AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BANGALORE, COIMBATORE, CHENNAI)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.Tech. in COMPUTER SCIENCE AND ENGINEERING

(BTC-CSE)

SYLLABUS 2019

SYLLABUS

SEMESTER I

19ENG111	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-3-3

Course Objectives

To introduce the students to the fundamentals of mechanics of writing
To facilitate them with the style of documentation and specific formal written communication
To initiate in them the art of critical thinking and analysis
To help them develop techniques of scanning for specific information, comprehension and organization of ideas
To enhance their technical presentation skills

Course Outcome

CO1: To gain knowledge about the mechanics of writing and the elements of formal correspondence.
CO2: To understand and summarise technical documents.
CO3: To apply the basic elements of language in formal correspondence.
CO4: To interpret and analyze information and to organize ideas in a logical and coherent manner.
CO5: To compose project reports/ documents, revise them for language accuracy and make technical Presentations.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2				1						2				
CO3										3				
CO4				1						2				
CO5									2	1				

Syllabus

Unit 1
Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers
General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2
Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals
Formal Correspondence: Writing formal Letters
Mechanics of Writing: impersonal passive & punctuation
Scientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting
Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation
Reading and listening comprehension of technical documents
Mini Technical project (10 -12 pages)
Technical presentations

Reference(s)

Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.
Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
Michael Swan. '' Practical English Usage'', Oxford University Press, 2000

Evaluation Pattern

Assessment	Internal	External
Periodical 1	20	
Periodical 2	20	
Continuous Assessment (Lab) (CAL)	40	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MAT101	SINGLE VARIABLE CALCULUS	L-T-P-C:1-0-1-1

Course Objectives

- Understand the various functions and their graphs.
- Understand the basic concept of continuous function and find the extreme values of the continuous functions.
- Understand the definite integral and various integration techniques.

Course Outcomes

CO1: To understand the concepts of single variable calculus.
CO2: To sketch graphs for functions using the concepts of single variable calculus and apply the fundamental theorem of calculus to evaluate integrals.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	---	---	---	---	---	---	---	---	---	---		
CO2	1	2	---	---	2	---	---	---	---	---	---	---		

Syllabus

Unit 1
Calculus
Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. (1.5)

Unit 2
Limit and Continuity**:** Limit (One Sided and Two Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity. (2.1, 2.6)

Unit 3
Graphing : Extreme Values of Functions, Concavity and Curve Sketching, (4.1, 4.4).

Unit 4
Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques. (5.2 - 5.3, 8.1 – 8.5)

Text Book
Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.

Reference
'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002

Evaluation pattern
At the end of the course, a two-hour test will be conducted for 50 marks. The marks will be converted to 100 for grading.

19MAT111	MULTIVARIABLE CALCULUS	L-T-P-C: 2- 0-0 -2

Course Objective

- To understand parameterisation of curves and to find arc lengths.
- To familiarise with calculus of multiple variables.
- To use important theorems in vector calculus in practical problems.

Course Outcomes

CO1: Select suitable parameterization of curves and to find their arc lengths
CO2: Find partial derivatives of multivariable functions and to use the Jacobian in practical problems.
CO3: Apply Fundamental Theorem of Line Integrals, Green's Theorem, Stokes' Theorem, of Divergence Theorem to Evaluate integrals.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	---	---	---	---	---	---	---	---	---	---
CO2	1	2	---	---	2	---	---	---	---	---	---	---
CO3	2	2			3							

Syllabus

Unit 1
Functions of severable variables
Functions, limit and continuity. Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian. Taylor's series for two variables.

Unit 2
Vector Differentiation
Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

Unit 3
Vector Integration
Line Integral, Line Integrals Independent of Path.
Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem.

Unit 4

Lab Practice Problems:

Graph of functions of two variables, shifting and scaling of graphs. Vector products. Visualizing different surfaces.

Text Book

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Book(s)

Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19MAT102	MATRIX ALGEBRA	L-T-P-C: 2- 0 -0- 2

Course Objectives

- Understand basic concepts of eigen values and eigen vectors.
- Apply eigen values and eigen vectors for diagonalization and quadratic form.
- Apply various iterative techniques to solve the system of equations.

Course Outcomes

CO1: Understand the notion of eigenvalues and eigenvectors, analyse the possibility of diagonalization and hence compute a diagonal matrix, if possible.
CO2: Apply the knowledge of diagonalization to transform the given quadratic form into the principal axes form and analyse the given conic section.
CO3: Understand the advantages of the iterative techniques and apply it to solve the system of equations and finding eigenvectors.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	3	1									
CO3	3		1									

Syllabus
Unit 1
Review: System of linear Equations, linear independence.
Unit 2
Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite
Unit 3
Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices.
Unit 4
Numerical Computations: L U factorization, Gauss Seidal and Gauss Jacobi methods for solving system of equations. Power Method for Eigen Values and Eigen Vectors.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19CSE100	PROBLEM SOLVING AND ALGORITHMIC THINKING	L-T-P-C: 2-1-3-4

Course Objectives

- This course provides the foundations of computational problem solving.
- The course focuses on principles and methods thereby providing transferable skills to any other domain.
- The course also provides foundation for developing computational perspectives of one's own discipline.

Course Outcomes

CO 1: Apply algorithmic thinking to understand, define and solve problems
CO 2: Design and implement algorithm(s) for a given problem
CO 3: Apply the basic programming constructs for problem solving
CO 4: Understand an algorithm by tracing its computational states, identifying bugs and correcting them

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1												
CO2	3	2	3		3				2	2				
CO3	2	1												
CO4	1	1	2		2									

Syllabus

Unit 1
Problem Solving and Algorithmic Thinking Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms vs programs.
Unit 2
Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation – expressions, logic; algorithms vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, data organization: lists, arrays etc. algorithms to programs.
Unit 3
Problem solving with algorithms – Searching and Sorting, Evaluating algorithms, modularization, recursion. C for problem solving – Introduction, structure of C programs, data types, data input, output statements, control structures.

Text Book(s)
Riley DD, Hunt KA. Computational Thinking for the Modern Problem Solver. CRC press; 2014 Mar 27.

Reference(s)
Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.
Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.
Curzon P, McOwan PW. The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker. World Scientific Publishing Company; 2017.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19MEE100	ENGINEERING GRAPHICS - CAD	L-T-P-C: 2-0-3-3

Course Objectives

- Familiarize with Bureau of Indian Standards (BIS) for creating engineering drawings
- Train the students on proper dimensioning and construction of simple geometries
- Inculcate with the concept of developing orthographic projections and isometric views using CAD drafting package

Note:

1. Drawing practice to be carried out using drafting package (Auto-CAD)
2. First angle projection to be followed

Course Outcomes

CO1: Understand the engineering drawing standards and their usage
CO2: Interpret engineering drawings
CO3: Construct and dimension 2-D geometries using CAD software
CO4: Improve coherent visualization skills
CO5: Inculcate with the concept of developing orthographic projections and isometric views

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	2	3	1	2	3		3	2	2	2
CO2	3	3	3	3		2	3	1	2	3		3	2	2	2
CO3	3	3	3	3	3	2	3	1	2	3		3	2	2	2
CO4	3	3	3	3		2	3	1	2	3		3	2	2	2
CO5	3	3	3	3	3	2	3	1	2	3		3	2	2	2

Syllabus

Unit 1

Basic principles of engineering drawing, Standards and conventions, lettering and types of lines, Introduction to drafting software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional drawing environment. Selection of drawing size and scale. Sketching of 2D simple geomentries, editing and dimensioning of 2D geomentries.

Unit 2

Orthographic Projections: Introduction, planes of projection, projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, Projection of regular solids, Sectioning of solids

Unit 3

Plan and elevation of simple buildings with dimensions

Text Book

BasantAgarwal and C M Agarwal., "Engineering Drawing", 2e, McGraw Hill Education, 2015

Reference Book(s)

Bhat N.D. and Panchal V.M. , " Engineering Drawing Plane and Solid Geometry , 42e, Charoatar Publishing House , 2010James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014
K.R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications
Narayan K.L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003
John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE101	COMPUTER SYSTEMS ESSENTIALS	L-T-P-C: 3-0-3-4

Course Objectives

- The course gives students an overview of computer science: A foundation from which they can appreciate the relevance and interrelationships of further courses in the field.
- This course provides an insight on the general structures of operating systems, database management systems and computer networks.

Course Outcomes

CO1: Understand the basic components of computer systems and its functionality.

CO2: Demonstrate the functions of operating system and its role as a resource manager to execute any application

CO3: Understand the need for database storage and learn to retrieve using SQL.

CO4: Implement the connection between operating systems, computer networks and database management through a case study

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			2								2	1
CO2	3	2			2								2	1
CO3	3	2			2								2	1
CO4	3	2			2			2	2	2			2	1

Syllabus

Unit 1

Introduction to Computers, Computer Science, Computer Systems. Essential components of computer systems: Operating Systems Fundamentals, Principles of Database Systems, Basic concepts in Computer Networks. Installing a Linux virtual machine. Using package manager to install/update software. Understanding disk partitions and obtaining partition information using system tools. Obtaining essential system resource utilization and information using system tools and proc file system: disk utilization, memory utilization, process information, CPU utilization. Pipes and redirection. Searching the file system using find and grep with simple regular expressions. Basic process control using signals: pausing and resuming process from a Linux terminal, terminating a process. Adding/removing from search path using PATH variable. Compressing/uncompressing using tar/gzip and zip tools. Using man pages to understand tool documentation.

Unit 2

Querying a database using simple SQL commands. Writing simple SQL queries. Creating and editing tables. Creating indexes to improve performance. Exporting and importing data from/to database tables to/from Excel.

Unit 3

Obtaining essential system network information using system tools: network interfaces and their addresses, routing table, active processes using network communication. Basic network debugging: using traceroute to discover route to a remote computer, ping to check network connectivity, nslookup for DNS lookup. Understanding basic HTTP client and server using netcat. Using ssh and sftp.

Text Book(s)

Brookshear JG. Computer science: an overview. Eleventh Edition, Addison-Wesley Publishing Company; 2011.

