Fixed; Values and Beliefs.

Learning Outcomes:

After completion of this unit, the student will be able to:

define the characteristics of different perceptions, attitudes and personality types(L1) • distinguish between fixed and growing mindsets(L3) • define the importance and meaning of values and beliefs(L2)

Module III: Number of hours(LTP) 8 0 0

Motivation and Achieving Excellence; Self-Actualisation Need; Goal Setting, Life and Career Planning; Constructive Thinking

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the need for having high motivation and achieving excellence(L2)
2. define the need for self-actualization(L1)
3. plan the life and career goals based on self assessment(L4)
4. explain the attributes of constructive thinking(L2)

Module IV: Number of hours(LTP) 8 0 0

Communicating Clearly: Understanding and Overcoming barriers; Active Listening; Persuasive Speaking and Presentation Skills.

Learning Outcomes:
After completion of this unit, the student will be able to:
1. self-assess the barriers for communicating clearly (L4)
2. list the attributes of active listening(L1)
3. describe the minimal aspects of effective presentation(L2)
4. organize ideas resulting a persuasive talk(L3)

Module V: Number of hours(LTP) 8 0 0

Conducting Meetings, Writing Minutes, Sending Memos and Notices; Netiquette: Effective E-mail Communication; Telephone Etiquette; Body Language in Group Discussion and Interview

Learning Outcomes:
After completion of this unit, the student will be able to:
1. describe the format and structure of writing meeting minutes(L2)
2. identify the essential components of memos and notices(L3)
3. explain the principles of effective email communication(L2)
4. list the basic etiquette of telephone conversation(L1)
5. describe the effective body traits during group discussion and interviews(L2)

Text Books(s)

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman& Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

Course Outcomes:
1. carry out self-assessment and describe the significance of self-discipline(L4)
2. define, classify and compare attitudes, mind sets, values and beliefs(L3)
3. plan career and goals through constructive thinking and personal assessment(L4)
4. overcome barriers for active listening and persuasive speaking (L5)
5. conduct meetings, write minutes and involve in active group discussions(L3)

19ECS702: SOFT COMPUTING

L	T	P	C
3	0	2	4

This course gives an introduction to some fields in soft computing with its principal components of Fuzzy logic, Neural Networks and Genetic Algorithms. It also focuses on simple implementation of neural networks and fuzzy logic using Matlab/Python. This course would be quite useful to study the fundamental concepts of soft computing for the pursuit of allied research also.

Course objectives:

1. Understand the fundamental concepts of soft computing and machine learning
2. Perform operations on fuzzy sets
3. Develop neural networks algorithms in machine learning
4. Illustrate and apply genetic algorithms in machine learning
5. Get practical exposure to implement artificial neural networks and fuzzy logic through matlab/Python

Module I: Introduction to Soft Computing and Neural Networks — Number of hours(LTP) 9 0 6

Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define soft computing and neural network(L1)
2. illustrate the evolution of the field of soft computing(L1)
3. explain the basics of machine learning(L2)
4. explain conventional AI
5. illustrate Computational Intelligence

Module II: Basics of Fuzzy Logic — Number of hours(LTP) 9 0 6

Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Name what are fuzzy sets, fuzzy operations and relations(L1)
2. Define fuzzy reasoning and fuzzy inference systems(L1)
3. Illustrate fuzzy expert systems and decision making using fuzzy logic (L2)
4. Explain fuzzy expert system
5. Elabotate fuzzy decision making

Module III: Introduction to Neural Networks — Number of hours(LTP) 8 0 6

Neural Networks: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list various forms of neural networks(L1)
2. define different types of learning a neural network (L1)
3. identify how autonomous agents choose optimal decisions in their environments(L3)
4. Illustrate reinforcement learning(L2)
5. Explain difference between supervised and unsupervised neural networks (L1)

Module IV: Basics of Genetic Algorithms Number of hours(LTP) 8 0 6

Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition

Learning Outcomes:

After completion of this unit, the student will be able to:

1.Model genetic learning method by an analogy to biological evolution(L3)
2.Experiment with hypothesis space search in genetic learning(L3)
3.Apply the concepts of genetic programming(L4)
4.Illustrate structure of genetic algorithm
5. Machine Learning Approach to Knowledge Acquisition

Module V: Introduction to Matlab/Python Number of hours(LTP) 8 0 6

Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Arrays and array operations
2. experiment with toolboxes of neural network and fuzzy logic(L3)
3. inspect a simple implementation of artificial neural network and fuzzy logic(L4)
4.illustrate the functions and files
5..identify various fundamental concepts of Matlab/Python(L3)

Text Books(s)

1. Jyh-Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro:Fuzzy and Soft Computing®, Prentice Hall of India, 2003
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, PrenticeHall, 1995.
3. MATLAB ToolkitManual
4. Saroj Kaushik, Sunita Tiwari, Soft computing: Fundamentals, Techniques and applications, Mc Graw Hill Education, 2018

Reference Book(s)

1. Snehashish Chakraverty, Deepti Moyi Sahoo, Nisha Rani Mahato, Concepts of Soft Computing: Fuzzy and ANN with Programming, Springer, 2019.
2. Samir Roy, Udit Chakraborty, Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms, Pearson, 2013

Course Outcomes:

After completion of this course, the student will be able to..

1.Illustrate the evolution and basics of soft computing and machine learning. (L1)
2.Experiment with fuzzy sets, operations, fuzzy inference and expert systems. (L5)
3. list various forms of neural networks and their learning. (L1)
4.Illustrate genetic algorithms and their applications. (L3)
5.Experiment with Matlab/Python to understand the implementation of artificial neural network and fuzzy logic. (L5)

PROGRAMS FOR PRACTICAL SESSION

1. Tutorial on Tensorflow or Tutorial on keras.

2. Implement Union, Intersection, complement and difference operations on Fuzzy sets.

3. Create Fuzzy relation by Cartesian product of any two Fuzzy sets and perform Max-Min composition of any two Fuzzy relations(with different conditions).

4. Build Logistic Regression Classifier using Neural Networks .

5. Build Deep neural network for classification .

6. Build neural network for Regression.

7. Build classification model using Mini Batch gradient and Stochastic Gradient techniques.

8. Implement Genetic algorithm (Selection, Crossover, Mutation).

19ECS704 : Pragmatics of Information Security

M. Tech (CF&IS)

L	T	P	C
3	0	2	4

The goal of this course is to provide an up-to-date survey of developments in computer security. Central problems that confront security designers and security administrators include defining the threats to computer and network systems, evaluating the relative risks of these threats, and developing cost-effective and user-friendly countermeasures.

Course objectives:

1. Understanding the basic security concepts and learn about Intrusion detection and prevention systems.
2. Demonstrate various issues relating to authentication and access control mechanisms.
3. Demonstrate approaches to meet specific computer security requirements such as message integrity and confidentiality.
4. Design and configure Internet protocol security mechanisms.
5. An understanding of the current status and future direction of threats and technology in information security.

Module I: Number of hours(LTP) 9 0 6

Overview: Computer Security Concepts, Requirements, Architecture, Trends, Strategy Perimeter Security: Firewalls, Intrusion Detection, Intrusion Prevention systems, Honeypots Case Study: Readings, Intrusion and intrusion detection by John McHugh.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the key security requirements of confidentiality, integrity, and availability.(L2)
2. understand the types of security threats and attacks that must be dealt with different categories of computer and network assets. (L2)
3. understand the basic principles of and requirements for intrusion detection and prevention systems. (L2)

Module II: Number of hours(LTP) 9 0 6

User Authentication: Password, Password-based, token based, Biometric, Remote User authentication. Access Control: Principles, Access Rights, Discretionary Access Control, Unix File Access Control, Role Based Access Control Internet Authentication Applications: Kerberos, X.509, PKI, Federated Identity Management.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. discuss the four general means of authenticating a user's identity. (L6)
2. explain how access control fits into the broader context that includes authentication, authorization, and audit. (L2)
3. summarize the basic operation of Kerberos. (L2)

Module III: Number of hours(LTP) 10 0 6

Cryptographic Tools: Confidentiality with symmetric encryption, Message Authentication & Hash Functions, Digital Signatures, Random Numbers. Symmetric Encryption and Message confidentiality: DES, AES, Stream Ciphers, Cipher Block Modes of Operation, Key Distribution

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the basic operation of symmetric block encryption algorithms. (L2)
2. discuss the use of secure hash functions for message authentication. (L6)
3. discuss the issues involved in key distribution. (L2)

Module IV: Number of hours(LTP) 9 0 6

Internet Security Protocols: SSL, TLS, IPSEC, S/ MIME. Public Key Cryptography and Message Authentication: Secure Hash Functions, HMAC, RSA, Diffie Hellman key exchange Algorithm. Case Study: Readings, Programming Satan's Computer Ross Anderson and Roger Needham.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. understand the functionality of S/MIME and the security threats it addresses. (L2)
2. present an overview of the use of HMAC for message authentication. (L2)
3. describe the RSA algorithm and Diffie-Hellman algorithm. (L2)

Module V: Number of hours(LTP) 8 0 6

Malicious Software: Types of Malware, Viruses & Counter Measures, Worms, Bots, Rootkits Software Security: Buffer Overflows, Stack overflows, Defence, Other overflow attacks Case Study. Readings: Smashing The Stack For Fun And Profit, Aleph One

http://www.phrack.com/issues.html?issue=49&id=14#article

Learning Outcomes:
After completion of this unit, the student will be able to:

1. describe three broad mechanisms malware uses to propagate. (L2)
2. understand the different threats posed by bots, spyware, and root kits. (L2)
3. describe some malware countermeasure elements. (L4)

Text Books(s)

1. William Stalling, Lawrie Brown, Computer Security: Principles and Practice, Pearson, 4th Edition, 2017.
2. William Stallings, Cryptography and Network Security: Principles and Practice, 7th edition, 2017.

Reference Book(s)

1. Behrouz A Fourozen and DebdeepMukhopadhyaya, Cryptography and Network Security, 3/e, McGraw Hill, 2015.
2. Atul Kahate, Cryptography and Network Security, 4/e, McGraw Hill, 2019.
3. Buchmann, Introduction to Cryptography, Springer, 2004
4. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C (cloth), 2/e, Publisher: John Wiley & Sons, Inc., 1996.
5. Chwan-Hwa(John) Wu, Introduction to Computer Networks and Cybersecurity, CRC Press, 2013.

Course Outcomes:

1. distinguish among various types of intruder behaviour patterns(L4)
2. describe the key security requirements of confidentiality, integrity, and availability(L1)
3. explain how access control fits into the broader context that includes authentication, authorization, and audit(L5)
4. describe the structure and function of DES and AES. (L2)
5. describe the broad categories of malware payloads. (L4)

19ECS765: DATA VISUALIZATION

L	T	P	C
3	0	2	4

This course is all about data visualization, the art and science of turning data into readable graphics. We'll explore how to design and create data visualizations based on data available and tasks to be achieved. This process includes data modelling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding. Provides all the theory, details, and tools necessary to build visualizations and systems involving the visualization of data. Shows how various public and commercial visualization systems are used to solve specific problems in diverse domains.

Course objectives:

1. Enable the student to tell about data visualization and relevant models, illustrating methods of finding similarity while representing on visualization of data.
2. Familiarize the student to demonstrate on Techniques of spatial and Time oriented data.
3. Explain various methods of Visualization on trees, graphs and networks.
4. Distinguish various Interaction design approaches
5. Evaluate various data visualization systems and their diverse designs

Module I: Number of hours(LTP) 9 0 6

Introduction: What Is Visualization? , History of Visualization Relationship between Visualization and Other Fields, The Visualization Process Pseudocode Conventions, The Scatterplot and The Role of the User.

Data Foundations Types of Data, Structure within and between Records, Data Pre-processing.

Human Perception and Information Processing: What Is Perception? Physiology, Perceptual Processing, Perception in Visualization, Metrics Visualization Foundations. The Visualization Process in Detail, Semiology of Graphical Symbols, The Eight Visual Variables Historical Perspective, Taxonomies

Learning Outcomes:

After completion of this unit, the student will be able to:

1. show how data visualization can be visualized(L2)
2. illustrate how visualization data is structured can be used to find similarities among items for perception in visualization. (L2)
3. list the visualization process(L4)
4. interpret of visual variables and graphical symbols.(L5)

Module II: Number of hours(LTP) 9 0 6

Visualization Techniques for Spatial Data: One-Dimensional Data, Two-Dimensional Data, Three-Dimensional Data, Dynamic Data Combining Techniques.

Visualization Techniques for Geospatial Data: Visualizing Spatial Data, Visualization of Point Data, Visualization of Line Data, Visualization of Area Data, Other Issues in Geospatial Data Visualization.

Visualization Techniques for Time-Oriented Data Introduction, Definitions: Characterizing Time-Oriented Data, Visualizing Time-Oriented Data, Time Bench: A Data Model and Software Library for Visual Analytics of Time-Oriented Data

Learning Outcomes:
After completion of this unit, the student will be able to:

1. explain visualization techniques for spatial data(L2)
2. list out issues in geospatial data, visualization (L4)
3. visualizing dynamic data combining techniques(L3)
4. elaborate visualizing time-oriented data(L5)

Module III: Number of hours(LTP) 8 0 6

Visualization Techniques for Multivariate Data Point-Based Techniques, Line-Based Techniques, Region-Based Techniques, Combinations of Techniques.

Visualization Techniques for Trees, Graphs, and Networks: Displaying Hierarchical Structures, Displaying Arbitrary Graphs/Networks.

Text and Document Visualization Introduction, Levels of Text Representations, The Vector Space Model, Single Document Visualizations, Document Collection Visualizations, Extended Text Visualizations.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. interpret visualization techniques for multivariate data(L3)
2. illustrate hierarchical structures and arbitrary graphs/networks. (L4)
3. evaluate single document visualization and document visualization.(L6)

Module IV: Number of hours(LTP) 8 0 6

Interaction Concepts: Interaction Operators, Interaction Operands and Spaces, A Unified Framework.

Interaction Techniques Screen Space, Object Space (D Surfaces), Data Space (Multivariate Data Values), Attribute Space (Properties of Graphical Entities), Data Structure Space (Components of Data Organization), Visualization Structure Space (Components of the Data Visualization). Animating Transformations Interaction Control.

Designing Effective Visualizations: Steps in Designing Visualizations, Problems in Designing Effective Visualizations.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. list opportunities for effective visualizations(L4)
2. explain unified framework, data space(L2)
3. interpret limitations of designing effective visualizations.(L5)

Module V: Number of hours(LTP) 8 0 6

Comparing and Evaluating Visualization Techniques User Tasks, User Characteristics Data Characteristics ,Visualization Characteristics ,Structures for Evaluating Visualizations Benchmarking Procedures ,An Example of Visualization Benchmarking .

Visualization Systems: Systems Based on Data Type, Systems Based on Analysis Type Text Analysis and Visualization, Modern Integrated Visualization Systems Toolkits

Research Directions in Visualization: Issues of Data Issues of Cognition, Perception, and Reasoning, Issues of System Design, Issues of Evaluation, Issues of Hardware Issues of Applications

Learning Outcomes:
After completion of this unit, the student will be able to:

1. evaluate and comparison of different techniques.(L5)
2. interpret various visualization systems(L5)
3. appraise types of research direction(L5)

Text Books(s)

1. Ward, Grinstein Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick: A K Peters, Ltd,2015.
2. Charu C. Aggarwal, Recommender Systems: The Textbook, 1/e, Springer, 2016.
3. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer, 2015.
4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer, 2013. (no update)

Reference Book(s)

1. Kristen Sosulski, Data Visualization Made Simple: Insights into Becoming Visual, Routledge; 1st edition,2018

Course Outcomes:
After completing this Course, the student should be able to

2. state the basics of data visualization (L1)
3. understand the importance of data visualization and the design and use of many visual components(L2)
4. apply various visualization structures such as tables, spatial data, time-varying data, tree and network, etc.(L3)
5. apply basics of colors, views, and other popular and important visualization-based issues.(L3)
6. analyze basic algorithms in data visualization (L4)

19ECS767: BIG DATA ANALYTICS

L	T	P	C
3	0	2	4

Thecourseisdesignedwhich largely involves collecting data from different sources, manage it in a way that it becomes available to be consumed by analysts and finally deliver data products useful to the organization business. The process of converting large amounts of unstructured raw data, retrieved from different sources to a data product useful for organizations forms the core of Big Data Analytics.

Course objectives:

- Optimize business decisions and create competitive advantage with Big Data analytics.
- Introducing Java concepts required for developing map reduce programs.
- Derive business benefit from unstructured data.
- Imparting the architectural concepts of Hadoop and introducing map reduce paradigm.
- To introduce programming tools Hbase& HIVE in Hadoop echo system.

Module I: Introduction to Bigdata Number of hours(LTP) 9 0 6

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. demonstrate the big data concepts for real world data analysis (L1).
2. building a complete business data analytic solution and apply structure of Hadoop data with Hive (L6).

Module II: Introduction to NoSQL Number of hours(LTP) 9 0 6

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. develop Map Reduce concepts through Java (L2).
2. demonstrate the big data concepts for real world data analysis (L1)
3. analyze the configuring of Hadoop clusters effectively (L3).

Module III: Hadoop distributed file system Number of hours(LTP) 9 0 6

Data format, analysing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Analyse the configuring of Hadoop clusters effectively (L3).
2. Develop Map Reduce concepts through Java (L2).

Module IV: Map-Reduce Number of hours(LTP) 9 0 6

MapReduce workflows, Unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. develop Map Reduce concepts through Java (L2).
2. analyse the configuring of Hadoop clusters effectively (L3).
3. illustrate Hadoop API for Map reduce framework (L4).

Module V: HBase Data Model Number of hours(LTP) 9 0 6

HBase, data model and implementations, HBase clients, HBase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Analyse the configuring of Hadoop clusters effectively (L3).
2. Illustrate Hadoop API for Map reduce framework (L4).
3. Develop basic programs of map reduce framework particularly driver code, mapper code, reducer code (L5).
4. Building a complete business data analytic solution and apply structure of Hadoop data with Hive (L6).

Text Books(s)

1. 1 Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. P. J. Sadalage, M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2014.
3. Tom White, "Hadoop: The Definitive Guide", 3/e,4/e O'Reilly, 2015.

Course Outcomes:

1. demonstrate the big data concepts for real world data analysis (L1).
2. develop Map Reduce concepts through Java (L2).
3. analyze the configuring of Hadoop clusters effectively (L3).
4. illustrate Hadoop API for Map reduce framework (L4).
5. develop basic programs of map reduce framework particularly driver code, mapper code, reducer code (L5).
6. Building a complete business data analytic solution and apply structure of Hadoop data with Hive (L6).

19ECS769: DATA STORAGE TECHNOLOGIES AND NETWORKS

L	T	P	C
3	0	2	4

The course is designed to enable the student to define about various data storage technologies and networks like storage media, etc. It concentrates on the technologies and techniques along with their limitations. It explains about the data memory hierarchy with fast caches located in between CPU and main memory, about hardware and software design for access with performance issues and also data access methods. This course lays the foundation about the data storages in different sources with partitions and security.

Course objectives:

1. To introduce different storage media and their technologies.
2. To determine the usage and access methods of different media along with performance.
3. To provide the details of network attached storage media.
4. To describe the underlying architecture and design of storage media
5. To understand reliability, performance, security issues of network attached storage media

Module I: Number of hours (LTP) 9 0 6

Storage Media and Technologies – Magnetic, Optical and Semiconductor Media, Techniques for read/write Operations, Issues and Limitations.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Classify different types of storage media (L2)
2. Illustrate the technologies involved in storing data (L3)
3. Identify techniques used to read/write operations (L4)
4. Distinguish the issues and limitations of storage media and technologies(L4)

Module II: Number of hours(LTP) 9 0 6

Usage and Access – positioning in the memory hierarchy, hardware and software design for access, performance issues.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Identify the position memory hierarchy for a particular storage media(L2)
2. Explain the details of hardware and software for a particular memory type(L4)
3. Summarize the design issues for accessing data from a memory type(L2)
4. Outline the performance issues while retrieving data.(L4)

Module III: Number of hours(LTP) 9 0 6

Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Illustrate networked storage capabilities which include management principles storage network design principles(L3)
2. Predict the scalability issues in large storages(L5)
3. Determine the networking issues in large storages(L5)
4. Assess performance degradation, security issues, configuration conflicts, network performance issues(L5)

Module IV: Number of hours(LTP) 8 0 6

Storage Architecture - Storage Partitioning, Storage System Design, Caching, Legacy Systems.

Learning Outcomes:

After completion of this unit, the student will be able to:

1 Explain system design in storage architecture(L4)
2 Implement the storage partitioning(L3)
3 Identify cache storage problems(L2)
4 Define the legacy systems in storing the old systems data for future reference and for many other reasons(L1)

Module V: Number of hours(LTP) 8 0 6

Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids.
Storage QoS – Performance, Reliability, and Security issues, storage appliances.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Identify the storage cluster/grids that employs multiple self-contained storage nodes.(L2)
2. Explain the hardware and software components.(L4)
3. Assess storage performance, reliability and security issues.(L5)

Text Books(s):

1. Dailey, Franklyn E. *The Complete Guide to Data Storage Technologies for Network-centric Computing*. Computer Technology Research Corporation, 1997.
2. Poulton, Nigel. *Data Storage Networking: Real World Skills for the Comp TIA Storage+ Certification and Beyond*. John Wiley & Sons, 2014.

Reference Book(s)

1. Mee, C. Denis, and Eric D. Daniel, eds. *Magnetic Recording: Computer Data Storage*. Vol. 2. McGraw-Hill Companies, 1988.
2. Spalding, Robert. *Storage networks: the complete reference*. Tata McGraw-Hill Education, 2003.

Course Outcomes:

1 Apply, implement and manage various storage technologies storing information.(L3)
2 Evaluate the design and performance issues in accessing information.(L4)
3 Organize network attached storage devices and manage the scalability issues as well as the emerging long-term data storage technology alternatives. (L4)
4 Analyze storage devices principles including architecture, design and partitioning. (L4)
5 Interpret quality issues of networked storage devices along with hardware and software components. (L3)

19ECS779 : Cyber Security

L	T	P	C
3	0	2	4

This course enables the students to gain knowledge on various Cybercrimes. The course briefs the students regarding the Indian IT Act, Global perspective of Cybercrimes, Cyber stalking, cyber cafe, key loggers, DoS attacks, crimes on mobile, wireless devices, etc. The knowledge gained in this course can be applied to identify, classify, estimate the criminal plans of the attackers and predict the web threats and security implications.

Course objectives:

1. Introduce the fundamentals of Cybercrime and its legal perspectives with respect to India.
2. Acquaint the student with various types of attacks and Cyber offenses
3. Make the student aware of securing devices and Inner perimeter
4. Familiarize the student with methods to secure the perimeter.

Module I: Introduction to Cybercrime Number of hours(LTP) 9 0 6

Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, And Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. classify the types of Cybercrimes(L4)
2. outline the Indian stance and Acts towards Cybercrime(L2)
3. compare the Indian perspective to Global perspective(L4)

Module II: Cyber Offenses Number of hours(LTP) 9 0 6

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

Learning Outcomes:
After completion of this unit, the student will be able to:

1. interpret how attacks are formulated(L2)
2. explain the concepts of Cyber stalking and Cyber cafe(L2)
3. infer how Botnets and cloud computing provide base for cultivating Cybercrime(L2)

Module III: **Tools and Methods used in Cybercrime** Number of hours(LTP) 9 0 6

Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers andSpywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks,SQL Injection, Buffer Overflow

Learning Outcomes:
After completion of this unit, the student will be able to:

1. list various tools and methods that assist attackers in performing the Cybercrime(L1)
2. analyse how password cracking is done(L4)
3. distinguish between Viruses and Worms and Trojan Horses(L4)

Module IV: **Securing Devices and Inner Perimeter** Number of hours(LTP) 9 0 6

The Three Layers of Security, Securing Host Devices, Securing Outer-Perimeter Portals, AdditionalInner-Perimeter Access Options, The Inner Perimeter, Operating Systems, Operating

SystemSecurity Choices, Common Operating System Security Tools, Using Local Administrative Tools,Implementing Data Encryption.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. list various layers of security(L1)
2. analyseways of securing devices(L4)
3. Learn methods to secure inner perimeter(L4))

Module V: **Securing the perimeter** Number of hours(LTP) 9 0 6

Perimeter Security in the Real World, Security Challenges, The Basics of Internet Security,Understanding the Environment, Hiding the Private Network, Understanding Private Networks,Protecting the Perimeter, Understanding the Perimeter, Firewalls, Network Appliances, ProxyServers, Demilitarized Zones (DMZs), Honeypots, Extranets.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. identify the challenges in perimeter security(L3)
2. assess the requirements for hiding private networks(L5)
3. Analyse the various methods to protect the perimeter (L6)

Text Books(s)

1. Charles J. Brooks,ChristopherGrow,PhilipCraig,Donald Short, Cyber Security Essentials1/e,Sybex Wiley, 2019.

Reference Book(s)

1. James Graham, Richard Howard and Ryan Otson, Cyber Security Essentials, 1/e, CRC Press,2011.
2. Chwan-Hwa(John) Wu,J.DavidIrwin, Introduction to Cyber Security, 1/e, CRC Press T&FGroup, 2013
3. Nina Godbole and Sunil Belapure, Cyber Security: Understanding Cyber Crimes, ComputerForensics and Legal Perspectives, 1/e, Wiley INDIA.

Course Outcomes:

1. explain the types of Cybercrimes happening all around(L3)
2. select tools and practices that boost up the crime rate(L5)
3. demonstrate the tools to secure inner perimeter(L2)
4. demonstrate the contribution of key loggers, password crackers, viruses, and worms towardsenabling the possibilities of Cybercrime(L2)
5. assess the methods to protect the perimeter(L5)

19ECS760: STEGANOGRAPHY AND DIGITAL WATERMARKING

L	T	P	C
3	0	2	4

Information Hiding plays a very important role in providing of security to information and copy right protection. It consists of two parts: Digital Steganography and Digital Watermarking. Steganography is the art of information hiding in objects or images. It is a field with a rich heritage, and an area of rapid current development. Watermarking provides a copyright protection of video and audio products against multimedia pirates. Like probability theory, information and coding theory, signal processing procedures used for embedding of additional information into cover objects can be completely described by computer programs. Therefore, this course is especially useful for students specialized in computer science.

Course Objectives:

1. To learn about steganography methods of hiding data
2. To learn about steganography Algorithm and Techniques
3. To learn about the watermarking models, applications and tools
4. To learn about watermark security and authentication
5. To learn about steganography Perceptual models

Module I: Introduction Number of hours(LTP) 7 0 6

Overview of Information Hiding, Steganography and Watermarking. Importance of Digital Watermarking and Steganography. Applications and Properties of Steganography and Watermarking. Evaluating and Testing Steganographic Systems. Basic idea of Watermarking Models& Message Coding

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Understand the techniques of information hiding(L2).
2. Apply Digital Watermarking and Steganography(L3).

Module II: Watermarking Models and Message Coding Number of hours(LTP) 7 0 6

Models of Watermarking: Notation, Communications, Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modelling Watermark Detection by Correlation.
Basic Message Coding: Mapping Messages into Message Vectors, Error Correction Coding, Detecting Multi symbol Watermarks.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. ClassifyModels of Watermarking. (L2)
2. Analyze how error correction coding works. (L4)

Module III: Watermarking with Side Information & Analyzing Errors Number of hours(LTP) 8 0 6

Watermarking with Side Information: Informed Embedding, Watermarking Using Side Information, Dirty-Paper Codes.
Practical Dirty-Paper Codes: Practical Considerations for Dirty-Paper Codes, Approaches toDirty-Paper Code Design, Implementing DM with a Simple Lattice Code, Typical Tricks in Implementing Lattice Codes, Coding with Better Lattices, Making Lattice Codes Survive Valumetric Scaling.