Reference(s)

Silberschatz A, Gagne G, Galvin PB. Operating system concepts. Ninth Edition, Wiley; 2012.
Cobbaut P. Linux Fundamentals. Samurai Media Limited; 2016.
Silberschatz A, Korth HF, Sudarshan S. Database system concepts. Sixth Edition, McGraw Hill;2010.
Kurose JF, Ross KW. Computer networking: a top-down approach. Sixth Edition, Pearson;2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE180	COMPUTER HARDWARE ESSENTIALS	L-T-P-C: 0-0-3-1

Course Objectives

- Computer hardware essentials is designed to introduce students to a basic understanding of the different types of computing devices, computer components (CPU, memory, power supplies, etc.), and operating systems as well as maintaining and troubleshooting the basic hardware and software issues.
- It also introduces building a fully functional Linux-based computer using Raspberry Pi and other components

Course Outcomes

CO1: Understanding the working principles of different computing devices (desktop computers, laptops, etc.)

CO2: Understand PC and laptop hardware components

CO3: Understand peripheral devices, storage devices, displays and connection interfaces and Troubleshoot common hardware issues

CO4: Understand the procedure for Installation of OS - Linux and Supporting, upgrading and troubleshooting OS related issues.

CO5: Understand the concepts of Physical Computing and related use cases

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			1							1	3	2
CO2	3	2			1							1	3	2
CO3	2	1											3	2
CO4	1	1	2	2	2				2	2		1	3	2
CO5	1	1	2	2	1				2	2	1	1	3	2

Syllabus

Unit 1
Disassembling a PC to its basic components, identifying the components, bus subsystems, main chipsets on the motherboard (northbridge, southbridge), and reassembling it back.

Unit 2
Building a fully functional computer using Raspberry Pi (e.g., Pi Zero W), small low cost HDMI/VGA display, user input devices, running Linux. Reinstalling and configuring on-board Linux. Connecting to network.

Unit 3
Physical Computing Basic: Reading GPIO input and output using command line tools (gpio utility) and simple python scripts.

Text Book(s)

Margolis M. Arduino Cookbook: Recipes to Begin, Expand, and Enhance Your Projects.Third Edition, O'Reilly Media, Inc.; 2014.

References(s)

Halsey M. Windows 10 Troubleshooting. Apress; 2016.
Soyinka W. Linux Administration: A Beginner's Guide. Fifth Edition, Mc Graw Hill Professional;2008.

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CUL101	CULTURAL EDUCATION I	L-T-P-C: 2-0-0-2

Course Objective

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

Course Outcomes

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education**.**
CO2: Understand the foundational concepts of Indian civilization like *puruśārtha*-s, law of karma and *varṇāśrama*.
CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices**.**
CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.
CO5: Get guidelines for healthy and happy living from the great spiritual masters

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	2	3				2		
CO2						3	1	3				2		
CO3						3	1	3				2		
CO4						3	3	3				2		
CO5						3	1	3				2		

Syllabus

Unit 1
Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life and vision of holistic education.

Unit 2
Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

Unit 3
Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

Text Book
Cultural Education Resource Material Semester-1

Reference Book(s)

The Eternal Truth (A compilation of Amma's teachings on Indian Culture)
Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.
Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9
My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER II

19MAT115	DISCRETE MATHEMATICS	L-T-P-C: 3-1-0-4

Course Objectives

- Familiar various concepts in logic and proof techniques.
- Understand the concepts of various types of relations, partial ordering and equivalence relations.
- Understand the concepts of generating functions and apply to solve the recurrence relations.
- Familiar basic results in number theory and understand it applications in information security.

Course Outcomes

CO1: Understand the basic concepts of Mathematical reasoning and basic counting techniques. Also understand the different types of proves like mathematical induction.
CO2: Understand the concepts of various types of relations, partial ordering and equivalence relations.
CO3: Apply the concepts of generating functions to solve the recurrence relations.
CO4: Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics.
CO5: Understand various definitions in number theory and study their properties.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	2	1									
CO5	2	3	2									

Syllabus

Unit 1
Logic, Mathematical Reasoning and Counting: Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving, Functions, Mathematical Induction. Recursive Definitions, Recursive Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations. (Sections: 1.1 -1.3, 1.5 -1.7, 2.3, 4.1 - 4.4, 5.1 - 5.3 and 5.5)

Unit 2
Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions. (Sections: 7.1, 7.3 - 7.6)
Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion. (Sections: 6.1 - 6.6)

Unit 3
Number Theory: Divisibility and Factorization**b.** Simultaneous linear congruences, Chinese Remainder Theorem. Wilson's Theorem, Fermat's Theorem, pseudoprimes and Carmichael numbers, Euler's Theorem. Arithmetic functions and Quadratic residues:

Text Book(s)

Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
James Strayer, Elementary Number Theory, Waveland Press, 2002.

Reference(s)

R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.
Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited , 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19MAT112	LINEAR ALGEBRA	L-T-P-C:2-1-0-3

Course Objectives

- Understand the basic concepts of vector space, subspace, basis and dimension.
- Familiar the inner product space. Finding the orthogonal vectors using inner product.
- Understand and apply linear transform for various matrix decompositions.

Course Outcomes

CO1: Understand the basic concepts of vector space, subspace, basis and dimension.
CO2: Understand the basic concepts of inner product space, norm, angle, Orthogonality and projection and implementing the Gram-Schmidt process, to obtain least square solution.
CO3: Understand the concept of linear transformations, the relation between matrices and linear transformations, kernel, range and apply it to change the basis, to get the QR decomposition, and to transform the given matrix to diagonal/Jordan canonical form.
CO4: Understand the concept of positive definiteness, matrix norm and condition number for a given square matrix.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	3	2	1									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	2	1									

Syllabus
Pre-requisite: Matrices
Review of matrices and linear systems of equations. (2 hrs)
Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis.
(12 hrs)
Orthogonal complements - Projection on subspace - Least Square Principle. (6 hrs)

Linear Transformations: Positive definite matrices - Matrix norm and condition number - QR- Decomposition - Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation. (10 hrs)
Change of basis - Nilpotent transformations - Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form. (10 hrs)
SVD.

Text Book
Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.

Reference Book(s)
D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
Gilbert Strang, "Linear Algebraand its Applications", Third Edition, Harcourt College Publishers, 1988.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19PHY101	ENGINEERING PHYSICS - A	L-T-P-C: 2- 1- 0- 3

Course Objective

- To learn fundamental concepts of electricity and magnetism for applications in engineering and technology.
- To familiarize the principles of interference, diffraction and polarization and apply in engineering context.
- To gain knowledge of basic quantum mechanics, crystal structure and classification of solids based on their properties and applications.

Course Outcomes

CO1: Be able to apply the concepts of electric and magnetic field including Maxwell's equations to engineering application and problem solving.
CO2: Understand the principles of interference, diffraction and polarization and apply it in engineering context and to solve numerical problems
CO3: Understand the principles and applications of solid state and gas lasers
CO4: Be exposed to basic principles of Quantum mechanics with elementary applications in one dimensional potential well
CO5: Be familiar with crystals structure, free electron theory and basic semiconductor theory.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3								2
CO2	3	3	2	3								2
CO3	3	3	2	3								2
CO4	3	3	2	3								2
CO5	3	3	2	3								2

Syllabus

Unit 1
Electrostatics, Magnetostatics and Electrodynamics
Electric field and electrostatic potential for a charge distribution, divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential, Biot-Savart law, divergence and curl of static magnetic field, vector potential, Stoke's theorem, Lorentz force, Faraday's law and Lenz's law, Maxwell's equations.

Unit 2
Waves and Optics
Huygens' Principle, superposition of waves and interference of light by wave front splitting and amplitude splitting, Young's double slit experiment, Newton's Rings, Michelson interferometer.
Fraunhofer diffraction from single slit and circular aperture, Rayleigh criterion for limit of resolution and its application to vision, diffraction gratings and their resolving power.
Polarization: Unpolarized, polarized and partially polarized lights, polarization by reflection, double refraction by uniaxial crystals, Polaroid, half wave and quarter wave plates.

Unit 3

Lasers

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid-state lasers (Ruby, Neodymium), dye lasers.

Unit 4

Quantum Mechanics

De Broglie waves, wave functions, wave equation, Schrodinger wave equation: time dependent and time independent form, operators – Eigenfunctions and Eigenvalues, uncertainty principle, particle in a finite potential one -dimensional box, tunnelling effect (Qualitative).

Unit 5

Introduction to Solids

Crystal systems: Miller indices, crystal planes and directions, packing fraction, Classification of solids: Metals, semiconductors and insulators (qualitative), free electron theory of metals, Fermi level, Density of states, Kronig-Penney model and origin of energy bands.

Text Books

David J Griffiths "Introduction to Electrodynamics" , 4th Edition , Pearson, 2015.
Ajay Ghatak, "Optics", 6th Edition, McGraw Hill Education India Private Limited,2017.
Eugene Hecht, A R Ganesan, "Optics", 4th Edition, Pearson Education, 2008.
Arthur Beiser, ShobhitMahajan, S. RaiChoudhury"Concepts of Modern Physics", McGraw Hill Education India Private Limited, 2017.
Charles Kittel, "Introduction to Solid State Physics" 8th Edition, Wiley, 2012.

Reference Books

Halliday, Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley,2015.
John David Jackson, "Classical Electrodynamics",3rd Edition, Wiley,2007.
F A Jenkins, H E White, "Fundamental of Optics", 4thEdition,McGraw Hill Education India Private Limited, 2017.
David J Griffiths, "Introduction to Quantum Mechanics",2nd Edition, PearsonEducation,2015.
M A Wahab, "Solid State Physics", 3rd Edition, Narosa Publishing House Pvt. Ltd.,2015.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE102	COMPUTER PROGRAMMING	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE100 Problem Solving and Algorithmic Thinking

Course Objectives

- This course provides the foundations of programming.
- Apart from the usual mechanics of a typical programming language, the principles and methods will form the main focus of this course.
- Shift from learn to program to programming to learn forms the core of this course.