Analyzing Errors: Message Errors, False Positive Errors, False Negative Errors, ROC Curves, Interpolation Along One or Both Axes, The Effect of Whitening on Error Rates, Analysis of Normalized Correlation.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand information embedding. (L3)
2. Identify and implement practical dirty-paper codes. (L3)
3. Recognize various message errors (L4)

Module IV: Perceptual Models Number of hours(LTP) 7 0 6

Evaluating Perceptual Impact of Watermarks, 8.2 General Form of a Perceptual Model, Robust watermarking approaches- Redundant Embedding, Embedding in Perceptually significant coefficients. Watson's DCT-Based Visual Model, Perceptual Model for Audio, Perceptually Adaptive Watermarking.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Choose Perceptual Models for visual media and audio. (L5)
2. Evaluate impact of watermarks(L3)
3. Embedding in perceptual model(L3)

Module V: Steganography Number of hours(LTP) 10 0 6

Steganographic Communication, Notation and Terminology, Information-Theoretic Foundations of Steganography, Practical Steganographic Methods, Masking Embedding as Natural Processing, Minimizing the Embedding Impact.

Steganalysis: Steganalysis Scenarios, LSB Embedding and the Histogram Attack, Sample Pairs Analysis, Blind Steganalysis of JPEG Images Using Calibration, Blind Steganalysis in the Spatial Domain

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Make use of different steganalysis techniques for embedding(L3)
2. Understand different type of steganography methods of hiding data(L2

Text Books(s)

1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Digital Watermarking and Steganography, Margan Kaufmann Publishers, 2nd Edition, 2008.
2. Neil F. Johnson, Zoran Duric, SushilJajodia, Information Hiding: Steganography and Watermarking - Attacks and Counter measures, Springer, 2012.
3. Stefan Katzenbeisser, Fabien A. P. Petitcolas, Information Hiding Techniques for Steganography and Digital Watermarking, 2016.

Reference Book(s)

1. Michael Arnold, Martin Schmucker, Stephen D. Wolthusen, "Techniques and Applications of Digital Watermarking and Contest Protection", Artech House, London, 2003.
2. Peter Wayner, "Disappearing Cryptography – Information Hiding: Steganography & Watermarking", Morgan Kaufmann Publishers, New York, 2002.

Course Outcomes:

1. Understand different type of steganography methods of hiding data(L2)
2. Understand public key steganography and apply the steganography algorithm(L2)
3. Make use of different steganography techniques(L3)
4. Apply different tools(L3)

19ECS782: INTRUSION DETECTION AND PREVENTION SYSTEM

L	T	P	C
3	0	2	4

This course covers the fundamentals of intrusion detection and prevention techniques, exploration ofintrusion detection system (IDS) and intrusion prevention system (IPS) with their differences, technologies and in designing, implementing, configuring, securing, monitoring, and maintaining intrusion detection and prevention systems (IDPS),also provides practical, real-world guidance for each of four classes of IDPS: network-based, wireless, network behaviour analysis software, and host-based. This course also addresses how to detect attacks using neural networks, artificial intelligence and machine learning approaches, practicaldemonstration on IDPS by using various open source IDP tools which are currently used in Industry.

Course objectives:

1. Familiarize the students that how to evaluate the security of an organization and appropriately apply Intrusion Detection tools and techniques in order to improve their security posture.
2. Apply the knowledge to the architecture, configuration, and analysis of specific intrusion detection systems
3. To identify and describe appropriate situations and scenarios where intrusion detection may be applied to achieve an increased level of situational awareness and information assurance.
4. Enable the students to master the knowledge about intrusion detection and prevention in the context of real-life applications.
5. Demonstrate various tools for Intrusion Detection and Prevention Mechanisms.

Module I: Introduction: Number of hours(LTP) 9 0 6

Basic Concepts of Security, Introduction to Intrusions, Intrusion Detection and Prevention Systems (IDPS), IDPS History, Needs, Intrusion Detection vs. Prevention, Network Traffic Monitoring and Analysis.Intrusion Detection and Prevention Principles: IDPS Technologies Uses, functions, Methodologies, Types. IDPS Technologies: Components and Architecture, Security Capabilities, Management.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand modern concepts related to Intrusion Detection and Prevention System. (L2)
2. Understand the physical location, the operational characteristics and the various functions performed by the intrusion detection and prevention system (L2)
3. Summarize network traffic monitoring and analysis. (L2)

Module II: IDS and IPS Architecture Number of hours(LTP) 8 0 4

Tiered architectures, Single-tiered, Multi-tiered, Peer-to-Peer. Sensor: sensor functions, sensor deployment and security. Agents: agent functions, agent deployment and security. Manager component: manager functions, manager deployment and security. Information flow in IDS and IPS, defending IDS/IPS, Case study on commercial and open-source IDS.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Classify various types of components and architectures of IDPSbased on their behaviour (L2)
2. Analyse how mathematical back ground used to design IDPS framework (L4)

Module III: Intrusion Detection and Prevention Technologies and their Integration **Number of hours(LTP) 8 0 4**

Intrusion Detection and Prevention Technologies: Network based IDPS, Wireless IDPS, Host based IDPS: Components and Architecture, Security Capabilities, Management. Information Sources for IDS, Host and Network Vulnerabilities and Countermeasures.

Using and Integrating multiple IDPS Technologies: The Need for Multiple IDPS Technologies, Direct and Indirect IDPS Integration, Other Technologies with IDPS Capabilities: Network Forensic Analysis Tool (NFAT) Software, Anti Malware Technologies, Firewalls and Routers, Honeypots.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Apply intrusion detection technique for real world applications. (L3)
2. Identify security issues of a cyber-security and security requirements. (L3)

ModuleIV: Applications of Neural Networks, Artificial Intelligence and Machine Learning in and for IDPS **Number of hours(LTP) 9 0 4**

Neural Networks, Artificial Intelligence and Machine Learning in Intrusion Detection and Prevention, Challenges and Limitations, Potential Countermeasures, Rule-based and state-based anomaly detection and prevention: statistical based, machine learning based, data mining based hybrid detection and prevention. New Unknown Attack Detection with the Neural Network–Based IDS.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Utilize Artificial intelligence-based intrusion detection techniques in wired networks. (L3)
2. Adapt machine learning algorithms to detect attacks. (L6)
3. Choose Neural Network- Based IDS to detect unknown attacks. (L5)

Module V: IDP TOOLS **Number of hours(LTP) 9 0 6**

Introduction to Snort, Snort Installation Scenarios, Installing Snort, Running Snort on Multiple Network Interfaces, Snort Command Line Options. Step-By-Step Procedure to Compile and Install Snort Location of Snort Files, Snort Modes Snort Alert Modes. Other tools: Suricata, Bro (Zeek), OSSEC, Samhain Labs, OpenDLP.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Apply intrusion detection alerts and logs to distinguish attack by using SNORT and other open source tools. (L2)
2. Analysewired and wireless IDPS and detect threats. (L4)

Text Books(s)

1. Ali A. Ghorbani, Network intrusion detection and prevention concepts and techniques, Springer, 2010
2. Al-Sakib Khan Pathan, The State of the Art in Intrusion Prevention and Detection, CRC Press.
3. C. Endorf, E. Schultz and J. Mellander, Intrusion Detection & Prevention, McGrawHill/Osborne, 2004.
4. RafeeqRehman, Intrusion Detection with SNORT, Apache, MySQL, PHP and ACID, 1st Edition, Prentice Hall , 2003

Reference Book(s)

1. K. A. Scarfone, P. M. Mell, Guide to Intrusion Detection and Prevention Systems, DIANE Publishing Company.
2. Christopher Kruegel,FredrikValeur, Giovanni Vigna: “Intrusion Detection and Correlation Challenges and Solutions”, 1st Edition, Springer, 2005.
3. Carl Endorf, Eugene Schultz and Jim Mellander“Intrusion Detection & Prevention”, 1st Edition, Tata McGraw-Hill, 2004.
4. Stephen Northcutt, Judy Novak : “Network Intrusion Detection”, 3rd Edition, New Riders Publishing, 2002

Online Resources (Additional Information)

1. https://opensourceforu.com/2017/04/best-open-source-network-intrusion-detectiontools/
2. https://security.berkeley.edu/intrusion-detection-guideline
3. https://www.snort.org/
4. https://cybersecurity.att.com/blogs/security-essentials/open-source-intrusion-detection-tools-a-quick-overview

Course Outcomes:

1. Illustrate the operational characteristics and the various functions performed by the intrusion detection and prevention system. And how to utilize various IDS tools to Network Traffic Monitoring and Analysis. (L2)
2. Make use of routers, sensors and honeypots for collecting warm attacks in networks. Design Honeypot management framework. (L3)
3. Analyse how to protect critical infrastructure from attacks using Intrusion detection system and how to provide security for smart gird infrastructure. (L4)
4. Apply knowledge of neural networks, artificial intelligence and machine learning in system and network protection. Optimize performance of detection systems by employing various novel and advanced techniques. (L3)
5. Compare alternative tools and approaches for Intrusion Detection through quantitative analysis to determine the best tool or approach to reduce risk from intrusion (L6)

19ECS744: SECURE SOFTWARE DESIGN AND ENTERPRISE COMPUTING

L	T	P	C
3	0	2	4

This course provides an overall idea of design, development and implementation methods of secure software as well asdeployment, integration and testing processes. It is used for ensuring that software functions as intended and it is free of design defects and implementation flaws.

Course objectives:

1. Learn about need for computer security, vulnerability, database security, attacks and threats.
2. Build a secure system from requirements analysis, design and coding to testing.
3. Methodologies and tools to design and implement secure software.
4. Identifying the deployment, integration and validating that each security requirement has been implemented
5. Auditing the critical applications and maintain the software securely.

Unit I Number of hours(LTP) 8 0 6

Security in Software Systems: Need for Computer Security, Vulnerability and Attacks, Various Security Attacks, Computer Security, Counter External Threats, Security Programming, Database Security, Security Standards.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Remember the vulnerability, attacks and threats to software. (L1)
2. Understand the need for computer and database security. (L2)

Unit II Number of hours(LTP) 7 0 6

Architecting Secure Software Systems: Building Secured Systems, Security Requirements Analysis, Threat Modeling, Security Design, Security Coding, Safe Programming, Security Review, Generating the Executable, Security Testing.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand the architecture of secure software design. (L2)
2. Differentiate the security in design and coding. (L2)

Unit III Number of hours(LTP) 9 0 6

Design Activities: Security Tiers, Requirements and Specifications, Design and Architecture, Deployment and Operations Planning.

Implementation Activities: Stress the Positive and Strike the Balance, Security Mechanisms and Controls, Code Reuse, Coding Resources, Implementing Security Tiers, Code Reviews.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Apply the secure design and implementation activities. (L3)
2. Create security specification for design and architecture. (L6)

Unit IV Number of hours(LTP) 9 0 6

Deployment and Integration: How Does Deployment Relate to Confluence, A Road Map, Advanced Topics in Deployment, integrating with the Security Operations Infrastructure, Third-Generation Log Analysis Tools, Retrofitting Legacy and Third-Party Components. Testing Activities: Security Testing, Tools of the Trade, Security Bug Life Cycle.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Analysis the developed software using tools and techniques. (L4)
2. Integration of third-party components if it is needed. (L4)

Unit V Number of hours(LTP) 8 0 6

Operating Software Securely: Adjusting Security Thresholds, Dealing with IDS in Operations, Identifying Critical Applications, CSIRT Utilization.

Maintaining Software Securely: Common Pitfalls, Maintaining Software Securely Relate to Confluence, learning from History, Evolving Threats, The Security Patch, Maintaining Software Securely Fit into Security SDLCs.

Learning Outcomes:
After completion of this unit, the student will be able to:

1. Evaluate and identify the common pitfalls.(L5)
2. Maintain the software to recover from attack. (L5)

Text Books(s)

1. Asoke K. Talukder, Manish Chaitanya, Architecting Secure Software Systems, CRC Press.
2. Kenneth R. VanWyk, Mark G. Graff, Enterprise Software Security, Addison Wisley.

Reference Book(s)

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & BartlettX
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley.

Course Outcomes:

1. Differentiate between various software vulnerabilities, attacks and threats.
2. Interrelate security, softwaredesign and development process.
3. Methods and tools to design and implement a secure software.
4. Identify software process vulnerabilities for an organization
5. Monitor resources consumption in a software

19ECS780 : Web Application Security

L	T	P	C
3	0	2	4

This course offers extensive knowledge for every web developer and web application engineer. A participant will discover important principles of modern web security, and learn about current security best practices. This course also explores the Open Web Application Security Project (OWASP) top 10 2017 which is essential to organizations and IT pros for better managing the emerging impact of application security risks.

Course objectives:

1. Recognize common web application security vulnerabilities and how to determine if they are present in web applications(L1).
2. Recognize web application design assumptions and how to exploit them(L1).
3. Be familiar with the capabilities of various Browser Proxies(L2).
4. Be prepared to detect SQL Injection Vulnerabilities(L3)
5. Be prepared to detect Cross-Site Scripting (XSS) Vulnerabilities(L4).
6. Be prepared to test web application security(L5).

Module I: Introduction to Web application Number of hours(LTP) 7 0 6

The Evolution of Web Applications, Common Web Application Functions, Benefits of Web Applications, Web Application Security. Core Defense Mechanisms: Handling User Access Authentication, Session Management, Access Control, Handling User Input, Varieties of Input Approaches to Input Handling, Boundary Validation. Multistep Validation and Canonicalization: Handling Attackers, Handling Errors, Maintaining Audit Logs, Alerting Administrators, Reacting to Attacks.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand common web app security vulnerabilities(L2).
2. Best practices to mitigate vulnerabilities(L3).

Module II: Web Application Technologies Number of hours(LTP) 8 0 6

The HTTP Protocol, HTTP Requests, HTTP Responses, HTTP Methods, URLs, REST, HTTP Headers, Cookies, Status Codes, HTTPS, HTTP Proxies, HTTP Authentication, Web Functionality, Server-Side Functionality, Client-Side Functionality, State and Sessions, Encoding Schemes, URL Encoding, Unicode Encoding, HTML Encoding, Base64 Encoding, Hex Encoding, Remoting and Serialization Frameworks.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand the basic aspects of HTTP(L2)
2. The client-server structure, combined with the ability to simply add headers, allows HTTP to advance along with the extended capabilities of the Web(L3)

Module III: Mapping the Application Number of hours(LTP) 8 0 6

Enumerating Content and Functionality, Web Spidering, User Directed Spidering, Discovering Hidden Content, Application Pages Versus Functional Paths, Discovering Hidden Parameters, Analyzing the Application, Identifying Entry Points for User Input, Identifying Server-Side Technologies, Identifying Server-Side Functionality, Mapping the Attack Surface.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Enumerate application's content and functionality(L3).
2. Some is hidden, requiring guesswork and luck to discover(L1).