Course Outcome

CO1: Understand the typical programming constructs: data (primitive and compound), control, modularity, recursion etc. thereby to understand a given program
CO2: Understand and analyze a given program by tracing, identify coding errors and debug them
CO3: Make use of the programming constructs appropriately and effectively while developing computer programs
CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1				1									
CO2	1	1	1		1									
CO3	1	2	2		2									
CO4	2	3	2		3									

Syllabus

Unit 1
Introduction and Review of C language constructs. Functions – inter function communication, standard functions, scope. Recursion – recursive definition, recurivse solution, designing recursive functions, limitations of recursion. Arrays – 1D numeric, searching and sorting, 2D numeric arrays.

Unit 2
Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings.

Unit 3
Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments.

Text Book(s)
Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.

Reference(s)

Byron Gottfried. Programming With C. Fourth Edition, McGrawHill,; 2018.
Brian W. Kernighan and Dennis M. Ritchie. The C Programming Language. Second Edition, Prentice Hall, 1988.
Eric S. Roberts. Art and Science of C. Addison Wesley; 1995.
Jeri Hanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE111	ELECTRICAL AND ELECTRONICS ENGINEERING	L-T-P-C: 3 0 0 3

Course Objectives

- To impart basic knowledge of electrical quantities and provide working knowledge for the analysis of DC and AC circuits.
- Understand the characteristics and applications of diode and Transistors.
- To facilitate understanding of Thyristors and operational amplifier circuits.

Course Outcomes

CO1: Ability to understand the basic electric and magnetic circuits.
CO2: Ability to analyse DC and AC circuits.
CO3: Ability to understand the basic principles of pn junctions and transistors.
CO4: Ability to analyse basic transistor and op amp based circuits.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	3	-

SYLLABUS

Module I: Introduction to Electrical Engineering, current and voltage sources, Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Energy and Power – Series parallel combination of R, L, C components,Voltage Divider and Current Divider Rules – Super position Theorem, Network Analysis – Mesh and Node methods- Faraday's Laws of Electro-magnetic Induction, Magnetic Circuits, Self and Mutual Inductance, Generation of sinusoidal voltage, Instantaneous, Average and effective values of periodic functions, Phasor representation. Introduction to 3-phase systems, Introduction to electric grids.

Module II: PN Junction diodes, Diode Characteristics, Diode approximation- Clippers and Clampers, Rectifiers: Half wave, Full wave, Bridge- Zener Diode- Design of regulator and characteristics, Optoelectronic devices, Introduction to BJT, Characteristics and configurations, Transistor as a Switch.

Module III: Field Effect Transistors – Characteristics, Thyristors – operation and characteristics, Diac, Triac – Thyristor based power control, IC 555 based Timer-multi-vibrators, Operational Amplifiers – Inverting and Non-inverting amplifier, Oscillators, Instrumentation amplifiers.

Textbook(s)

Edward Hughes. "Electrical and Electronic Technology", 10th Edition, Pearson Education Asia, 2019.
A. P. Malvino, "Electronic Principles", 7th Edition, Tata McGraw Hill, 2007.

Reference Book(s)

S. K. Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.
Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Limited, 2nd Edition, 2003.
David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.
(Michael Tooley B. A., "Electronic circuits: Fundamentals and Applications", 3rd Edition, Elsevier Limited, 2006.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE182	ELECTRICAL AND ELECTRONICS ENGINEERING PRACTICE	L-T-P-C: 0-0-3-1

Course Outcomes

CO1: Ability to create basic electrical connections for domestic applications
CO2: Ability to measure the various electrical parameters in the circuit
CO3: Ability to construct and analyze basic electronic circuits
CO4: Ability to construct the amplifier circuits using Op-Amp

LIST OF EXPERIMENTS

1. Electrical
    a) Wiring practices
    b) Study of Electrical protection systems.
2. Verification of circuit theorem
3. VI characteristics of PN junction and Zener diode
4. Implementation of Half wave and Full wave rectifier using PN junction diode
5. Transistor as a switch
6. Characteristics of BJT
7. Experiment on Thyristor
8. Implementation of inverting and non-inverting amplifier using Op-amp
9. Experiments on Oscillators and Multivibrators

REFERENCES / MANUALS / SOFTWARE:
Lab Manuals

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE103	USER INTERFACE DESIGN	L-T-P-C: 1-0-3-2

Course Objectives

- Focus in this course is on the basic understanding of user interface design by applying HTML, CSS and Java Script.
- On the completion of the course, students will be able to develop basic web applications
- This course will serve as the foundation for students to do several projects and other advanced courses in computer science

Course Outcome

CO1: Understand the basics of World Wide Web.
CO2: Understand the fundamentals of HTML5.
CO3: Understand the fundamentals of CSS and Java Script.
CO4: Design and deploy a simple web application.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2			2	2						3	2
CO2	2	2	2							3			3	2
CO3	2	2	2					1		3			3	2
CO4	2	2	3	2	3			3	2				3	2

Syllabus

Unit 1
Introduction to Web – Client/Server - Web Server - Application Server- HTML Basics- Tags - Adding Web Links and Images-Creating Tables-Forms - Create a Simple Web Page - HTML 5 Elements - Media – Graphics.

Unit 2
CSS Basics – Features of CSS – Implementation of Borders - Backgrounds- CSS3 - Text Effects - Fonts - Page Layouts with CSS

Unit 3
Introduction to Java Script – Form Validations – Event Handling – Document Object Model - Deploying an application

Text Book(s)
Kogent Learning Solutions Inc. Html5 Black Book: Covers Css3, Javascript, Xml, Xhtml, Ajax, Php And Jquery. Second Edition, Dreamtech Press; 2013.

Reference(s)

Tittel E, Minnick C. Beginning HTML5 and CSS3 For Dummies. Third edition, John Wiley & Sons; 2013.
Powell TA, Schneider F. JavaScript: the complete reference. Paperback edition, Tata McGraw-Hill; 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE111	FUNDAMENTALS OF DATA STRUCTURES	L-T-P-C: 2-0-0-2

Course Objectives

- This course aims to provide the students an introduction to the structure and functionalities of the common data structures used in computer science, and solve simple problems applying the properties and functionalities of these data structures.

Course Outcome

CO1: Understand the basics of analysis of algorithms
CO2: Understand the linear data structures, hash tables and their functionalities
CO3: Solve simple problems that uses the properties and functions of the data structures

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		1								2	1
CO2	2	2	2	2									2	1
CO3	1	2	1	1									2	1

Syllabus

Unit 1
Basic concepts of Data Structures; Basic Analysis of Algorithms - big-Oh notation, efficiency of algorithms, notion of time and space complexity. Stacks: properties, LIFO, functions, Simple problems.

Unit 2
Recursion – Simple Examples , Linear Recursion , Binary Recursion. Queues: Properties - FIFO- Functions, simple problems, Double Ended Queue, Circular Queue.

Unit 3
Linked Lists - Types, Properties , Functions, Simple problems. Vectors and Hash Tables - Functions and Properties. Sets – properties and implementation.

Text Book(s)
Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Python. John Wiley & Sons Ltd; 2013.

References(s)
Goodrich MT, Tamassia R, Data structures and algorithms in Java. Fifth edition, John Wiley & Sons; 2010.
Tremblay JP, Sorenson PG. An introduction to data structures with applications. Second Edition, McGraw-Hill; 2002.
Shaffer CA. Data Structures and Algorithm Analysis. Third Edition, Dover Publications; 2012.

Evaluation Pattern 50:50 (Internal: External)

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19MEE181	MANUFACTURING PRACTICE	L-T-P-C: 0-0-3-1

Course Objectives

- Introduce basic concepts pertaining to product dismantling and assembly.
- Familiarize with basic pneumatic components and design & validate simple pneumatic circuits.
- Familiarize with sheet metal tools and operations.
- Provide hands-on training on welding and soldering.
- Familiarize with plumbing tools and processes.
- Inculcate and apply the principles of 3D printing to build simple geometries.

Course Outcomes

CO1: Interpret the functionality of various components in a product through dismantling and assembly
CO2: Identify various pneumatic and electro-pneumatic components
CO3: Fabricate simple sheet metal objects using concepts of surface development
CO4: Perform metal joining operations using soldering and arc welding
CO5: Make simple plumbing joints for domestic applications
CO6: Build simple geometries using 3D printing tools

CO-PO MAPPING

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1							2	1		1	1		
CO2	2	2	1		1				2	1		1	1	1	
CO3	2	2							2	1		1	1		
CO4	2	1							2	1		1	1		
CO5	2		2		2							1	1	1	
CO6	2	2	1		1				2	1		1	1	1	

Syllabus

Product Workshop
Disassemble the product of sub assembly-Measure various dimensions using measuring instruments-Free hand rough sketch of the assembly and components-Name of the components and indicate the various materials used-Study the functioning of the assembly and parts-Study the assembly and components design for compactness, processing, ease of assembly and disassembly-Assemble the product or subassembly.

Pneumatic and PLC Workshop
Study of pneumatic elements-Study of PLC and programming. Design and simulation of simple circuits using basic pneumatic elements-Design and simulation of simple circuits using electro-pneumatics.

Sheet Metal Workshop

Study of tools and equipment - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.)-Fabrication of components using small shearing and bending machines-Riveting practice.

Welding, Soldering and Plumbing Workshops

Study of tools and equipment - Study of various welding & soldering methods
Arc welding practice - fitting, square butt joint and lap joint - Soldering practice. Plumbing tools – Make a piping joint to a simple piping layout (should include cutting, threading and pipe fixing)

3D-Printing Workshop

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CUL111	CULTURAL EDUCATION – II	L-T-P-C: 2-0-0-2

Course Objective

- To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage.
- To in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

Course Outcome

CO1: Get an overview of Indian contribution to the world in the field of science and literature.
CO2: Understand the foundational concepts of ancient Indian education system.
CO3: Learn the important concepts of Vedas and *Yogasutra*-s and their relevance to daily life.
CO4: Familiarize themselves with the inspirational characters and anecdotes from the *Mahābhārata* and *Bhagavad-Gītā* and Indian history.
CO5: Gain an understanding of Amma's role in the empowerment of women

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3					2		
CO2						1		3				2		
CO3						3	3	3				2		
CO4						3	3	3				2		
CO5						1		1						

Syllabus

Unit 1
To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

Unit 2
The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

Unit 3
Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

Text Book
Cultural Education Resource Material Semester-2

Reference Book(s)

Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.
The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.
Indian Culture and India's Future. Michel Danino. DK Publications.
The Beautiful Tree. Dharmapal. DK Publications.
India's Rebirth. Sri Aurobindo. Auroville Publications.