3. Examine every aspect of behavior, security mechanisms, and technologies(L2).
4. Determine attack surface and vulnerabilities(L4).

Module IV: Attacking Authentication Number of hours(LTP) 8 0 6

Authentication Technologies, Design Flaws in Authentication Mechanisms, Bad Passwords, Brute-Forcible Login, Verbose Failure Messages, Vulnerable Transmission of Credentials, Password Change, Functionality, Forgotten Password Functionality, "Remember Me" Functionality, User Impersonation, Functionality Incomplete, Validation of Credentials, Nonunique Usernames, Predictable Usernames, Predictable Initial Passwords, Insecure Distribution of Credentials. Attacking Access Controls: Common Vulnerabilities, Completely Unprotected, Functionality Identifier-Based Functions, Multistage Functions, Static Files, Platform Misconfiguration, Insecure Access Control Methods.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Authentication also lies at the heart of an application's protection against malicious attack(L1).
2. Know Front line of defense(L2).
3. What could an attacker achieve if he were to target our authentication mechanism(L5).

Module V: Attacking Data Stores Number of hours(LTP) 9 0 6

Injecting into Interpreted Contexts, Bypassing a Login, Injecting into SQL, Exploiting a Basic Vulnerability Injecting into Different Statement Types, Finding SQL Injection Bugs, Fingerprinting the Database, The UNION Operator, Extracting Useful Data, Extracting Data with UNION, Bypassing Filters, Second-Order SQL Injection, Advanced Exploitation Beyond SQL Injection: Escalating the Database Attack, Using SQL Exploitation Tools, SQL Syntax and Error Reference, Preventing SQL Injection.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand web applications use a database(L2).
2. How to exploiting a basic Vulnerability(L6).

Text Book(s)

1. Author(s), Title, Publisher, Edn, Year. 1. The Web Application Hacker's Handbook: Finding and Exploiting Security Defydd Stuttard, Marcus Pinto Wiley Publishing, Second Edition.
2. Professional Pen Testing for Web application, Andres Andreu, Wrox Press
3. Carlos Serrao, Vicente Aguilera, Fabio Cerullo, Web Application Security, Springer, 1st Edition
4. Joel Scambray, Vincent Liu, Caleb Sima,"Hacking exposed", McGraw-Hill; 3rd Edition, 2010
5. Web Security Privacy and Commerce, OReilly 2ndEdition, 2011.
6. Software Security Theory Programming and Practice, Richard sinn, Cengage Learning Database Security and Auditing, Hassan, Cengage Learning

Course Outcomes:

1. Underlying security principles of the web (L1).
2. Overview of concrete threats against web applications(L2).
3. Insights into common attacks and countermeasures(L3).
4. Current best practices for secure web applications(L4).
5. Capacity to perform a security assessment, penetration and defense of web systems(L5

19ECS771: WEB ANALYTICS AND DEVELOPMENT

L	T	P	C
3	0	2	4

Web Analytics is the measurement, collection, analysis, and reporting of Internet data for purposes of understanding and optimizing Web usage. Web Analytic is a tool that can measure Web site traffic. This course will begin by discussing the definition and categories of Web Analytics, some examples of Web-based Analytics such as Click Stream Analysis, A/B testing, to name a few. This course will also tackle Web Search and Retrieval and connection.

Course objectives:

1. Identify, define and interpret commonly used web metrics and KPIs.
2. Understand and discuss click stream data collection techniques, their impact on metrics, and their inherent limitations.
3. Apply the common monitoring or analysis tasks and techniques used in web analytics.
4. Articulate how effectively use the resulting insights to support website design decisions, campaign optimization, search analytics, etc.
5. Determine the robustness in social environment by diffusion of innovation

Module I: Introduction Number of hours(LTP) 9 0 6

Introduction – Social network and Web data and methods, Graph and Matrices, Basic measures for individuals and networks, Information Visualization

Learning Outcomes:

After completion of this Unit the student will be able to:

1. enumerate the social network and different methods. (L1)
2. understand the terminology of graphs and measures of networks. (L2)
3. determine the systematic method to evaluate social media efforts, replacing anecdotes with scientifically based evidence. (L2)

Module II: Web Analytics tools Number of hours(LTP) 9 0 6

Web Analytics tools: Click Stream Analysis, A/B testing, Online Surveys.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the relationship between social media systems and the networks they implicitly and explicitly created. (L1)
2. apply click stream data collection techniques, their impact on metrics, and their inherent limitations. (L3)
3. analyze the qualitative and quantitative data from the website and to drive a continual improvement of the online experience. (L4)

Module III: Web Search and Retrieval Number of hours LTP) 9 0 6

Web Search and Retrieval: Search Engine Optimization, Web Crawling and indexing, Ranking Algorithms, Web traffic models

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the amount of data sent and received by visitors to a website in web traffic model(L1)
2. compare and contrast the functionality of search engine algorithms updates. (L2)
3. develop an optimization strategy following best practices for a client to implement to help increase their ranking. (L3)
4. critique the role of advertisements and corporate funding in the development of search(L4)

Module IV: Making Connection Number of hours(LTP) 9 0 6

Making Connection: Link Analysis, Random Graphs and Network evolution, Social Connects: Affiliation and identity

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the Link Analysis and its impact on the connections(L1)
2. distinguish the affiliations in the social connections(L2)
3. construct the random graphs by using the tools(L3)

Module V: Connection Number of hours(LTP) 9 0 6

Connection: Connection Search, Collapse, Robustness Social involvements and diffusion of innovation

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the off-site and on-site web analytics (L2).
2. analyze the Key Analytic Metrics to Monitor the Average Time on Site/Page, Bounce/Exit Rates, etc.(L4)
3. examine the KPI (Key Performance Indicator) which evaluates the success of an activity(L3)

Text Books(s)

1. Derek Hansen, Ben Shneiderman, Marc A. Smith, Itai Himelboim, Analyzing Social Media Networks with NodeXL: Insights from a Connected World, 2/e, MK,2020.
2. AvinashKaushik, Web Analytics 2.0: The Art of Online Accountability, Wiley Publishers, 2009.

Reference Book(s)

1. Easley, D., Kleinberg, J., Networks, Crowds, and Markets: Reasoning About a Highly Connected World. New York: Cambridge University Press, 2010. http://www.cs.cornell.edu/home/kleinber/networks-book/
2. Kim Ann King, The Complete Guide to B2B Marketing: New Tactics, Tools and Techniques to Complete in the Digital Economy, Paul Boger, 2015.

Course Outcomes:

After completion of the course, students will be able to

1. determine the systematic method to evaluate social media efforts, replacing anecdotes with scientifically based evidence. (L2)
2. apply click stream data collection techniques, their impact on metrics, and their inherent limitations. (L3)
3. develop an optimization strategy following best practices for a client to implement to help increase their ranking. (L3)
4. construct the random graphs by using the tools(L3)
5. analyze the Key Analytic Metrics to Monitor the Average Time on Site/Page, Bounce/Exit Rates, etc.(L4)

19ECS750: GPU COMPUTING

L	T	P	C
3	0	2	4

Most modern computers come with Graphical Processing Units (GPUs) that can be used for general-purpose computing. GPUs provide much more computing power than CPUs do, by using more of their hardware resources for computing than CPUs do. GPUs deal with memory access latency primarily through multi-threading; when some threads are stalled accessing data, other threads can perform computation without a significant context-switch penalty. This course will describe different approaches to solve such problems, to develop efficient parallel algorithms for a variety of problems.

Course objectives:

1. Explain theoretical and empirical knowledge about graphics programming, memory management using for evaluating various parameters across the devices.
2. Enable to acquire knowledge about different synchronization methods exists within the CPU and learn about common application kernels.
3. Familiarize algorithms to provide parallel solutions to computationally challenging problems.
4. Enable to implement such solutions on GPU using CUDA and show effectiveness of the GPU based solutions using standard benchmarks and tools.

Unit I: Introduction Number of hours (LTP) 9 0 6

Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA OpenCL / Open ACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps/ Wavefronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D/ 3D thread mapping, Device properties, Simple Programs

Learning Outcomes:

After completion of this unit, the student will be able to:

1. show the various parallel programs. (L1)
2. understand the different graphics processors(L2)
3. identify the kernels and Thread mappings. (L2)
4. develop simple programs(L3)

Unit II: Memory Number of hours (LTP) 9 0 6

Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the categories of memories. (L2)
2. implement dynamic memory allocation (L3).
3. explain arrays and pointers(L2).

Unit III: Synchronization Number of hours (LTP) 9 0 6

Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked lists.

Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels, using libraries (such as Thrust), and developing libraries.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the synchronization procedures(L2).
2. summarize about CPU and GPU functions(L4).
3. explain the concurrent data structures(L2).'

Unit IV: Support Number of hours (LTP) 9 0 6

Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects

Streams: Asynchronous processing, tasks, Task-dependence, overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the debugging process of GPU programs(L2).
2. explain about pitfalls and event-based synchronization(L2).

Unit V: Case Studies Number of hours (LTP) 9 0 6

Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing

Learning Outcomes:

After completion of this unit, the student will be able to:

1. implement the different scenarios using graph simulations(L4)
2. explain Image processing(L2).
3. outline about deep learning(L2).

Textbooks(s)

1. David B. Kirk, Wen-mei W.Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 3/e, Mk, 2017
2. Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, Morgan Kaufman, 2012
3. Aditi Majumder, M. Gopi, Introduction to Visual Computing: Core Concepts in Computer Vision, Graphics, and Image Processing, CRC Press, 2018.
4. Bertil Schmidt, Jorge Gonzalez-Dominguez, Christian Hundt, Moritz Schlarb, Parallel Programming: Concepts and Practice, MK, 2018.

Course Outcomes:

1. Understand the GPU and its aspects(L1)
2. Demonstrate synchronization and kernel functions(L3).
3. Determine different web-based applications using deep learning (L3).

19ECS773: Deep Learning

L	T	P	C
3	0	2	4

In Machine Learning tasks such as speech recognition and computer vision, the mapping of raw data to the output is often a complicated function with many factors of variation. Deep Learning focuses to learn feature hierarchies with features at higher levels in the hierarchy formed by the composition of lower level features. This course aims to cover the basics of Deep Learning and some of the underlying theory with a particular focus on supervised Deep Learning along with a good coverage of unsupervised methods.

Course objectives:

1. Recall neural networks and learn dropout regularization and its role in improving the efficiency.
2. Learn various architectures and visualization of Convolution Neural Networks.
3. Learn deep recurrent architectures and its effectiveness.
4. Learn various encoders of deep unsupervised leaning.
5. Apply deep learning mechanisms to various learning problems

Module I: Number of hours(LTP) 9 0 6

Introduction: Feed forward neural networks (FFNN). Gradient descent and the back propagation algorithm. Unit saturation, aka the vanishing gradient problem, and ways to mitigate it. Regularization techniques.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. recall gradient descent and back propagation algorithms of FFNN(L1)
2. examine relu function and its importance(L4)
3. assess regularization of neural networks(L5)

Module II: Number of hours(LTP) 9 0 6

Convolution Neural Network: Architectures, convolution / pooling layers, Visualizing Convolution Networks, Deep learning frameworks.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the underlying mechanism of CNN(L2)
2. analyze the working principle of pooling layers(L4)
3. contrast variants of CNN(L4)

Module III: Number of hours(LTP) 9 0 6

Recurrent Neural Networks: LSTM, GRU, Encoder Decoder architectures. The Unreasonable Effectiveness of Recurrent Neural Networks.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain the encoder and decoders of RNN architectures(L2)
2. illustrate reservoir computing and its usage(L2)
3. inspect the effectiveness of RNN(L4)

Module IV: Number of hours(LTP) 9 0 6

Deep Unsupervised Learning: Auto encoders (standard, sparse, de-noising, contractive, etc), Variational Auto encoders, Adversarial Generative Networks, Auto encoder and DBM.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. outline various encoders of unsupervised learning(L2)
2. analyze adversarial networks and variational encoders(L4)
3. examine DBM(L4)

Module V: Number of hours(LTP) 9 0 6

Applications of Deep Learning: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. build a NN for automatic image captioning(L6)
2. improve the efficiency of NN(L6)
3. elaborate Generative networks for image generation(L6)

Text Books(s)

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press,2015.
3. Francois Chollet, Deep Learning with Python, 1/e, Manning Publications Company,2017

Course Outcomes:

1. explain the basics of deep learning and relu function (L2).
2. define dropout regularization and its importance in improving the efficiency (L1).
3. construct the architectures of CNN and their usage (L3).
4. outline variations of RNN and their implementations (L2).
5. elaborate the underlying unsupervised techniques in deep learning (L6).
6. analyze and build CNN for various real time applications (L4).

19ECS742: ADVANCED WIRELESS AND MOBILE NETWORKS

L	T	P	C
3	0	2	4

The course is designed to enable the student to learn the fundamental aspects of wireless networks, with emphasis on current and next-generation wireless networks. Various aspects of wireless networking will be covered including: fundamentals of cellular communication, mobile radio propagation, multiple access techniques, mobility support, channel allocation, Wireless PAN/LAN/MAN standards, mobile ad-hoc networks, wireless sensor networks, mobile networks. The goal of this course is to introduce the students to state-of-the-art wireless network protocols and architectures and will introduce the students to wireless networking research and guide them to investigate novel ideas in the area via semester-long research projects.

Course objectives:

1. Understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards.
2. Compare recent technologies used for wireless communication.
3. Explain the architecture, functioning, protocols, capabilities and application of various wireless communication networks and wireless cellular networks
4. Explain multiple access techniques for Wireless Communication
5. Evaluate design challenges, constraints and security issues associated with wireless networks and mobile networks.

Module I: Number of hours(LTP) 9 0 6

Introduction: Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies -CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy, etc.