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER III

19MAT201	NUMERICAL METHODS	L-T-P-C:1-0-0-1

Course Objectives

Gain the knowledge of root finding methods.
Understand the concept of interpolation.

Course Outcomes

CO1: Understand the different root finding methods in solving nonlinear equations
CO2: Understand and apply concept of interpolation and inverse interpolation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	3	2									

Numerical Methods

Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, system of nonlinear equations.
Interpolation and Approximation: Lagrange, Newton's Divided Difference, Newton's Forward and Backward interpolations.

Text Book(s)
Numerical Methods in Engineering with Python, Jaan Kiusalaas, Cambridge University Press, 2010.

Reference Book(s)

R.L. Burden, J. D. Faires, Numerical Analysis, Richard Stratton, 2011, 9th edition.
S.D. Conte and Carl de Boor, 'Elementary Numerical Analysis; An Algorithmic Approach'. International series in Pune and Applied Mathematics, McGraw Hill Book Co., 1980.

Course Evaluation Pattern: A two hours test will be conducted at the end of the course for 50 marks. The marks will be converted into 100 for grading.

19MAT202	OPTIMIZATION TECHNIQUES	L-T-P-C: 2-0-0-2

Course Objectives

Understand the concept of single variable optimization techniques.
Understand the techniques of multi-variable optimizations and able to solve the problems.

Course Outcome

CO1: Learn gradient based Optimizations Techniques in single variables as well as multivariable (non-linear).
CO2: Understand the Optimality criteria for functions in several variables and learn to apply OT methods like unidirectional search and direct search methods.
CO3: Learn constrained optimization techniques. Learn to verify Kuhn-Tucker conditions and Lagrangian Method.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	3	2	1									
CO3	2	3	2									

Optimization Techniques

Introduction, Conditions for local minimization. One dimensional Search methods: Golden search method, Fibonacci method, Newton's Method, Secant Method, Remarks on Line Search.
Gradient-based methods- introduction, the method of steepest descent, analysis of Gradient Methods, Convergence, Convergence Rate. Analysis of Newton's Method, Levenberg-Marquardt Modification, Newton's Method for Nonlinear Least-Squares.

Text book(s)
Edwin K.P. Chong, Stanislaw H. Zak, “An introduction to Optimization”, 2nd edition, Wiley, 2013.

Reference Book(s)
S.S. Rao, “Optimization Theory and Applications”, Second Edition, New Age International (P) Limited Publishers, 1995.
Kalyanmoy Deb, “Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2002.

Course Evaluation Pattern: Class test / tutorials / assignments for 30 marks. A two hours test will be conducted at the end of the course for 70 marks. Supplementary exam for this course will be conducted as a two-hour test for 50 marks.

19ECE204	DIGITAL ELECTRONICS AND SYSTEMS	L-T-P-C: 3-1-0-4

Course Objectives

- To understand the fundamentals of Boolean Logic and the building blocks of digital circuits
- To introduce the abstraction of simple practical problems into Boolean Logic and their efficient implementation and to introduce the fundamentals of design with combinational and sequential subsystems

Course Outcomes

CO1: Able to frame Boolean equations for solving a simple real-life Coure and realize them using gate-level building blocks

CO2: Able to apply minimization techniques for efficient Boolean logic implementation

CO3: Able to realize digital blocks using combinational and sequential subsystems

CO4: Able to design using state machine descriptions for practical real-life engineering problems

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											3	
CO2	3	3											3	
CO3	3	2											3	
CO4	3	3	2										3	

Syllabus

Unit 1

Introduction to logic circuits: Variables and functions, inversion - Truth tables - Logic gates and Networks - Boolean algebra - Synthesis using gates - Design examples - Optimized implementation of logic functions: Karnaugh map - Strategy for minimization - Minimization of product of sums forms - Incompletely specified functions - Multiple output circuits - Tabular method for minimization - Number representation and arithmetic circuits: Addition of unsigned numbers - Signed numbers - Fast adders.

Unit 2

Combinational circuit building blocks: Multiplexers - Decoders - Encoders - Code converters - Arithmetic comparison circuits. Sequential circuit building blocks: Basic latch - Gated SR latch - Gated D latch - Master slave and edge triggered - D flip-flops - T flip-flop - JK flip-flop - Registers - Counters - Reset synchronization - Other types of counters

Unit 3

Synchronous sequential circuits: Basic design steps - State assignment problem - Mealy state model - Serial adders - State minimization. Introduction to Asynchronous sequential circuits – Introduction to CMOS logic

Reference(s)

Brown S, Vranesic Z. Fundamentals of Digital logic with Verilog Design.Special Indian Edition, Tata McGraw Hill Publishing Company Limited; 2007.
Mano MM, Ciletti MD. Digital Design with Introduction to the Verilog HDL.Fifth Edition, Pearson Education; 2015.
Wakerly JF. Digital Design Principles and Practices. Fourth Edition, Pearson Education; 2008.
Givone DD. Digital Principles and Design. Tata McGraw Hill Publishing Company Limited; 2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE201	ADVANCED PROGRAMMING	L-T-P-C: 2-0-3-3

Pre-Requisite(s): 19CSE102 Computer Programming

Course Objectives

- Primary objective of this course is to introduce advanced programming concepts such as Object oriented paradigm, advanced pointers etc
- This course focuses on learning Python and C++ with an emphasize on ADT and STL usage for implementing data structures.

Course Outcomes

CO1: Understand the static object oriented programming concepts and thereby to understand a given program.
CO2: Understand the dynamic object oriented programming concepts and thereby to understand a given program.
CO3: Implement ADT in static and dynamic object oriented paradigm.
CO4: Understand the similarities, differences and code efficiency among object-oriented programming languages.
CO5: Develop computer programs that implement suitable algorithms for given problem scenario and applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3		3								3	2
CO2	2	2	3		3								3	2
CO3	1	3	2	2	3			2		1			3	2
CO4	2	2	1		1					1			3	2
CO5	2	3	2		3	2	2	3		2			3	2

Syllabus

Unit 1
Overview of Object Oriented Paradigm, Programming in C++: Objects as a group of variables, Classes as a named group of methods and data, Morphing from structures to classes, Input and Output, Access Specifiers, Member functions: Accessor, Mutator and Auxiliary, Constructors and Destructors, New and Delete Operators, Overloading, Inheritance: Handling Access and Specialization through Overriding, Polymorphism: Virtual Functions, Abstract Class and Virtual Function Tables.

Unit 2
Revisiting Pointers: Pointers to Pointers, Pointers and String Array, Void Pointers and Function Pointers, Standard Template Library, Implementation of Stack, Queue, Hash Table and Linked Lists with STL.Basic Python: Multi-paradigm language, Data Types and Variables, Indentation, Input and Output statements, Lists and Strings, Deep and Shallow Copy, Tuples and Dictionaries, Set and Frozen Sets, Control Statements and Loops, Iterators and Iterable, Functions, Recursion and Parameter Passing, Namespaces and Variable Scope, Exception Handling.

Unit 3

Object Oriented Concepts in Python: Class, Instance Attributes, Getters, Setters, Inheritance, Multiple Inheritance, Magic Methods and Operator Overloading, Class Creation, Slots, Meta Classes and Abstract Classes, Implementation of Stack, Queue, Hash Table and Linked Lists.

Text Book(s)

Stroustrup B. Programming: principles and practice using C++. Second edition, Addison Wesley; 2014.
Charles R. Severance. Python for Everybody: Exploring Data Using Python 3, Charles Severance; 2016.

Reference(s)

Guttag J. Introduction to Computation and Programming Using Python: With Application to Understanding Data. Second Edition. MIT Press; 2016.
Gaddis T. Starting Out with Python. Third Edition, Pearson; 2014.
Lambert KA. Fundamentals of Python: first programs. Second Edition, Cengage Learning; 2018.
Downey AB. Think Python: How to Think Like a Computer Scientist. O'Reilly Media; 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE205	PROGRAM REASONING	L-T-P-C:2-0-3-3

Pre-Requisite(s): 19CSE102 Computer Programming

Course Objectives

- The course aims at teaching students to reason about program's correctness from a formal stand point.
- It exposes the students to use tools and techniques to ascertain functional and behavioural correctness for sequential as well as concurrent programs.

Course Outcomes

CO1: Understand the necessity of proving correctness of programs with respect to formal specification or property
CO2: Apply program verification techniques to prove and analyze correctness of programs.
CO3: Understand the problems associated with concurrent programs and their effects on their behavioral correctness
CO4: Understand and use a few modern tools to model and verify sequential and concurrent systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			1								3	2
CO2	3	2	2	2	2			1					3	2
CO3	2	1			1								3	2
CO4	3	2	2	2	2			1					3	2

Syllabus

Unit 1
Proving the correctness of sequential programs with respect to a given contract: verification rules and application examples, partial and total correctness. Verification of simple C programs using tools such as Alt-Ergo and Frama-C.

Unit 2
Specifying the input-output contract of a sequential program using logical formulae with bounded quantifiers. Applying the Weakest Preconditions calculus for deriving verification conditions for programs with well-structured control and linear data structures. Formulating loop invariants for iterative programs. Applying the technique for programs such as sorting and searching.

Unit 3
Developing finite-state models for concurrent programs and specifying their behavioral correctness using propositional temporal logic. Defining models using a language such as Promela and checking their correctness using SPIN. Applying the technique to check safety properties, such as mutual exclusion and absence of deadlock, and liveness properties such as responsiveness to requests.

Text Book(s)

Allan Blanchard, "Introduction to C program proof with Frama-C and its WP plugin", 2020
Ben-Ari M. Principles of the Spin model checker. 2008 edition, Springer Science & Business Media; 2008.

Reference(s)

Huth M, Ryan M. Logic in Computer Science. Second Edition, Cambridge University Press; 2004.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE202	DATABASE MANAGEMENT SYSTEMS	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE101 Computer Systems Essentials

Course Objective

- This course aims to understand the concepts of database design, database languages, database-system implementation and maintenance.

Course Outcomes

CO1: Formulate and apply relational algebraic expressions, *SQL* and *PL/SQL* statements to query relational databases.
CO2: Design and build *ER* models for real world databases.
CO3: Design and build a normalized database management system for real world databases.
CO4: Understand and apply the principles of transaction processing and concurrency control.
CO5: To learn different high level databases and selection of right database.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3								3	2
CO2	1	3	3	3	3								3	2
CO3	2	3	2	3				2	2	2	2		3	2
CO4	1	1	1	2									3	2
CO5	1	1											3	2

Syllabus

Unit 1
Introduction: Overview of DBMS fundamentals – Overview of Relational Databases and Keys. Relational Data Model: Structure of relational databases – Database schema – Formal Relational Query Languages – Overview of Relational Algebra and Relational Operations. Database Design: Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas - Entity Relationship Design Issues - Extended E-R Features – Alternative E-R Notations – Overview of Unified Modeling Language (UML).

Unit 2
Relational Database Design: Features of Good Relational Designs - Atomic Domains and 1NF - Decomposition using Functional Dependencies: 2NF, 3NF, BCNF and Higher Normal Forms. Functional Dependency Theory - Algorithm for Decomposition – Decomposition using multi-valued dependency: 4NF and 4NF decomposition. Database design process and its issues. SQL: review of SQL – Intermediate SQL – Advanced SQL.

Unit 3

Transactions: Transaction concept – A simple transaction model - Storage structure - Transaction atomicity and durability - Transaction isolation – Serializability – Recoverable schedules, Casecadeless schedules. Concurrency control: Lock-based protocols – Locks, granting of locks, The two-phase locking protocol, implementation of locking, Graph-based protocols. Deadlock handling: Deadlock prevention, Deadlock detection and recovery.
Case Study: Different types of high level databases – MongoDB, Hadoop/Hbase, Redis, IBM Cloudant, DynamoDB, Cassandra and CouchDB etc . Tips for choosing the right database for the given problem.

Text Book(s)

Silberschatz A, Korth HF, Sudharshan S. Database System Concepts. Sixth Edition, TMH publishing company limited; 2011.

Reference(s)

Garcia-Molina H, Ullman JD, Widom J. Database System ; The complete book. Second Edition, Pearson Education India, 2011.
Elmasri R, Navathe SB. Fundamentals of Database Systems. Fifth Edition, Addison Wesley; 2006.
Ramakrishnan R, Gehrke J. Database Management Systems. Third Edition, TMH; 2003.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE204	OBJECT ORIENTED PARADIGM	L-T-P-C: 2-0-3-3

Pre-Requisite(s): 19CSE102 Computer Programming

Course Objectives

- This course aims at equipping the learners to develop Object-Oriented software using the Unified Modelling Language and the Java Programming Language.
- This course motivates to think of problem solving in Object-Oriented way using the methods and tools that support this paradigm.

Course Outcomes

CO1: Understand Object Oriented paradigm and represent the problem using objects and classes
CO2: Apply the Object Oriented concepts to design and develop effective models using UML
CO3: Develop programs using Object oriented concepts in Java
CO4: Understanding parallelizing of tasks and synchronization using threads
CO5: Design applications in Java using Java libraries

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1		2					1			3	2
CO2	3	3	2	1	2	2				3			3	2
CO3	1	2	3	2	3	2	2	2	2				3	2
CO4	1	1	2	2	2								3	2
CO5	2	2	3	3	2			2					3	2

Syllabus

Unit 1
Structured to Object Oriented Approach by Examples, Object Oriented languages, Properties of Object Oriented system, UML and Object Oriented Software Development, Use case diagrams as a functional model, Identifying Objects and Representation by Object Diagram: state and behaviour, Identifying classes and CRC Cards, Simple Class using class diagram: Encapsulation, Data Hiding, Reading and Writing Objects, Class Level and Instance Level Attributes and Methods, Generalization using Class Diagram: Inheritance, Constructor and Over Riding, Visibility: Attribute, Parameter, Package, Local and Global.

Unit 2
Aggregation and Composition using Class Diagram: Polymorphism, Overloading, Abstract Classes and Interfaces, Exception Handling, Inner Classes, Wrapper classes, String, and StringBuilder classes, Number, Math, Random, Array methods, File Streams.

Unit 3
Generics, Collection framework- Comparator and Comparable, Vector and Array list, Iterator and Iterable, Introduction to Threads, Creating Threads, Thread States, Runnable Threads, Coordinating Threads, Interrupting Threads, Runnable Interface, Swings – Frame Layouts, Widgets, displaying image and graphics.

Text Book(s)

Weisfeld M. The object-oriented thought process. Third edition, Addison-Wesley Professional; 2013.
Wampler BE. The Essence of Object-Oriented Programming with Java and UML. Addison-Wesley Professional; 2002.

Reference(s)

Deitel PJ. Java how to program. Eleventh Edition, Pearson; 2018.
Nino J, Hosch FA. Introduction to programming and object-oriented design using Java. Wiley India Private Limited; 2010.
Naughton P. and Schildt H. Java 2: the complete reference. Eighth Edition, Tata McGraw- Hill; 2011.
Bahrami A. Object Oriented Systems Development. Second Edition, McGraw-Hill; 2008.
Booch G, Maksimchuk RA. Object-oriented Analysis and Design with Applications. Third Edition, Pearson Education; 2009.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE282	DIGITAL ELECTRONICS AND SYSTEMS LAB	L-T-P-C: 0-0-3-1

Course Objectives

- Familiarization of digital components and ICs used as building blocks for realizing larger systems.
- To learn to realize and troubleshoot simple digital circuits using logic gate ICs on the breadboard and verify their truth tables.
- To learn to use off-the-shelf subsystems such as MSI ICs including adders, decoders and multiplexers by appropriately configuring them with the help of datasheet for realizing circuits to solve a practical engineering problem.

Course Outcomes

CO1: Able to identify, configure and use off-the-shelf digital ICs
CO2: Able to realize and troubleshoot combinational and sequential digital circuits
CO3: Able to employ MSI ICs of appropriate configuration for realizing a digital system
CO4: Able to design and implement simple digital system for a real-life problem

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											3	
CO2	3	2	2										3	
CO3	3	2	2		2								3	
CO4	3	2	2		2								3	

Syllabus

Study of Logic Gate ICs, Realization of Boolean functions using logic gate ICs, Truth table based design and implementation of simple real life problems, Implementation of digital systems using MSI building blocks such as adders, multiplexers and decoders, Breadboard realization of synchronous sequential circuits, Digital system design and implementation for a real-life problem

References(s)

Brown S, Vranesic Z. Fundamentals of Digital logic with Verilog Design.Special Indian Edition, Tata McGraw Hill Publishing Company Limited; 2007.
Mano MM, Ciletti MD. Digital Design with Introduction to the Verilog HDL.Fifth Edition, Pearson Education; 2015.
Wakerly JF. Digital Design Principles and Practices. Fourth Edition, Pearson Education; 2008.
Navas KA. Electronic Lab Manual – Volume 1. Fifth Edition, Prentice Hall of India; 2015

Evaluation Pattern:

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19AVP201	**AMRITA VALUES PROGRAM I**	**1 0 0 1**
19AVP211	**AMRITA VALUES PROGRAM II**	**1 0 0 1**

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Course Outcome

CO1: Understanding the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata

CO2: Enabling students to importance of fighting *adharma* for the welfare of the society through Sabha and Vanaparva.

CO3: Understanding the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishma parvas.

CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, Sauptika Parvas.

CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and Swargarohana Parvas.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata
Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads
Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita
Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting
Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability
Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems
Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

TEXT BOOKS/REFERENCES:

1. Rajagopalachari. C, *The Ramayana*

2. Valmiki, *The Ramayana*, Gita Press

SEMESTER IV

19MAT205	PROBABILITY AND RANDOM PROCESSES	L-T-P-C: 3-1-0-4

Course objectives

To understand the concepts of basic probability and random variables.
To understand some standard distributions and apply to some problems.
To understand the concepts of random process, stationarity and autocorrelation functions.
To understand markov process and markov chain and related concepts.

Course Outcomes

CO1: Understand the basic concepts of probability and probability modeling.
CO2: Gain knowledge about statistical distributions of one and two dimensional random variables and correlations
CO3: Understand the basic concepts of stochastic processes and the stationarity.
CO4: Understand the purpose of some special processes
CO5: Gain knowledge about spectrum estimation and spectral density function

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	2	-	-	-	-	-	-	-	-	-	-	-

Module I

Review of probability concepts - conditional probability- Bayes theorem.
Random Variable and Distributions: Introduction to random variable – discrete and continuous random variables and its distribution functions- mathematical expectations – moment generating function and characteristic function.

Module II

Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (moment generating function, mean, variance and simple problems) – Chebyshev's theorem.

Module III
Stochastic Processes:
General concepts and definitions - stationary in random processes - strict sense and wide sense stationary processes - autocorrelation and properties- special processes – Poisson points, Poisson and Gaussian processes and properties- systems with stochastic inputs - power spectrum- spectrum estimation, ergodicity –Markov process and Markov chain, transition probabilities, Chapman Kolmogrov theorem, limiting distributions classification of states. Markov decision process.

Text Book(s)

Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.

A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.

Reference Book(s)

J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.