Wireless Local Area Networks: IEEE 802.11 Wireless LANs Physical & MAC layer, 802.11 MAC Modes (DCF & PCF) IEEE 802.11 standards, Architecture & protocols, Infrastructure vs Adhoc Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues

Learning Outcomes:

After completion of this unit, the student will be able to:

1 Demonstrate WLAN architecture. [L2]
2 learn the characteristics of the wireless channel and multiple access technologies [L2]
3 analyze the functionality of MAC layer of WLAN [L4]

Module II: Number of hours(LTP) 9 0 6

Wireless Cellular Networks:1G and 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving
Coverage and capacity in cellular systems, Spread spectrum Technologies

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Determine the coverage and capacity of Wireless Cellular Networks. [L5]
2. Analyze different technologies in Wireless Cellular Networks [L4]

3. Compare the strategies in TCP over wireless networks[L4]
4. Demonstrate Cellular Architecture [L2]

Module III: Number of hours(LTP) 9 0 4

WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22 Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover Overview

Learning Outcomes:

After completion of this unit, the student will be able to:

1 Select which protocol can be used for a specific application [L4]
2 Demonstrate WiMax Architecture. [L2]
3 Demonstrate Regional Area Networks. [L2]

Module IV: Number of hours(LTP) 10 0 4

Wireless PANs: Bluetooth AND ZigBee, Introduction to Wireless Sensors, Wireless Sensor Networks: Introduction, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS Overview.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Demonstrate Wireless PANs technology. [L2]
2. Determine different protocols and sensors in Wireless communication [L5]
3. Demonstrate WSN architecture. [L2]
4. Evaluate the power management in WSN [L4]

Module V: Number of hours(LTP) 9 0 4

Security: Security in wireless Networks, Vulnerabilities, Security techniques, WiFi Security, DoS in wireless communication

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Evaluate design challenges, constraints and security issues associated with wireless networks and mobile networks. [L4]
2. Learn different security techniques in Wireless communication [L2]
3. Compare the different DoS attacks in wireless communication [L5]

Text Books(s)

1. Schiller, Jochen H. *Mobile communications*. Pearson education, 2003.
2. Beard, Cory, and William Stallings. *Wireless communication networks and systems*. Pearson, 2015.
3. Sinha, Koushik, Sasthi C. Ghosh, and Bhabani P. Sinha. *Wireless networks and mobile computing*. Chapman and Hall/CRC, 2019.

Reference Book(s):

1. Hu, Fei, and Xiaojun Cao. *Wireless sensor networks: principles and practice*. Auerbach Publications, 2010.
2. Stojmenovic, Ivan, ed. *Handbook of wireless networks and mobile computing*. Vol. 27. John Wiley & Sons, 2003.

Course Outcomes:

1. Demonstrate their understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards.[L2]
2. Compare different technologies used for wireless communication systems.[L5]
3. Explain the architecture, functioning, protocols, capabilities and application of various wireless communication networks. [L2]
4. Demonstrate multiple access techniques for wireless communication [L2]
5. Demonstrate e design challenges, constraints and security issues associated with wireless networks and wireless cellular networks.[L2]

19ECS766: BIOMETRICS

L	T	P	C
3	0	2	4

The course is designed to enable the student to apply biometric principles and practices for the secure real time systems, scientific and business applications. This course lays the foundation both for developing program logic and for writing programs in to diagnose the biometric and cyber problems and to build the system with advance solution to solve problem with cyber ethics.

Course objectives:

1. familiarize the student to understand the basics of Biometrics and its functionalities
2. enable the student to understand the role of biometric in the organization build program
3. explain the context of Biometric Applications
4. demonstrate the handle to learn to develop applications with biometric security train the student to design of biometric recognition for the organization

Module I: Introduction Number of hours(LTP) 9 0 6

Definitions of bio-metrics, Traditional authenticated methods and technologies. -benefits of biometrics in identification systems-selecting a biometric for a system –Applications - Key biometric terms and processes - biometric matching methods -Accuracy in biometric systems.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand basics of Biometrics(L2).
2. list the traditional methods (L1).
3. Interpret the technologies of biometrics(L2)

Module II: Biometric Models Number of hours(LTP) 8 0 6

Physiological Biometric Technologies: Fingerprints - Technical description –characteristics - Competing technologies - strengths – weaknesses – deployment - Facial scan - Technical description - characteristics - weaknesses-deployment - Iris scan - Technical description – characteristics - strengths – weaknesses – deployment - Retina vascular pattern, 3D Face Recognition, Dental Identification and DNA.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand fingerprint, face, iris(L2).
2. analyse 3DFace Recognition (L4).
3. understand DNA(L2).

Module III: Multi biometrics and multi factor biometrics Number of hours(LTP) 8 0 6

Two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. analyze law of biometric systems (L4).
2. make use of the multi-biometric systems(L3).

Module IV: Number of hours(LTP) 10 0 6

Statistical measurement of Bio-metric. Bio-metrics in Government Sector and Commercial Sector. signature and handwriting technology - Technical description – classification – keyboard / keystroke dynamics- Voice – data acquisition

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the government sector and commercial sector for biometrics (L2).
2. Apply the statistical measurement of biometric (L3).
3. Understand recognition of biometrics based on voice and handwriting (L2)
4. make use statistical measurements in biometric (L3).

Module V: Case Studies Number of hours(LTP) 10 0 6

Case Studies of bio-metric system, Bio-metric Transaction. Bio-metric System Vulnerabilities. Recent trends in Bio-metric technologies and applications in various domains. Case study of 3D face recognition and DNA matching

Learning Outcomes:

After completion of this unit, the student will be able to:

1. develop programs biometric system (L6).
2. understand recent trends in biometric technologies(L2)

Text Books(s)

1. Paul Reid, Biometrics for network security, Hand book –Pearson publications ,2nd Edition
2. Samir Nanavathi, Michel Thieme, and Raj Nanavathi : “Biometrics -Identity verification in a network”, 1st Edition, Wiley Eastern, 2002,3rd Edition
3. D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar, Handbook of Fingerprint Recognition, Springer Verlag, 2003.
4. A.K. Jain, R. Bolle, S. Pankanti (Eds.), BIOMETRICS: Personal Identification in Networked Society, Kluwer Academic Publishers,1999, 2nd Edn

Reference Book(s)

1. J. Wayman, A.K. Jain, D. Maltoni, and D. Maio (Eds.), Biometric Systems: Technology, Design and Performance Evaluation, Springer,2004.
2. Anil Jain, Arun A. Ross, Karthik Nanda kumar, Introduction to biometric, Springer,2011.
3. J. Wayman, A. K. Jain, D. Maltoni, and D. Maio, Biometric Systems: Technology, Design and Performance Evaluation

Course Outcomes:

1. Identify various Biometric Technologies (L2)
2. understand DNA(L2).
3. analyse law of biometric systems (L3).
4. understand the government sector and commercial sector for biometrics (L2).
5. Understand Recent trends in Biometrics (L 2)

19ECS752: DIGITAL FORENSICS

L	T	P	C
3	0	2	4

The course is designed to enable the student to understand underlying principles and many of the techniques associated with the digital forensic practices and cybercrime, investigate attacks, handling evidence. Student can have a sneak review of Computer Forensics, Network Forensics, And Mobile Forensics.

Course objectives:

1. Familiarize the student about digital and computer forensics.
2. Enable the student to learn analysis of crime scene.
3. Manage and present evidence
4. Demonstrate investigation process.

Module I: Introduction Number of hours(LTP) 9 0 6

Forensic Science, Digital Forensics, Digital Evidence, The Digital Forensics Process, The Identification Phase, The Collection Phase, The Examination Phase, The Analysis Phase, The Presentation Phase

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand basics of digital forensics (L1)
2. differentiate the types of forensic technologies (L4)

Module II: Digital Forensic Readiness Number of hours(LTP) 9 0 6

Digital Forensic Readiness, Law Enforcement versus Enterprise Digital Forensic Readiness, A Rationale for Digital Forensic Readiness, Frameworks, Standards, and Methodologies, Becoming "Digital Forensic" Ready, Enterprise Digital Forensic Readiness,

Learning Outcomes:

After completion of this unit, the student will be able to:

1. differentiate between law enforcement and enterprise forensics (L4)
2. understand the Frameworks, Standards, and Methodologies of digital forensics(L1)

Module III: Computer Forensics Number of hours(LTP) 9 0 6

Evidence Collection: Data Acquisition, Forensic Copy, Examination: Disk Structures, File Systems Analysis: Analysis Tools, Timeline Analysis, File Hashing, Filtering, Data Carving, Memory Analysis : Collection Phase, Examination Phase

Learning Outcomes:

After completion of this unit, the student will be able to:

1. illustrate duplication and preservation of digital evidence. (L3)
2. perform analysis on captured data (L2)

Module IV: Mobile and Embedded Forensics Number of hours(LTP) 9 0 6

Embedded Systems and Consumer Electronics, Mobile Phones, Telecommunication Networks, Mobile Devices and Embedded Systems as Evidence, Malware and Security Considerations, Ontologies for Mobile and Embedded Forensics

Collection Phase, Examination Phase

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand various embedded systems and consumer electronics(L1)
2. Collect data and perform analysis on captured data(L3)

Module V: Internet Forensics Number of hours(LTP) 9 0 6

Computer Networking, Layers of Network Abstraction, The Internet, Tracing Information on the Internet, Collection Phase – Local Acquisition, Collection Phase – Network Acquisition, The Examination and Analysis Phases

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand about various networks (L1)
2. Perform forensic analysis to find evidences on internet(L3)

Text Books(s)

1. Andre Arnes, Digital Forensics, Wiley, 1st, 2017.

Reference Book(s)

1. John R.Vacca, John Sammons ,Computer Forensics computer crime scene investigation, second edition,2014
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Course Outcomes:

1. understand the basics of digital forensics. (L2)
2. implement the capture, duplication, and preservation of digital evidence. (L4)
3. analyse the digital evidence to find the digital artifacts. (L6)
4. understand basics of performing analysis to find the evidence (L3)

19ECS786: CLOUD SECURITY

L	T	P	C
3	0	2	4

This course will help the students to get familiar with Cloud computing infrastructure as a mainstay of the IT industry, opening the possibility for on-demand, highly elastic and infinite compute power with scalability and supporting the delivery of mission-critical secure enterprise applications and services. This course provides the ground-up coverage on the high-level concepts of cloud landscape, architectural principles, techniques, design patterns and real-world best practices applied to Cloud service providers and consumers and delivering secure Cloud based services.

Course objectives:

1. Cloud computing and architectural principles with primary focus on security techniques and security design.
2. Deep dive on Security architecture, Technological Influences, and best practices.
3. Current security standards, protocols, and best practices intended for delivering Cloud based enterprise IT services.
4. Architectural and design approaches to designing secure cloud services.
5. Applying industry security standards, regulatory mandates, audit policies and compliance requirements. Survey on Cloud vendor security implementations, compliance, and autonomic protection mechanisms.

Module I: Number of hours(LTP) 9 0 6

Cloud Computing Fundamentals: Essential Characteristics, Architectural Influences, Technological Influences, Operational Influences, Outsourcing.

Cloud Computing Architecture: Cloud Delivery Models, Cloud Deployment Models, Expected Benefits.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Define the Cloud computing(L1)
2. Illustrate the Architectural and Technological Influences of Cloud Computing(L2)
3. Demonstrate Cloud deployment models and Scope of Control(L2)

Module II: Number of hours(LTP) 10 0 6

Cloud Computing Software Security Fundamentals: Cloud Information Security Objectives, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Approaches to Cloud Software Requirements Engineering, Cloud Security Policy Implementation, Secure Cloud Software Testing, Cloud Computing and Business Continuity Planning/Disaster Recovery, Redundancy Provided by the Cloud, Secure Remote Access, Integration into Normal Business Processes

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Develop secure software is based on applying the secure software design principles that form the fundamental basis for software assurance. (L3)
2. Identify the cloud security services, cloud security principles, secure software requirements, and testing concepts. (L3)
3. Categorize the cloud business continuity planning, disaster recovery, redundancy, and secure remote access.

Module III: Number of hours(LTP) 9 0 6

Cloud Computing Risk Issues: The CIA Triad, Privacy and Compliance Risks, Threats to Infrastructure, Data, and Access Control, Cloud Service Provider Risks

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Estimate the cloud computing risks, threats privacy assurance and compliance regulations. (L6)
2. Distinguish the "traditional" concepts of data, identity, and access management (IAM) risks. (L4)
3. How those risks and threats may be unique to cloud service providers. (L1)

Module IV: Number of hours(LTP) 9 0 6

Cloud Computing Security Challenges: Security Policy Implementation, Policy Types, Computer Security Incident Response Team (CSIRT), Virtualization Security Management, VM Security Recommendations, VM-Specific Security Techniques

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Identify the management challenges, opportunities, and security posture of the organization it relates to the virtualization perimeter. (L3)
2. Apply security policy and computer intrusion detection and response implementation techniques. (L3)
3. Demonstrate the virtualization security management issues. (L2)

Module V: Number of hours(LTP) 9 0 6

Cloud Computing Security Architecture: Architectural Considerations, General Issues, Trusted Cloud Computing, Secure Execution Environments and Communications, Microarchitectures, Identity Management and Access Control, Identity Management, Access Control, Autonomic Security

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Illustrate the important cloud computing security architectural issues, including trusted cloud computing, secure execution environments, and micro architectures. (L2)
2. Identify the identity management and access control. (L3)
3. Compare the concepts of autonomic systems and autonomic protection mechanisms.(L4)

Text Books

1. Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, 2010, Wiley Publishing, Inc

Reference Book(s)

1. John R. Vacca, "Cloud Computing Security: Foundations and Challenges", Kindle Edition

Course Outcomes:

1. Evaluate the fundamentals of cloud computing architectures based on current standards, protocols, and best practices intended for delivering Cloud based enterprise IT services and business applications. (L5)
2. Identify the known threats, risks, vulnerabilities, and privacy issues associated with Cloud and evolve appropriate safeguards and countermeasures. (L3)
3. Design Cloud security architectures that assure secure isolation of compute, network and storage infrastructures, comprehensive data protection, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates. (L6)
4. Compare the security guidelines set forth by ISO, NIST, ENISA and Cloud Security Alliance. (L5)
5. Analyze Cloud Security - CBK Certifications from Cloud Security Alliance (CSA) and Policies. (L4)

19ECS774: SOCIAL NETWORK ANALYSIS

L	T	P	C
3	0	2	4

The course is designed to enable the student to learn about the network perspective and how to apply it to answer important questions in various fields in social science. The course teaches students a range of social network analysis techniques, provides training in social network analysis software and students work on an independent research project.