Scott L. Miller, Donald G. Childers, "Probability and Random Processes", Academic press, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE212	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE111 Fundamentals of Data Structures

Course Objectives

- This course aims to provide the students an in-depth understanding of structure and implementation of the common data structures used in computer science.
- It imparts the ability to solve problems by choosing and applying the right data structures.
- It also imparts the ability to improve the efficiency of programs by applying the right data structures.

Course Outcomes

CO1: Understand the concept and functionalities of Data Structures and be able to implement them efficiently
CO2: Identify and apply appropriate data structures and their libraries to solve problems and improve their efficiency
CO3: Analyze the complexity of data structures and associated algorithms
CO4: Analyze the impact of various implementation and design choices on the data structure performance
CO5: Conceptualize and build data structures based on application needs

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		3			3		1			3	1
CO2	3	3	3	2		2	2	3		3			3	1
CO3	1	3	1	2				3		1			3	1
CO4	2	2	2	2	3	1	1	3		3			3	1
CO5	3	1	3	1		2	2	3		2			3	1

Syllabus

Unit 1
Refresher of Data Structures - Abstract Data Types and Data Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis -Analyzing Programs – Space Bounds, recursion-linear, binary, and multiple recursions. -Sorting and Selection – Linear Sorting –Divide and Conquer based sorting – Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort - Studying Sorting through an Algorithmic Lens. Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Stack Applications. Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue, applications.

Unit 2
Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables - Dictionary ADT. Skip Lists - Implementation - Complexity.

Unit 3

Search trees – Binary search tree, AVL tree, Trees – Segment Trees - B-Trees. Implementation. External Memory Sorting and Searching. Graphs: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

Text Book(s)

Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Python. John Wiley & Sons Ltd; 2013.

Reference(s)

Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Java. Fifth edition, John Wiley & Sons Ltd; 2010.

Tremblay JP, Sorenson PG. An introduction to data structures with applications. Second Edition, Tata McGraw-Hill; 2002.

Shaffer CA. Data Structures and Algorithm Analysis. Third Edition, Dover Publications; 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE214	THEORY OF COMPUTATION	L-T-P-C: 3-0-0-3

Course Objectives

- This course provides an overview of the problems that can be solved by various kinds of abstract machines such as finite state machine, pushdown automata and Turing machine.
- This course deals with how efficiently problems can be solved on a model of computation, using an algorithm.

Course Outcomes

CO1: Design and develop of various finite state machines.
CO2: Demonstrate the push down automata model for a given language.
CO3: Understand and design the various types of Turing machine.
CO4: Analyze the properties of different languages.
CO5: Understand the concepts of undecidability.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	3						3	1
CO2	3	3	2	2	2	2	3						3	1
CO3	3	2	2	2	2	2	3						3	1
CO4	3	2	1	2		2							3	1
CO5	3	3	2	2		1							3	1

Syllabus

Unit 1
Finite State machines –Deterministic finite state machine – Non-Deterministic finite state machine- Equivalence of NFA and DFA –Minimization of Finite State Machine – Regular Expression -Regular Language – Properties of Regular Languages.

Unit 2
Context Free Grammar -Pushdown Automata – Variants of Pushdown automata – Equivalence between PDA and CFG- Context Free Languages – Properties of CFL – Normal Forms.

Unit 3
Context Sensitive Language- Linear Bound Automata- Turing Machine – Variants of Turing Machine – Decidability- Post correspondence problem – Introduction to undecidable problems

Text Book(s)
Linz P. An introduction to formal languages and automata. Sixth edition, Jones and Bartlett Publishers; 2016.

Reference(s)

Hopcroft JE, Motwani R, Ullman JD. Introduction to Automata Theory, Languages and Computation. Third Edition, Pearson; 2006.
Sipser M. Introduction to the Theory of Computation. Third Edition Cengage Publishers; 2005.
Martin JC. Introduction to Languages and the Theory of Computation. Fourth Edition McGraw-Hill; 2010.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE211	COMPUTER ORGANIZATION AND ARCHITECTURE	L-T-P-C: 3-0-3-4

Course Objectives

- This course aims at introducing the concepts of computer architecture and organization.
- It describes overview of MIPS architecture in terms of instruction set, data path and pipelining
- It introduces pipelining and memory systems in detail along with performance metrics for designing computer systems

Course Outcomes

CO1: Understand the design principles of Instruction Set Architecture (ISA) by taking MIPS as reference.
CO2: Design, and Analyze datapath for instruction execution using Single Clock Cycle
CO3: Understand design of instruction execution using Multiple Clock Cycles and Analyze / Evaluate the performance of processors.
CO4: Understand Pipelined architecture and Design of 3 and 5 stage pipeline processor in MIPS
CO5: Understand the working of Arithmetic and Logic Unit
CO6: Understanding the concepts of Memory Organization

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1		3								3	2
CO2	3	3	3	2									3	2
CO3	2	2	2		3								3	2
CO4	2	2	3	2									3	2
CO5	2	2	2	2	3	2	2						3	2
CO6	2	2											3	2

Syllabus

Unit 1
Introduction and Performance of Computing system, Processor Architecture with example as MIPS & Instruction Set, Single Cycle Datapath Design, Control Hardware, Computer Arithmetic, Floating Point Arithmetic, Role of performance.

Unit 2
Introduction to multicycle at a path, Pipelining Technique – Design Issues, Hazards: Structural Hazards, Data Hazards and Control Hazards, Static Branch Prediction, Dynamic Branch Prediction, Advanced Concepts in pipelining.

Unit 3
Memory Organization - Introduction, Cache Memory Organization, Main Memory & Interleaving, I/O Organization, Modern Processors, Parallel Processing.

Text Book(s)
Patterson DA, Hennessy JL. Computer Organisation and Design, The Hardware/Software interface (ARM Edition). Fourth Edition, Morgan Kaufmann; 2010.

Reference(s)

Palnitkar S. Verilog HDL: a guide to digital design and synthesis. Second Edition, Pearson Education Asia; 2006.
Hamacher et. al. Computer Organisation. Sixth Edition, McGraw-Hill; 2017.
Hennessy JL, Patterson DA. Computer architecture: a quantitative approach. Fifth Edition, Morgan Kauffmann; 2011.
Hayes JP. Computer Organisation and Architecture. Third Edition, McGraw Hill; 2017.
Stallings W. Computer Organisation and Architecture. Tenth Edition, PHI; 2016.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE213	OPERATING SYSTEMS	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE101 Computer Systems Essentials

Course Objectives

- This course aims at introducing the structure and implementation of modern operating systems, virtual machines and their applications.
- It summarizes techniques for achieving process synchronization and managing resources like memory, CPU, and files and directories in an operation system.
- A study of common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems (such a priority, performance comparison, and fair-share schemes) will be done.
- It gives a broad overview of memory hierarchy and the schemes used by the operating systems to manage storage requirements efficiently.

Course Outcomes

CO1: Understand the architecture and functionalities of modern OS
CO2: Understand and apply the algorithms for resource management and scheduling
CO3: Analyze and Apply semaphores and monitors for classical and real world synchronization scenarios
CO4: Engage in independent learning as a team to study characteristic features of modern operating systems

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1		2								3	2
CO2	2	2	3	1	3		2						3	2
CO3	2	3	3	2			2	2					3	2
CO4	2	2	1	2	3	2		2	2				3	2

Syllabus

Unit 1
Operating systems Services: Overview – hardware protection – operating systems services – system calls – system structure – virtual machines. Process and Processor management: Process concepts – process scheduling – operations on process – cooperating process – inter-process communication – multi threading models – threading issues – thread types – CPU scheduling – scheduling algorithms.

Unit 2
Process synchronization: critical section problem – synchronization hardware – semaphores – classical problems of synchronization – critical regions – monitors – deadlocks – deadlock characterization – methods of handling deadlocks – deadlock prevention – avoidance – detection and recovery. Memory management – swapping – contiguous memory allocation. Paging and segmentation – segmentation with paging – virtual memory – demand paging – process creation – page replacement – thrashing.

Unit 3

File management: File systems: directory structure – directory implementation – disk scheduling. Case study: threading concepts in operating systems, kernel structures.

Text Book(s)

Silberschatz A, Gagne G, Galvin PB. Operating system concepts. Tenth Edition, John Wiley and Sons; 2018.

Reference Book(s)

Deitel HM, Deitel PJ, Choffnes DR. Operating systems. Third Edition, Prentice Hall; 2004.
Tannenbaum AS. Modern Operating Systems. Fourth Edition, Prentice Hall; 2016.
Stevens WR, Rago SA. Advanced programming in the UNIX environment. Second Edition, Addison-Wesley; 2008.
Nutt G. Operating systems. Third Edition, Addison Wesley; 2009.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK211	**SOFT SKILLS I**	**L-T-P-C: 1-0-3-2**

Course Outcome

CO 1 - Soft Skills: At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.

CO 2 - Soft Skills: Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.

CO 3 - Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.

CO 4 – Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively.

CO 5 - Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.

CO 6 – Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4										3		3
CO5										3		3
CO6									3	3		3

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work - environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, Self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.

Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.

Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.

The Hard Truth about Soft Skills, by Amazone Publication.

Quantitative Aptitude by R. S. Aggarwal,S. Chand

Quantitative Aptitude – Abijith Guha, TMH.

Quantitative Aptitude for Cat - Arun Sharma. TMH.

REFERENCES:

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.

More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.

The BBC and British Council online resources

Owl Purdue University online teaching resources

www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER V

19CSE305	MACHINE LEARNING	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- The aim of this course is to provide foundational knowledge in machine learning.
- The students will learn to implement, train and validate the machine learning models and understand the recent algorithms in machine learning through case studies.

Course Outcomes

CO1: Understand issues and challenges of machine learning: data, model selection, model complexity
CO2: Design and implement various machine learning algorithms in a range of real-world applications
CO3: Understand strengths and weaknesses of many popular machine learning approaches
CO4: Analyze the underlying mathematical relationships within and across Machine Learning algorithms
CO5: Apply the paradigms of supervised and un-supervised learning

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3					1	3			3	2
CO2	3	2	3	2	2	2	2	3	3	3			3	2
CO3	3	2	1	2	3					2			3	2
CO4	3	1	2	1	3			2	2	3			3	2
CO5	3	1	2	1		2	2	1	1	3			3	2

Syllabus

Unit 1
Foundations of supervised learning - Decision trees and inductive bias, Regression Vs Classification, Supervised: Linear Regression, Logistic Regression, Generalisation, Training, Validation and Testing, Problem of Overfitting, Bias vs Variance, Performance metrics, Decision Tree, Random Forest, Perceptron, Beyond binary classification

Unit 2
Advanced supervised learning - Naive Bayes, Bayesian Belief Network, K-Nearest Neighbour, Support vector machines, Markov model, Hidden Markov Model, Parameter Estimation : MLE and Bayesian Estimate, Expectation Maximisation, Neural Networks

Unit 3
Unsupervised Learning : Curse of Dimensionality, Dimensionality Reduction Techniques, Principal component analysis, Linear Discriminant Analysis Clustering: K-means, Hierarchical, Spectral, subspace clustering, association rule mining. Case Study: Recommendation systems

Text Book(s)
Tom Mitchell. Machine Learning. McGraw Hill; 2017

Reference(s)

Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010
Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. Wiley, Second Edition;2007
Kevin P. Murphey. Machine Learning, a probabilistic perspective. The MIT Press Cambridge, Massachusetts, 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE302	DESIGN AND ANALYSIS OF ALGORITHMS	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE212 Data Structures and Algorithms

Course Objectives

- This course aims to provide the fundamentals of algorithm design and analysis, specifically in terms of algorithm design techniques, application of these design techniques for real-world problem solving and analysis of complexity and correctness of algorithms.

Course Outcomes

CO1: Evaluate the correctness and analyze complexity of algorithms.
CO2: Understand and implement various algorithmic design techniques and solve classical problems
CO3: Design solutions for real world problems by identifying, applying and implementing appropriate design techniques.
CO4: Design solutions for real world problem by mapping to classical problems
CO5: Analyze the impact of various implementation choices on the algorithm complexity

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	2								3	2
CO2	3	2	2		1								3	2
CO3	3	2	3	2	1	2	2	2		2			3	2
CO4	2	2	3	2	2	2	2	2		3			3	2
CO5	2	2	3	1	2	1	1			3			3	2

Syllabus

Unit 1
Introduction and Review- Algorithms vs. programs. Flow charts and pseudo code, Rate of growth of functions. Review of Asymptotic notation: motivation and types of notations. Recurrence relations and methods to solve them: Recursion tree, substitution, Master Method. Review of Sorting: Bubble –Insertion – Selection – Bucket – Heap, Comparison of sorting algorithms, Applications. Graph Algorithms – Graph Traversal: Applications of BFS: distance, connectivity and connected components and cycles in undirected graphs. Applications of DFS: Topological sort, cycles in directed graphs, Biconnected Components and Strong Connectivity. Path algorithms: Shortest path algorithms (along with analysis) SSSP: Bellman Ford. APSP: Floyd Warshall's. Review of Minimum Spanning Tree (with analysis and applications).

Unit 2
Divide and Conquer: Merge sort and Binary search type strategies, Pivot based strategies – Long integer multiplication – Maximum sub array sum - Closest Pair problem etc as examples. Greedy Algorithm - Introduction to the method, Fractional Knapsack problem, Task Scheduling Problem, Huffman coding etc as examples. Dynamic Programming: Introduction to the method, Fibonacci numbers, 0-1 Knapsack problem, Matrix chain multiplication problem, Longest Common Subsequence, and other problems including problems incorporating combinatorics as examples.

Unit 3

Backtracking, Branch and Bound 0-1 Knapsack, N- Queen problem, subset sum as some examples. String Matching: Rabin Karp, Boyer Moore, KMP. Network Flow and Matching: Flow Algorithms Maximum Flow – Cuts Maximum Bipartite Matching. Introduction to NP class: Definitions P, NP, NP complete, NP hard, Examples of P and NP.

Text Book(s)

Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein. Introduction to Algorithms. Third Edition, Prentice Hall of India Private Limited; 2009.

Reference(s)

Michael T Goodrich and Roberto Tamassia. Algorithm Design Foundations - Analysis and Internet Examples. John Wiley and Sons, 2007.

Dasgupta S, Papadimitriou C and Vazirani U. Algorithms. Tata McGraw-Hill; 2009.

Jon Kleinberg, Eva Tardos. Algorithm Design. First Edition, Pearson Education India; 2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE301	COMPUTER NETWORKS	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE101 Computer Systems Essentials

Course Objectives

- This course introduces the fundamental principles of computer networks including important layers and protocols
- This course will focus on the most important layers including transport layer and link layer along with their functionalities.
- This course will help students with network programming and debugging capabilities

Course Outcomes

CO1: Understand the basic architectural components of computer networks and apply mathematical foundations to solve computational problems in computer networking
CO2: Apply network application services, protocols and programming
CO3: Analyze protocols for data transfer mechanisms, buffer management and flow handling mechanisms
CO4: Analyze devices for routing and apply routing protocols
CO5: Apply and Analyze network access protocols and error handling codes to design Local Area Network
CO6: Comprehend concepts of virtualization and data centric networking

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2									3	2
CO2	2	2	2		3	2	2	2	2	2			3	2
CO3	3	3	3	2	3		2	2	2	2			3	2
CO4	3	3	2	2	3		2	2	2	2			3	2
CO5	3	3	2	2			2						3	2
CO6	2	2	1		3	2	2	2	2	2			3	2

Syllabus

Unit 1
The Internet-The Network Edge, the Network Core, Network Topology, Types of Networks, Delay, Loss, and Throughput in Packet Switched Networks. Protocol Layers and their Service Models. Principles of Network Applications: The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, DNS, Peer-to-Peer Applications. Introduction and Transport Layer Services: Multiplexing and demultiplexing, Connectionless Transport - UDP, Principles of Reliable Data Transfer.

Unit 2
Transport layer - Connection Oriented Transport - TCP, Principles of Congestion Control, TCP Congestion Control. Introduction Network Layer: Virtual Circuit and Datagram Networks, Inside a Router, The Internet Protocol (IP) -

Forwarding and Addressing in the Internet, Routing Algorithms, Routing in the Internet, Broadcast and Multicast Routing.

Unit 3

The Link Layer and Local Area Networks - Introduction and Services, Error-Detection and Correction Techniques, Multiple Access Protocols - Link-Layer Addressing, Ethernet, Link-Layer Switches– Case Study: Virtualization and data center Networking

Text Book(s)

Kurose J F and Ross K W. Computer Networking: A Top-Down Approach. Seventh Edition, Pearson Press, 2017.

Reference(s)

Tanenbaum A S. Computer Networks. Fifth Edition, Pearson Education India; 2013.
Stallings W. Data and computer communications. Tenth Edition, Pearson Education India; 2013.
Forouzan B A. Data Communication and Networking. Fourth Edition, Tata McGraw Hill; 2017.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE304	FOUNDATIONS OF DATA SCIENCE	L-T-P-C: 2-0-3-3

Pre-Requisite(s): 19MAT205 Probability and Random Processes

Course Objectives

- The objective is to teach primary tools for exploration, visualizations and descriptive statistics, for prediction are machine learning and optimization, and for inference are statistical tests and models.
- Through understanding a particular domain, the students learn to ask appropriate questions about their data and correctly interpret the answers provided by inferential and computational tools.

Course Outcomes

CO1: Understand the statistical foundations of data science.
CO2: Apply pre-processing techniques over raw data so as to enable further analysis.
CO3: Conduct exploratory data analysis and create insightful visualizations to identify patterns.
CO4: Identify machine learning algorithms for prediction/classification and to derive insights
CO5: Analyze the degree of certainty of predictions using statistical test and models.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1												2	2
CO2	1	1		1	3								2	2
CO3	3	1	1	2	3								2	2
CO4	3	1	1	2	2			2					2	2
CO5	3	3	1	3	2								2	2

Syllabus

Unit 1
Introduction, Causality and Experiments, Data Preprocessing: Data cleaning, Data reduction, Data transformation, Data discretization. Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of exploratory data analysis, Randomness, Probability, Introduction to Statistics, Sampling, Sample Means and Sample Sizes.

Unit 2
Descriptive statistics – Central tendency, dispersion, variance, covariance, kurtosis, five point summary, Distributions, Bayes Theorem, Error Probabilities; Permutation Testing, Statistical Inference; Hypothesis Testing, Assessing Models, Decisions and Uncertainty, Comparing Samples, A/B Testing, P-Values, Causality.

Unit 3
Estimation, Prediction, Confidence Intervals, Inference for Regression, Classification, Graphical Models, Updating Predictions.

Text Book(s)

Ani Adhikari. John DeNero, Computational and Inferential Thinking: The Foundations of Data Science. GitBook, 2019.

Reference(s)

Shmueli G, Bruce PC, Yahav I, Patel NR, Lichtendahl Jr KC. Data mining for business analytics: concepts, techniques, and applications in R. John Wiley & Sons; 2018..
Schutt R, O'Neil C. Doing data science: Straight talk from the frontline. First Edition, O'Reilly Media, Inc.; 2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE303	EMBEDDED SYSTEMS	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE211 Computer Organization and Architecture

Course Objectives

- Through this course, the students will get an insight about how processor works, microcontroller architecture basics and how electronic gadgets are designed, developed and built as embedded systems.
- This course emphasis on learn by doing and building solutions to real world problems using embedded systems

Course Outcomes

CO1: Understand the basic concepts of Embedded Systems and working of a general purpose microcontroller operations.
CO2: Write and interpret assembly program based on the instruction set of the microcontroller
CO3: Understand the ARM System-on-chip architecture using ARM assembly program
CO4: Analyze how to access Microcontroller ports using Embedded C program
CO5: Debug and verify Embedded program using a simulator and on the microcontroller.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											3	2
CO2	3	2	2	2				2	2	2	2	2	3	2
CO3	3	2										2	3	2
CO4	3	3	2	2	2	2	2	2	2	2	2	2	3	2
CO5	3	3	2	2	2	2	2	2	2	2	2	2	3	2

Syllabus

Unit 1
Basics of Embedded Systems – Definition, Characteristics, Architecture of Microprocessors: General definitions of computers, micro-processors, micro controllers and digital signal processors. ARM Architecture: RISC Machine, Architectural Inheritance, Programmers model, CPSR, ARM Organization and Implementation. 3 Stage pipeline, 5 Stage pipeline, ARM Instruction execution, Co-processor interface, ARM Assembly language Programming, Data processing instructions, Data Transfer Instructions, Control flow instructions, Architectural support for high level programming, Thumb Instruction set.