Course objectives:

1. Define a broad range of network concepts and theories.
2. Familiarize the student with how network analysis can contribute to increasing knowledge about diverse aspects of society.
3. Explain social network data using various software packages.
4. Demonstrate results from social network analysis, both orally and in writing
5. Describe the consequences of different network structures for network processes including Contagion and social influence.

Module I: **Number of hours 8 0 0**

Networks and Relations, Relations and Attributes, Analysis of Network Data, Interpretation of Network Data, An Overview. The Development of Social Network Analysis, Socio-metric analysis and Graph Theory, Interpersonal Configurations and cliques.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Acquiring knowledge on the basic concepts(L1)
2. Understand a Networks relations and attributes (L1).
3. List the steps involved in Socio-metric analysis (L1).
4. Interpret the Configurations and cliques (L1).
5. Understand the social network vocabulary(L1)

Module II: **Number of hours 8 0 6**

Analysing Relational Data, Collecting Relational Data, Selection and Sampling of Relational Data, Preparation of Relational Data, Organizing Relational Data. Lines, Neighbourhoods and Densities, Socio-metric and Graph Theory, Density: Ego-centric and Socio-centric, A Digression on absolute density, Community Structure and density.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Analysing the concept of Relational data (L2).
2. Construct preparation of relational data (L2).
3. Develop Graph Theory (L2).
4. Demonstrate the usage of Egocentric and socio centric (L2).
5. The use of social network in personal and Professional development (L2)

Module III: **Number of hours 8 0 6**

Centrality Peripherality and Centralization, Centrality: Local and Global, Centralization and Graph Centres, bank Centrality in Corporate Networks, Components, Cores and Cliques, Components, Cycles and Knots, The Contours of components, Cliques and their intersections.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Able to distinguish between local, global and centralization concepts (L3)
2. Make use Cycles, knots cliques (L3).
3. Analyse Corporate Networks and components (L3)

4. Solve problems related to cliques and their intersections (L3).
5. Demonstrate and understanding of social networks for business and professional use(L3)

Module IV: **Number of hours 8 0 6**

Positions, sets and clusters, the structural equivalence of points, Clusters: Combining and Dividing points, Block Modelling with CONCER, Towards Regular Structure Equivalence.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand the concept of Clusters (L4).
2. Apply the structural equivalence of points (L4).
3. Make use of block modelling (L4).
4. Infer the regular structure equivalence (L4).
5. Able to use Block Modelling with CONCER

Module V: **Number of hours 10 0 6**

Network Dynamics and Change over Time, Modelling change in Network Structure, Testing Explanations. Dimensions and displays, Distance, space and metrics, principal components and factors, Non-metric methods, Advances in Network Visualization, Elites, Communities and influence. Accessing twitter.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand network dynamics (L5).
2. Compare distance, space and metrics (L5).
3. Make use of accessing twitter (L5).
4. Demonstrate proficiency and understanding of public sector media and privacy(L5)
5. Understanding concepts in social networking and utilizing these concepts for solving real-world social n issues(L5)

Text Books(s)

1. John Scott, Social Network Analysis, 3/e, SAGE Publications, 2017
2. Matthew A. Russell and Mikhail Klassen, Mining the Social Web, 3/e, O'Reilly, 2019.
3. Charles Kadushin, Understanding Social Networks: Theories, Concepts, and Findings, Oxford University Press, 2012.
4. Maksim Tsvetovat, Alexander Kouznetsov, Social Network Analysis for Startups, O'Reilly, 2014.

Course Outcomes:

1. Understand a Networks relations and attributes (L1).
2. Analyse relational data (L2).
3. Solve problems related to cliques and their intersections (L3).
4. Infer the regular structure equivalence (L4).
5. Make use of accessing twitter (L5).

19ECS775: NATURAL LANGUAGE PROCESSING

L	T	P	C
3	0	2	4

Natural language processing *(NLP) is one of the most important technologies of the information age. Understanding complex language utterances is also a crucial part of artificial intelligence. Natural language processing (NLP) is the relationship between computers and human language. More specifically, natural language processing is the computer understanding, analysis, manipulation, and/or generation of natural language. This course enables the students to learn the Natural language processing at different levels like Morphological Level, Syntactic Level, Semantic Level, Discourse Level and Pragmatic Level.*

Course objectives:

- Understand the leading trends and systems in natural language processing.
- Understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above-mentioned concepts.
- Recognize the significance of pragmatics for natural language understanding.
- Describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Module I: **9 0** 6

Introduction – Models -and Algorithms - -Regular Expressions, Finite State Automata, Morphology, Morphological Parsing, Stemming- Porter Stemmer Algorithm, Text Normalization, Edit Distance

Learning Outcomes:
After completion of this unit, the student will be able to:

- Learn the Regular expressions and finite state automata(L2)
- Learn the morphology(L2)
- Understand the morphological parsing(L2)

Module II: **9 0** 6

N-grams Models of Syntax - Counting Words - Unsmoothed, Smoothing, Entropy, Sequence Labeling for Part of Speech Tagging, MM Part of Speech Tagging, Named Entities and Named Entities Tagging. Evaluation of Named Entity Recognition. Vector Semantics Embedding, Lexical Semantics, Vector Semantics, Words and Vectors, Term-frequency and Inverse Term Frequency (TF-IDF), Word2vec Model.

Learning Outcomes:
After completion of this unit, the student will be able to:

- Understand the syntactic level(L2)
- Learn different models of syntax(L2)
- Understand Speech tagging(L2)

Module III: **9 0** 6

Context Free Grammars for English Syntax, Sentence- Level Constructions, Parsing – Top-down –CYK-Early Parsing, Evaluating Parsers, Feature Structures – Probabilistic Context-Free Grammars

Learning Outcomes:
After completion of this unit, the student will be able to:

- Learn Context Free Grammars for English(L2)
- Understand Sentence – Level Constructions(L2)
- Analyze Probabilistic Context – Free Grammars(L4)

Module IV: **9 0** 6

Discourse -Reference Resolution - Relation Extraction, Word Senses, Word Sense Disambiguation, Text Coherence - Discourse Structure – Coherence, Center and Entity based Coherence, Local and Global Coherence, Coreference Resolution, Mention Detection, Architecture for Coreference Resolution, Classifier for Coreference Resolution. Evaluation of Coreference Resolution, Machine Translation - Transfer Metaphor–Interlingua- Statistical Approaches- IBM Model-1 and IBM model -2, MT evaluation.
Learning Outcomes:
After completion of this unit, the student will be able to:

- Understand the discourse level(L2)
- Learn Machine Translation(L2)
- Analyze Statistical Approaches(L4)

Module V: **9 0 6**

Applications of Natural Language Processing, Deep Architecture for Sequence Processing, Factoid Question Answering, Similar Question Detection, Dialogue Topic Tracking, Neural Summarization, Smart Reply

Learning Outcomes:
After completion of this unit, the student will be able to:

- Understand the applications of NLP(L2)
- Understand the research trends using Deep Learning(L2)
- Learn Dialogue topic tracking(L2)

Text Books(s):

1. Daniel Jurafsky, James H Martin, “Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 2/e, Prentice Hall, 2008.
2. C. Manning, H. Schutze, “Foundations of Statistical Natural Language Processing”, MIT Press. Cambridge, MA, 1999.
3. Jacob Eisenstein, Introduction to Natural Language Processing, MIT Press, 2019.
4. EBook: Le Deng, Yang Liu, Deep Learning in Natural Language Processing, Springer, 2018.
5. Jalaj Thanaki, Python Natural Language Processing: Explore NLP with machine Learning and deep learning Techniques, Packt, 2017.

Course Outcomes:

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

- Understand approaches to syntax and semantics in NLP(L2)
- Apply approaches to discourse, generation, dialogue and summarization within NLP(L3)
- Analyze current methods for statistical approaches to machine translation(L4)
- Evaluate machine learning techniques used in NLP, including hidden Markov models and probabilistic context-free grammars as applied within NLP(L4)

19ECS772: DATA SECURITY AND ACCESS CONTROL

L	T	P	C
3	0	2	4

The course provides fundamentals of data security and various access control techniques mechanisms that are introduced along with application areas of access control techniques. It also contains an RBAC and smart card technology that has great deal of attention for commercial and real time applications.

Course objectives:

1. To narrate and evaluate the design principles of conventional discretionary and mandatory security techniques.
2. To learn Different RBAC frameworks for modelling a secure system
3. To know methods for assigning access to information in a company based on the individual's need for the information,
4. To specify security administrator and enforce security policies that map naturally to the organization's structure.
5. To understand reliable and quality data transmission using smart cards.

Module I: Access Control Number of hours (LTP) 9 0 6

Introduction to Access Control, Purpose and fundamentals of access control, brief history.

Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. list the origins, history, and central concepts of access control (L1)
2. review the technical realization and security of data (L2)
3. compare principles of conventional discretionary and mandatory security techniques. (L2)
4. identify access control policies, access control models, and access control mechanisms. (L1)

Module II: Number of hours (LTP) 9 0 6

Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. review popular forms of access controls in use today (L2)
2. interpret the basic concepts of RBAC and its advantages for system, application, and network security(L3)
3. compare security levels of different RBAC models. (L2)
4. incorporate roles to users using RBAC(L6)

Module III: Number of hours (LTP) 9 0 6

Biba's intrigity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system, Temporal Constraints in RBAC, MAC and DAC.

Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi-line Insurance Company.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the similarities and differences between roles and groups(L1)
2. develop access control mechanisms and models (L3)
3. illustrate the research concepts and associated prototypes that have been developed to integrate RBAC model concepts into existing enterprise IT infrastructures. (L3)
4. trace the integration of the RBAC model into the Web applications (L2)

Module IV: Number of hours (LTP) 9 0 6

Smart Card based Information Security, Smart card operating system-fundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify smart card applications like identification, financial, mobile phones (SIM), public transit, computer security, schools, and healthcare(L1)
2. explain how Smart cards provide computing, portability and secure storage of data and value. (L4)
3. understand the integration of smart cards into system to introduce security. (L2)
4. construct present permissions set by the card issuer. (L3)

Module V: Number of hours (LTP) 9 0 6

Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems, Recent Trends related to data security management, vulnerabilities in different DBMS.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. record the experience of a real company in its transition from conventional access control methods to RBAC. (L1)
2. develop prototypes to integrate the RBAC model into the various enterprise technologies. (L3)
3. evaluate the benefits and costs of RBAC from the vantage point of a software end user. (L5)
4. report insights related to delegated administration and other functionalities afforded RBAC users. (L2)

Text Books(s)

1. David F. Ferraiolo, D. Richard Kuhn, Ramaswamy Chandramouli, Role Based Access Control, Artech House, 2003.
2. http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.

Reference Book(s)

1. Database and Applications Security: Integrating Information Security and Data Management (Hardcover) by Bhavani Thuraisingham, Auerbach Publications; 1st edition (May 26, 2005),
2. Michael Gertz and Sushil Jajodia (Editors), Handbook of Database Security: Applications and Trends , ISBN-10: 0387485325. Springer, 2007 xxxxx

Course Outcomes:

1. understand and implement classical models. (L2)
2. analyse the data, identify the problems, and choose the relevant models (L4)
3. assess the strengths and weaknesses of various access control models and to analyse their behaviour. (L5)
4. assign security levels are assigned to users, with subjects acting on behalf of users and objects. (L3)
5. Use of a common mechanism for a wide variety of purposes. (L3)

19ECS754: MOBILE APPLICATIONS AND SERVICES

L	T	P	C
3	0	2	4

This course is designed to enable the student to deploy the mobile based applications using android operating system as platform. First the basics of mobile applications and android system are taught then application deployment is explained in terms of network perspective and in line with the standard security protocols which can be consumed as a service.

Course objectives:

- Familiarize the student with the basics of mobile applications and android operating system.
- Enable the student to build mobile applications.
- Explain with the features and constructs of android operating system and networking.
- Demonstrate the handling of various functionalities such as graphical user interfaces, Data framework and tools.
- Demonstrate various platform and architecture with hacking and security issues.

Module I: Number of hours(LTP) 9 0 6

Introduction: Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User

Learning Outcomes:

After completion of this unit, the student will be able to:

- gain insights on mobile computing and android environment(L1).
- understand various factors of development, framework and tools involved(L2).

Module II: Number of hours(LTP) 9 0 6

More on UIs: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal UIs, Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider.

Learning Outcomes:

After completion of this unit, the student will be able to:

- select an appropriate model of UI that suits his requirement. (L1)
- familiarize themselves with data access and content providers. (L2)

Module III: Number of hours(LTP) 10 0 6

Communications via Network and the Web: State Machine, Correct communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony Notifications and Alarms: Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics.

Learning Outcomes:

After completion of this unit, the student will be able to:

- deal with the communication domain such telephony, notification management. (L1)
- analyse performance and memory management. (L3)

Module IV: Number of hours(LTP) 8 0 6

Putting It All Together: Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia.

Learning Outcomes:
After completion of this unit, the student will be able to:

- adapt a best field practice for deployment of service apps. (L3)
- gain fundamental knowledge on android related multimedia. (L1)

Module V: Module Name(if any) Number of hours(LTP) 8 0 6

Platforms and Additional Issues: Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, more on Security, Hacking Android

Learning Outcomes:
After completion of this unit, the student will be able to:

- build a final version of the app that is tested and deployed.(L5)
- deal with unforeseen circumstances such as hacking and other network related threats(L4).

Text Books(s)

1. Michael Burton, Android App Development for Dummies, 3/e, John Wiley and Sons, 2015.
2. Wei-Meng Lee, Beginning Android™ 4 Application Development, John Wiley & Sons, 2012.
3 .Padmini, Android App Development: A Complete Tutorial For Beginners, Educreation Publishing, 2016

Reference Book(s)

1. Serhan Yamacli, Beginner's Guide to Android App Development: A Practical Approach for Beginners, Create Space Independent Publishing Platform, 2017.

Course Outcomes:

After completion of this course, the student will be able to

- understand and analyze various factors of development, framework and tools involved in mobile computing and android environment. (L4)
- select an appropriate model of UI that suits the requirement and data access and content providers. (L6)
- deal with the communication domain prospects such as telephony, notification management. Analyse performance and memory management. (L4)
- choose best field practice for deployment of service apps in android related multimedia. (L5)
  - deploy a final version of the app that is tested and deployed and to deal with hacking and other network related threats(L6)

19ECS783: SOFTWARE PROJECT MANAGEMENT

L	T	P	C
3	0	2	4

This course provides an overall idea of management skills in the area of handling projects. This course helps to solve the problems occurred during the lifecycle of project. Learn about different tools of project management to solve the problems.

Course Objectives

1. To highlight the importance of software project management.
2. To discuss various processes in Software Project Management.
3. To provide tools and techniques for project monitoring.
4. To expose different project management life cycles.

Module I: Number of hours(LTP) 8 0 6

What is a Project: Defining a project**:** Sequence of Activities -Complex Activities-A Business focused definition, Understanding the Scope Triangle, Importance of Classifying Projects.
What is Project Management: Fundamentals of Project Management, Managing the Creeps, Introducing Project Management Life Cycles, Choosing the Best-Fit PMLC Model.

Learning Outcomes:

After completion of this unit the student will be able to

1. define different project management activities in order (L1)
2. understand the working of lifecycles of project management (L2)

Module II: Number of hours(LTP) 8 0 6

Project Management Process Groups: Defining the Five Process Groups, Nine Knowledge Areas, Mapping Knowledge Areas to Process Groups,
Traditional Project Management: To Scope a TPM Project: Using Tools, Templates, and Processes to Scope a Project, Managing Client Expectations.

Learning Outcomes:

After completion of this unit the student will be able to

1. understand the importance of process groups (L2)
2. grouping of mapping areas to process (L2)
3. Understand the Traditional Project Management(L1)

Module III: Number of hours(LTP) 10 0 6

Traditional Project Management: Plan a TPM Project: Using Tools, Templates, and Processes to Plan a Project-Using Application Software Packages- Project Planning Tools, Planning and Conducting Joint Project, Building the WBS, Estimating, Constructing the Project Network Diagram, Effective Project Proposal

Learning Outcomes:

After completion of this unit the student will be able to

1. choose the appropriate tools to manage the project(L3)
2. sketch the work breakdown structure and project network (L3)

Module IV: Number of hours(LTP) 8 0 6

Complex Project management: Complexity and Uncertainty in the Project Management: Understanding the Complexity/Uncertainty

Agile Project Management: What is Agile Project Management, Iterative Project Management Life Cycle- Adaptive Project Management Life Cycle – Adapting and Integrating the APM Toolkit.

Learning Outcomes:

After completion of this unit the student will be able to

1. understand the complexity/uncertainty of a project (L3)
2. categorize the different life cycles of management (L4)

Module V: Number of hours(LTP) 9 0 6

Establishing a Project Portfolio Management Process: Introduction to Project Portfolio Management, The Project Portfolio Management Life Cycle - **Establishing and Managing a Continuous Process Improvement Program** - Defining Process and Practice Maturity - Using Process Improvement Tools, Templates and Processes.

Learning Outcomes:

After completion of this unit the student will be able to

1. establishing and managing a continuous process improvement program(L4)
2. applying of Process improvement tools (L5)

Text Books(s)

1. Robert K. Wysocki, “Effective Project Management – Traditional, Agile, Extreme”, 7th Edition, Wiley Publication, 2011.
2. Robert K. Wysocki, “Effective Software Project Management”, 3rd Edition, Wiley Publication, 2010.

Course Outcomes:

1. understand the fundamentals of Software Project Management
2. apply the Traditional Project Management
3. develop the work breakdown structure and project network
4. understand the Project complexity/uncertainty
5. apply the tools for Software Project Management

19ECS785: BLOCKCHAIN TECHNOLOGY

L	T	P	C
3	0	2	4

To really be aware of what is special about Bitcoin, we need to understand how it works at a technical level. Bitcoin truly is a new technology and we can only get so far by explaining it through simple analogies to past technologies. Cryptography is a deep academic research field utilizing many advanced mathematical techniques that are notoriously subtle and complicated to understand. Fortunately, Bitcoin only relies on a handful of relatively simple and well-known cryptographic constructions. Here specifically we will study cryptographic hashes and digital signatures, two primitives that prove to be very useful for building cryptocurrencies and Bitcoin mining Strategies.

Course objectives:

1. Gain knowledge on Block Chain Fundamentals and Working Principle
2. Understand the basic concept of Cryptographic Hash Functions, Hash Pointers
3. Learn Elliptic Curve Digital Signature Algorithm.
4. Get an insight into the working of the Bitcoin network, wallet, Bitcoin mining and distributed consensus for reliability.
5. Gain knowledge about Bitcoin storage, Transaction and Usage
6. Be familiar with Bitcoin Mining Hardware, Pools, strategies and basics of Anonymity.

Module I: Block Chain Fundamentals Number of hours(LTP) 8 0 6

Tracing Blockchain's Origin, Revolutionizing the Traditional Business Network, How Blockchain Works, What Makes a Blockchain Suitable for Business?

Introduction to Cryptography: Cryptographic Hash Functions, SHA256, Hash Pointers and Data Structures, Merkle tree.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Learn Block chain Fundamentals and Working Principle.
2. Apply Cryptographic Hash Functions.
3. Implement Merkle Tree

Module II: Digital Signatures Number of hours(LTP) 8 0 6

Elliptic Curve Digital Signature Algorithm (ECDSA), Public Keys as Identities, A Simple Crypto currency.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Implement Elliptic Curve Digital Signature Algorithm.
2. Learn Simple Crypto currency like Goofy Coin, Scrooge Coin.

Module III: Number of hours(LTP) 8 0 6

Centralization vs. Decentralization, Distributed Consensus, Consensus without identity using a block chain, Incentives and proof of work.

Mechanics of Bitcoin: Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bitcoin network.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Work on Bitcoin network, wallet
2. Learn Bitcoin mining and distributed consensus for reliability
3. Use Bitcoin Transaction and applications

Module IV: Storage of and Usage of Bitcoins Number of hours(LTP) 8 0 6

Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Learn Types of Bitcoin Storage
2. Use Bitcoin Payment Services and Currency Exchange Markets.
3. Able to do mining job in Bitcoin transaction.

Module V: Bitcoin Mining Number of hours(LTP) 8 0 6

The Task of Bitcoin miners, Mining Hardware, Mining pools, Mining incentives and strategies. Bitcoin and Anonymity: Anonymity Basics, Mixing, Zerocoin and Zerocash

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Learn Mining Hardware and Pools
2. Design Bitcoin Mining strategies

Text Books(s)

1. Manav Gupta, BlockChain for dummies, 2nd IBM Limited Edition, Published by John Wiley & Sons, Inc, 2018.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies, 2016.

Reference Book(s)

1. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, 1/e, 2015.
2. Andreas M. Antonopoulos, Mastering Bitcoin: Programming the Open Blockchain, O'Reilly Media, 2/e, 2017.

Course Outcomes:

1. Learn Block chain Fundamentals and Working Principle.
2. Apply Cryptographic Hash Functions, Hash Pointers.
3. Implement Elliptic Curve Digital Signature Algorithm.
4. Work on Bitcoin network, wallet, Bitcoin mining and distributed consensus for reliability.
5. Use Bitcoin Transaction, Payment Services and Exchange Market Services.
6. Design Bitcoin Mining Hardware, Pools and strategies.

19ECS768: SECURITY ASSESSMENT AND RISK ANALYSIS

L	T	P	C
3	0	2	4

The course is designed to enable the student achieve the analytical tools to understand and analyze complex riskand security issues and developments, as well as the ability to plan and implement strategic processes in organizations and companies. The purpose of the course is to train students through critical reflection and professional insights, to identify opportunities for change in the complex and risky environments in which they operateandtoputthesereflections intoaction.

Course objectives:

1. Student will acquire theoretical and empirical knowledge about security policy, risk analysis and organizations in a changing world.
2. Enable the student to perform vulnerability analysis.
3. Student will acquire skills to analyze complex risk and security issues and developments.
4. Students will acquire the ability to plan and implement strategic processes in organizations and private companies.
5. Students will acquire competences to translate knowledge about the political field of risk and securityinto risk analysis and strategies and to identify socially, politically and economically sustainable solutions and opportunities for public organizations and private companies.

Module I: **Security Basics** Number of hours(LTP) 9 0 6

Information Security (INFOSEC) Overview: Threats, vulnerabilities, critical information characteristics – confidentiality, integrity, availability, information states – transmission, storage, processing, security countermeasures –technology, policy, procedures and practices, education, training and awareness.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Identify the threats and vulnerabilities (L1)
2. Describe the critical information characteristics (L1)
3. Understand the various information states(L1)
4. Explain Confidentiality, Integrity and Availability(L2)
5. Understand the security counter measures(L1)

Module II: **Threats to and Vulnerabilities of Systems** Number of hours(LTP) 9 0 6

Definition of terms (e.g., threats, vulnerabilities, risk), major categories of threats (e.g., fraud, Hostile Intelligence Service (HOIS), malicious logic, hackers, environmental and technological hazards, disgruntled employees, careless employees, HUMINT, and monitoring), threat impact areas, Countermeasures: assessments (e.g., surveys, inspections), Concepts of Risk Management: consequences (e.g., corrective action, risk assessment), cost/benefit analysis of controls, implementation of cost effective controls, monitoring the efficiency and effectiveness of controls (e.g., unauthorized or inadvertent disclosure of information), threat and vulnerability assessment).

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand major categories of threats. (L1)
2. identify threat impact areas.(L2)
3. Understand the concept of Risk management. (L1)
4. implement cost effective controls, monitoring the efficiency and effectiveness of controls.(L3)
5. understand threat and vulnerability assessment(L1)

Module III: **Security Planning** Number of hours(LTP) 9 0 6

Directives and procedures for policy mechanism, Risk Management: information identification, roles and responsibilities of all the players in the risk analysis process, risk analysis and/or vulnerability assessment components, risk analysis results evaluation, corrective actions, acceptance of risk (accreditation), Contingency Planning/Disaster Recovery: contingency plan components, agency response procedures and continuity of operations, team member responsibilities in responding to an emergency situation, guidelines for determining critical and essential workload, determination of backup requirements, development of procedures for offsite processing, development of plans for recovery actions after a disruptive event, emergency destruction procedures.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. explain directives and procedures for policy mechanism. (L4)
2. understand the procedures for risk management. (L1)
3. explain roles and responsibilities of all the players in the risk analysis process. (L4)
4. Identify components of contingency plan, team member responsibilities(L2).
5. understand the procedures for offsite processing, emergency destruction(L1).

Module IV: **Policies And Procedures** Number of hours(LTP) 9 0 6

Physical Security Measures: alarms, building construction, communications center, shielding, cabling, filtered power, physical access control systems (key cards, locks and alarms), stand alone systems and peripherals, Personnel Security Practices and Procedures: position sensitivity, employee clearances, access authorization/verification (need to know), security training and awareness, systems maintenance personnel, contractors, Administrative Security Procedural Controls: attribution, copyright protection and licensing , Auditing and Monitoring: conducting security reviews, effectiveness of security programs, investigation of security breaches, privacy, review of accountability controls, review of audit trails and logs.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand physical security measures. (L1)
2. employ personnel security practices and procedures.(L3)
3. explain administrative security procedural controls. (L3)
4. understand audit and monitoring process. (L1)
5. employ audit trails and logs reviews.(L3)

Module V: **Operations Security (OPSEC)** Number of hours(LTP) 9 0 6

Network security: public Vs private, dial UP Vs dedicated, traffic analysis, end to end access control, Crypto security: cryptography encryption (e.g., point to point, network, link), cryptography key management (to include electronic key), cryptography strength (e.g., complexity, secrecy, characteristics of the key).

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand various types of network security (L1)
2. explain cryptographic encryption and key management (L3)
3. outline cryptography strength (L3)

Text Books(s)

1. Whitman& Mattord, Principles of Incident Response and Disaster Recovery, Course TechnologyISBN:141883663X

Reference Book(s)

1. http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf(Web Link.

Course Outcomes:

1. understand the security counter measures(L1)
2. implement cost effective controls, monitoring the efficiency and effectiveness of controls (L3).
3. Understand the procedure for Risk Management(L1)
4. employ personnel security practices and procedures(L3).
5. Understand various types of network security(L1)

19ECS784: MOBILE APPLICATION SECURITY

L	T	P	C
3	0	2	4

This course provides an overall idea of defensive security mechanisms in mobile applications. Along with defensive techniques it also provides the offensive methods for the exploit the mobile application. It provides the techniques for mobile operating systems like iOS, Android, and Windows Mobile OS

Course objectives:

1. Learn the evolution of mobile application and its security
2. Understand IOS Applications and its security
3. Familiarize android applications and its security
4. Analyze the mobile application security in windows mobile OS, IOS and Android
5. Applying authentication and authorization on the mobile device

Module I: Number of hours (LTP) 9 0 6

Mobile Application security: Introduction to mobile application in security, The evolution of mobile applications, Mobile application security.

Analyzing IOS Applications: security Model, Understanding IOS Applications, Jail Breaking, data protection API, IOS Key chain, Touch ID, Reverse Engineering IOS binaries.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Understand mobile application security (L2)
2. Analysing IOS application (L3)
3. Identified the different data protection API's(L1)
4. Understand reverse engineering IOS(L2)
5. Comparing security models(L2)

Module II: Number of hours (LTP) 9 0 6

Attacking IOS Applications: Introduction to transport security, identifying insecure storage, Patching IOS Applications with HOPPER, Attacking IOS Runtime, inter process communication, Attacking using injection

IOS Applications Security: IOS implementation Insecurities, Disclosing Personally Identifiable Information, Data Leaks, Memory Corruption, Protecting Data, Avoiding Injection Vulnerabilities, Securing Your Application with binary protections

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Practice attacking the IOS Applications (L3)
2. Explain IOS application security techniques(L4)
3. Understand data leaks on mobile applications(L2)
4. Analyse memory corruptions (L4)
5. Identified the mobile vulnerabilities(L1)

Module III: Number of hours (LTP) 8 0 6

Analyzing Android Applications: Creating Android Environment. Understanding Android Applications, Understanding Security Model, Reverse-Engineering Applications.

Attacking Android Applications: Exposing Security Model Quirks, Attacking Application Components, accessing storage and logging, Misusing Insecure Communications, Exploiting other vectors, Additional testing techniques.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Analyse android applications (L3)
2. Implement techniques to attack android applications (L6)
3. Understand security model (L2)
4. Understand reverse engineering applications(L2)
5. Create Android Environment(L6)

Module IV: Number of hours (LTP) 8 0 6

Android Applications security: Reviewing pre-installed Applications, Exploiting Devices, infiltrating user data, Principle of least exposure, Essential Security Mechanisms, Advanced Security Mechanisms, Slowing down a reverse engineer.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Describe reviewing pre-installed applications(L1)
2. Understand android application security (L2)
3. Analyse android application security (L4)
4. Understand advanced security mechanisms(L2)
5. Classify security mechanisms(L2)

Module V: Number of hours (LTP) 10 0 6

Analyzing windows Phone Applications: Understanding Security Model, Understanding Windows Phone 8.x Applications, Analyzing application Binaries.

Cross platform Applications: Introduction. Bridging Native Functionality, Exploring Phone Gap and Apache Cordova

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Analyse windows phone applications (L4)
2. Understand security model(L2)
3. Learn various cross platform application (L6)
4. Illustrate exploring phone gaps(L1)
5. Determining various native functionalities(L3)

Text Books(s)

1. Dominic Chell, Tyrone Erasmus, The Mobile Application Hacker's Handbook, Wiley Publication ,1e
2. Mobile Application Security, Himanshu Dwivedi, Chris Clark, David Thiel, Tata McGraw Hill, 1st Edition, 2010
3. Hacking Exposed Mobile Security Secrets & Solutions, Neil Bergman, Mike Stanfield, Jason, Rouse, Joel Scambray, SarathGeethakumar, SwapnilDeshmukh, Scott Matsumoto, John Steven, Mike Price, McGraw-Hill Osborne Media,1st Edition ,2013.
4. Mobile Device Security: A Comprehensive Guide to Securing Your Information in a Moving World, Stephen Fried, Auerbach Publications,1st Edition,2010

Reference Book(s)

1. Mobile Device Security for Dummies, RichaCampagna, SubbuIyer, Ashwin Krishnan, Mark Bauhas, Wiley, 1st Edition, 2011

2. Mobile Application Development, Scott Guthery, Mary Cronin McGraw-Hill Education; 1st edition (December 6, 2001)
3. Android App Development, Hervé J. Franceschi, Jones & Bartlett Learning; 1st edition (January 11, 2017)
4. Cross-Platform Mobile Application Development, John R. Carlson Ph.D., independently published (January 24, 2021)
5. Mobile Application Development, Tarkeshwar Barua, Ruchi Doshi, Kamal Kant Hiran, De Gruyter (December 16, 2020)

Course Outcomes:

1. Understand evolution of mobile applications and its security(L2)
2. Analyse IOS, Android and Windows mobile applications(L3)
3. Implement security methodologies in IOS, Android and Windows mobile applications(L6)
4. Understand various cross platform mobile applications (L3)
5. Determining various native functionalities and exploring phone gaps (L3)

19EOE742: BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

This course introduces students to the science of business analytics. The goal is to provide students with the foundation needed to apply data analytics to real-world challenges they confront daily in their professional lives. Students will learn to identify the ideal analytic tool for their specific needs; understand valid and reliable ways to collect, analyze, and visualize data; and utilize data in decision making for managing agencies, organizations or clients in their workspace.

Course objectives:

1. To familiarize the scope, process and advantages of business analytics
2. To acquaint the student with the modeling and problem solving skills in business analytics
3. To impart the organization and management of business analytics
4. To introduce the forecasting models and techniques used in analytics
5. To expose the formulation and decision strategies used in business analytics

Module I: Number of hours(LTP) 8 0 0

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the scope and process of business analytics (L1)
2. choose an organizational structure to implement a business analytics process (L4)
3. describe the statistical tools and methods used for data modeling and analysis (L2)
4. identify the sampling and estimation requirements for data analysis (L1)

Module II: Number of hours(LTP) 8 0 0

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify the relationships and trends in data (L1)
2. utilize linear regression methods for identifying data relationships (L4)
3. list the types of data and their models used for business analytics (L1)
4. describe the methods for visualization and exploration of data (L2)

Module III: Number of hours(LTP) 8 0 0

Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the management issues in the organization structures (L2)
2. define the designing information policy and its usage (L1)
3. list the methods for ensuring data quality measuring contribution (L1)
4. explain the use of data mining methodologies for predictive analytics analysis (L3)
5. describe the use of prescriptive analytics methods in business analytics process (L2)

Module IV: Number of hours(LTP) 10 0 0

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. classify and describe the use of forecasting models (L3)
2. model the use of regression forecasting with casual variables (L5)
3. identify the appropriate forecasting model for a given data (L5)
4. explain the use of monte carlo simulation for forecasting and identify the involved risk (L2)

Module V: Number of hours(LTP) 8 0 0

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. formulate decision problems (L2)
2. list the decision strategies with and without probabilities (L1)
3. use the decision trees for analysis (L4)
4. describe the value of information, utility and its use in decision making (L4)

Text Books(s)

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications Pearson FT Press, 2014.
2. James Evans, Business Analytics, Pearson Education, 2013.

Course Outcomes:

1. define the scope, process and advantages of business analytics (L1)
2. explain the modeling and problem solving skills in business analytics (L2)
3. describe the organization and management of business analytics (L3)
4. utilize the forecasting models and techniques used in analytics (L4)
5. enumerate and utilize the formulation and decision strategies (L2)

19EOE746: OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

Optimization problems arise in all walks of human activity- particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically model real life optimization problems as Linear Programming (Optimization) Problems and subsequently educate the student to solve these models with the help of the available methods.

Course objectives:

1. to impart knowledge on developing mathematical formulation for linear programming and transportation problem
2. to familiarize the student in the construction of the required activities in an efficient manner to complete it on or before a specified time limit and at the minimum cost.
3. to expose the development of mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.
4. to illustrate PERT and CPM techniques for planning and implementing projects.
5. To impart the knowledge of formulating and analysis of real life problems using advanced tools and techniques for resource optimization
6. to provide frameworks for analyzing waiting lines using advanced queuing theory concepts.

Module I: Number of hours(LTP) 9 0 0

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify and develop operational research models from the verbal description of the real system. [L4]
2. understand the classification systems of effective Inventory control models[L2]

Module II: Number of hours(LTP) 9 0 0

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. translate a real-world problem, given in words, into a mathematical formulation. [L2]
2. utilize the mathematical tools that are needed to solve optimization problems. [L2]

Module III: Number of hours(LTP) 9 0 0

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the need and origin of the optimization methods[L2]
2. classify optimization problems to suitably choose the method needed to solve the particular type of problem[L3]

Module IV: Number of hours(LTP) 9 0 0

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

Learning Outcomes:

After completion of this unit, the student will be able to:

1. choose linear programming problems to suitably choose the method needed to solve the particular type of problem[L1]
2. identify industrial problems involved in inventory, MRP and scheduling[L2]

Module V: Number of hours(LTP) 9 0 0

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify the values, objectives, attributes, decisions, uncertainties, consequences, and trade-offs in a real decision problem[L2]
2. Apply the models to incorporate rational decision-making process in real life situations.[L3]
3. Analyze various modeling alternatives & select appropriate modeling techniques for a given situation.[L3]

Text Books(s)

1. H.A. Taha, Operations Research, An Introduction, Prentice Hall of India, 2008
2. H.M. Wagner, Principles of Operations Research, Prentice Hall of India, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, 2008
4. Hitler Libermann Operations Research: McGraw Hill Publishers, 2009
5. Pannerselvam, Operations Research: Prentice Hall of India, 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India, 2010

Course Outcomes:

Understand the basic concepts of different advanced models of operations research and their applications. (L2)

1. Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action. (L4)
2. Apply the models to incorporate rational decision-making process in real life situations. (L4)
3. Analyze various modeling alternatives & select appropriate modeling techniques for a given situation. (L3)
4. Validate output from model to check feasibility of implementations. (L5)
5. Create innovative modeling frameworks for a given situation. (L6) C
6. onduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship. (L3)

19EOE748: COST MANAGEMENT OF ENGINEERING PROJECTS

L	T	P	C
3	0	0	3

This course will equip the student with the expertise to mathematically model engineering projects and use effective methods and techniques to plan and execute engineering activities.

Course objectives:

1. to introduce the basic principles of strategic cost management and the related terminology
2. to familiarize the project planning and execution process involving technical/nontechnical activities
3. to acquaint the student with detailed engineering activities and their cost management analysis
4. to impart the knowledge of cost analysis and profit planning of engineering projects
5. to familiarize the quantitative techniques for optimization of budget allocation

Module I: Number of hours(LTP) 8 0 0

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the cost concepts in decision making(L2)
2. define the various costs involved in the cost management process(L2)
3. list the objectives of cost control(L2)
4. identify the different fields of a database for operational control(L2)

Module II: Number of hours(LTP) 8 0 0

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define the meaning of a project and list the different types(L2)
2. identify the measures to manage cost overruns(L2)
3. describe the various stages of project execution from conception to commissioning(L2)
4. plan the proper order of technical/nontechnical activities as part of project execution(L2)

Module III: Number of hours(LTP) 8 0 0

Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. identify the different clearance norms required in the pre-project execution phase(L2)
2. describe the hierarchy of project team and identify the role of each member(L2)
3. list the different contents of project contracts(L2)
4. present the project cost control and planning through bar charts, network diagrams etc.(L2)

Module IV: Number of hours(LTP) 8 0 0

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decisionmaking problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. describe the cost behavior and profit planning(L2)
2. distinguish between marginal costing and absorption costing(L2)
3. analyze the variance of standard costing(L2)
4. analyze the pricing strategies in project costing(L2)
5. identify the quality measures satisfying the appropriate constraints(L2)

Module V: Number of hours(LTP) 8 0 0

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. define and compare the different budgeting strategies(L2)
2. model the cost management as a linear programming problem(L2)
3. measure the divisional profitability and decide the appropriate pricing(L2)

Text Books(s)

Charles T. Horngren, ,Srikant M. DatarGeorge Foster, Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2006

Reference Book(s)

1. Charles T. Horngren, George Foster, Advanced Management Accounting, Greenwood Publishing, 2001.
2. Robert S Kaplan, Anthony A. Alkinson, Management & Cost Accounting, 1998.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, Wheeler Publisher, 2004.
4. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book, 2006.

Course Outcomes:

1. list the basic principles of strategic cost management and define the related terminology(L1)
2. plan the project execution process involving technical/nontechnical activities(L4)
3. describe the detailed engineering activities and their cost management analysis(L2)
4. carry out the cost analysis and profit planning of engineering projects(L5)
5. utilize quantitative techniques for optimization of budget allocation(L6)

19ECS792: TECHNICAL PAPER WRITING

L	T	P	C
0	0	4	2

Each student shall survey a technical topic related to a chosen specialization and prepare/submit a report in a specified format. Each student has to prepare a power point presentation on a selected technical topic with a novelty and get it evaluated by the faculty assigned for this purpose.

HSMCH102: Universal Human Values 2: Understanding Harmony

L	T	P	C
2	1	0	3

Human Values Courses: During the Induction Program, students would get an initial exposure to human values through Universal Human Values -1. This exposure is to be augmented by this compulsory full semester foundation course.

Course objectives:

- Development of a holistic perspective based on self-explanation about themselves (human being), family, society and nature/existence
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection
- Development of commitment and courage to act

Module I: Course Introduction – Need, basic guidelines, content and process for value education LTP 6 3 0

1. Purpose and motivation for the course, recapitulation from universal human values-1
2. Self-exploration-what is it? – Its content and process; 'Natural Acceptance' and Experimental Validation – as the process for self- exploration
3. Continuous happiness and prosperity – A look at basic human aspirations
4. Right understanding, relationship and physical facility – the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding happiness and prosperity correctly – A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and coexistence) rather than as arbitrariness in choice based on linking-dislinking.

Module II: Understanding harmony in the human being – harmony in myself? LTP 6 3 0

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of self ('I') and 'Body' – happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body; Sanyam and health; correct appraisal of physical needs, meaning of prosperity in detail
6. Programs to ensure Sanyam and Health

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module III: Understanding harmony in the family and society- harmony in human-human relationship LTP 6 3 0

1. Understanding values in human-human relationship; meaning of justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; trust and respect as the foundational values of relationship
2. Understanding the meaning of trust; difference between intention and competence
3. Understanding the meaning of respect, difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family); resolution, prosperity, fearlessness (trust) and co-existence as comprehensive human goals
5. Visualizing a universal harmonious order in society – undivided society, universal order – from family to world family

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discus with scenarios. Elicit examples from students' lives.

Module IV: Understanding harmony in the nature and existence – whole existence as coexistence LTP 6 3 0

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module V: Implications of the above Holistic Understanding of Harmony on Professional Ethics LTP 6 3 0

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems

6. Strategy for transition from the present state to Universal Human Order:
7. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
8. At the level of society: as mutually enriching institutions and organizations
9. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

Text Books(s)

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Book(s)

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakash an, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditS underlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - M aulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) Faculty-student or mentor-mentee programs throughout their time with the institution
b) Higher level courses on human values in every aspect of living. E.g. as a professional

19ECS891: PROJECT WORK I

L	T	P	C
0	0	26	13

Each student is required to submit a report of first part of project work i.e. about the problem definition, literature review and methodology to be adopted including experiments and tests to be performed on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester end.

19ECS892: PROJECT WORK II

L	T	P	C
0	0	26	13

Each student is required to submit a detailed project report about the work on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester and Final evaluation will be done at the end of semester as per the guidelines decided by the department from time to time. The candidate shall present/publish one paper in national/international conference/seminar/journal of repute. However, candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.