Unit 2
Interrupt structure - Vector interrupt table, Interrupt service routines, Asynchronous and Synchronous data transfer schemes, ARM memory interface, AMBA interface, Microcontroller ARM7-LPC2148 ports: GPIO, A/D Converters, PWM, timer / counter, UART and its interfacing – Embedded Programming Concepts: Role of Infinite loop, Compiler, Assembler, Interpreter, Linker, Loader, Debugger- Application development using Keil IDE.

Unit 3
Introduction to ARM Cortex M4 Microcontroller – GPIO and other Peripherals - System development process: Requirements, Design, Development, Testing and Deployment. Prototyping: Analog circuit design and construction on a solderless breadboard, Hardware and Software design, Programming simple logic and testing PLL and Systick Timers, Design strategy for building Finite State machine.

Text Book(s)

Furber SB. ARM system-on-chip architecture. pearson Education; 2000.
Martin T. The Insider's guide to the Philips ARM7-based microcontrollers. Coventry, Hitex, UK, Ltd. 2005.

Reference(s)

Valvano JW. Embedded Systems: Introduction to ARM Cortex-M Microcontrollers. Jonathan W. Valvano; 2016.
Valvano JW. Embedded microcomputer systems: real time interfacing. Cengage Learning; 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK301	SOFT SKILLS II	L-T-P-C: 1-0-3-2

Course Outcomes

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.

CO # 2 - Soft Skills: At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.

CO # 3 - Aptitude: At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.

CO # 4 – Verbal: At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.

CO # 5 - Verbal: At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.

CO # 6 – Verbal At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.

Syllabus

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quick Maths – Tyra.

Quicker Arithmetic – Ashish Aggarwal
Test of reasoning for competitive examinations by Thorpe.E. TMH
Non-verbal reasoning by R. S. Aggarwal, S. Chand

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV390	LIVE-IN-LAB I	L-T-P-C: 0-0-0-3

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human centered approach.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas
- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [75 marks]	
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
External [25 marks]	
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

SEMESTER VI

19CSE314	SOFTWARE ENGINEERING	L-T-P-C: 2-0-3-3

Course Objectives

- This course addresses issues in the engineering of software systems and development using live case studies from industries.
- The objectives of this course are to introduce basic software engineering concepts; to introduce the Agile Software development process; hands-on training (experiential learning) using state-of-the-art tools to understand the concepts learnt in the class.
- The course helps students to be industry-ready in terms processes, tools and terminologies from agile and devops point of view

Course Outcomes

CO 1: Understand and apply the principles of software engineering
CO 2: Understand various software process models
CO 3: Apply the appropriate software design methodology for a given scenario
CO 4: Evaluate a system developed for real-world applications in Agile Mode
CO 5: Understand and implement various industry standards

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											1	1
CO2	3											2	3	1
CO3	3	3	3			2	2			2		3	3	3
CO4		2	3	3	3	2	2	3	3	3	2		3	3
CO5					3				3	1	2	3	3	3

Syllabus

Unit 1
Process Models – overview, Introduction to Agile, Agile Manifesto, principles of agile manifesto, over-view of Various Agile methodologies - Scrum, XP, Lean, and Kanban, Agile Requirements - User personas, story mapping, user stories, estimating and prioritizing stories, INVEST, acceptance criteria, Definition of Done, Release planning Key aspects of Scrum: roles - Product Owner, Scrum Master, Team, Manager in scrum and product backlog Scrum process flow: product backlog, sprints backlog, scrum meetings, demos. How sprint works: Sprint Planning, Daily scrum meeting, updating sprint backlog, Burn down chart, sprint review, sprint retrospective. Scrum Metrics-velocity, burn down, defects carried over.

Unit 2
Traditional process Models: Waterfall, incremental, evolutionary, concurrent. Requirements Engineering: Tasks Initiation-Elicitation-Developing Use Cases-Building the analysis Model-Negotiation- Validation Requirements Modelling - building the analysis model, Scenario based methods, UML Models, Data Models. Design engineering Design concepts, Design models, software architecture, architectural styles and patterns, Architectural design: styles

and patterns, architectural design, Refining architecture to components. Performing user interface Design-Golden Rules-User Interface Analysis and Design- Interface Analysis-Interface design steps.

Unit 3
Testing strategies and tactics: Unit testing, integration testing, validation and system testing, Devops.

Text Book(s)
Pressman R S, Bruce R.Maxim, Software Engineering - A Practitioner's Approach. Eighth Edition, McGraw-Hill Education, 2019.

Reference(s)
Crowder JA, Friess S. Agile project management: managing for success. Cham: Springer International Publishing; 2015.
Stellman A, Greene J. Learning agile: Understanding scrum, XP, lean, and kanban. " O'Reilly Media, Inc."; 2015.
Gregory J, Crispin L. More agile testing: learning journeys for the whole team. Addison-Wesley Professional; 2015.
Rubin KS. Essential Scrum: a practical guide to the most popular agile process. Addison-Wesley; 2012.
Cohn M. User stories applied: For agile software development. Addison-Wesley Professional; 2004.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE313	PRINCIPLES OF PROGRAMMING LANGUAGES	L-T-P-C: 2-0-3-3

Course Objectives

- This course provides a quick overview of different paradigms of programming languages.
- It focuses primarily on the functional programming paradigm using Haskell and Scala and discusses the concurrent programming paradigm using Java.

Course Outcomes

CO1: Understand and write pure functional programs (especially in Haskell and Scala).
CO2: Understand and write concurrent programs in Java.
CO3: Formulate abstractions with higher order procedures.
CO4: Formulate abstractions with data.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1		3	2	1						3	2
CO2	2	2	2	1	3	2	1						3	2
CO3	3	3	3	3	3	2	2						3	2
CO4	3	3	3	3	3	2	2						3	2

Syllabus

Unit 1
Programming Paradigms – Overview of different programming paradigms. Functional Programming with Haskell – functions and types, functional composition, numbers, lists, tuples, type classes, pattern matching, higher order functions: currying, lambdas, maps and filters, folds, IO monad

Unit 2
Concurrency in Java - Issues with concurrency: safety, liveness, fairness, Threads, locks and synchronization, Thread pools, Futures and callables, fork-join parallel framework

Unit 3
Functional Programming overview with Scala – Basic types and operations, classes and objects, functional objects, functions and closure, composition and inheritance

Text Book(s)
Bird R. Thinking functionally with Haskell. Cambridge University Press; 2014.
Martin Odersky, Lex Spoon and Bill Venners, "Programming in Scala – A Comprehensive Step-by-Step Guide", Third Edition, Artima Inc. 2016.

Reference(s)
Herbert Schildt. Java: The Complete Reference. Eleventh Edition, McGrawHill Education; 2018.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE312	DISTRIBUTED SYSTEMS	L-T-P-C: 3-0-3-4

Course Objectives

- This course is an introduction to the design of distributed systems and algorithms that support distributed computing.
- It aims to provide a practical exposure into the design and functioning of existing distributed systems.

Course Outcomes

CO1: Understand the design principles in distributed systems and the architectures for distributed systems.
CO2: Apply various distributed algorithms related to clock synchronization, concurrency control, deadlock detection, load balancing, voting etc.
CO3: Analyze fault tolerance and recovery in distributed systems and algorithms for the same.
CO4: Analyze the design and functioning of existing distributed systems and file systems.
CO5: Design and implement a simple distributed system and implement different distributed algorithms over it.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2		2							3	2
CO2	3	3	2	2		3							3	2
CO3	3	3	2	2		2	3	2	2			2	3	2
CO4	3	3	2	2	2	3		2					3	2
CO5	3	3	3	1	3	3	1	3	2	2	2	2	3	2

Syllabus

Unit 1
A Taxonomy of Distributed Systems - Models of computation: shared memory and message passing systems, synchronous and asynchronous systems. Communication in Distributed Systems: Remote Procedure Calls, Message Oriented Communications and implementations over a simple distributed system.

Unit 2
Global state and snapshot algorithms. Logical time and event ordering, clock synchronization, Distributed mutual exclusion, Group based Mutual Exclusion, leader election, concurrency control, deadlock detection, termination detection, implementations over a simple distributed system.

Unit 3
Consistency and Replication: Data Centric Consistency, Client Centric Consistency, Replica Management, Consistency Protocols. Fault tolerance and recovery: basic concepts, fault models, agreement problems and its applications, commit protocols, voting protocols, check pointing and recovery. Distributed file systems: scalable performance, load balancing, and availability.
Case Studies: Dropbox, Google FS (GFS)/ Hadoop Distributed FS (HDFS), Bigtable/HBase MapReduce, RDDs, Apache Spark

Text Book(s)
Andrew S. Tannenbaum and Maarten van Steen, Distributed Systems: Principles and Paradigms, Third Edition, Prentice Hall, 2017.

Reference(s)

Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 2011.
Garg VK, Garg VK. Elements of distributed computing. John Wiley & Sons; 2002.
George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, Distributed Systems: Concepts and Design, Fifth Edition, Pearson Education, 2017.
Fokkink W. Distributed algorithms: an intuitive approach. Second Edition, MIT Press; 2018.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	30	
Continuous Assessment Lab(CAL)	15	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE311	COMPUTER SECURITY	L-T-P-C: 3-0-0-3

Course Objectives

- This course provides basic knowledge and skills in the fundamental theories and practices of cyber security.
- It provides an overview of the field of security and assurance emphasizing the need to protect information being transmitted electronically.

Course Outcomes

CO1: Understand the fundamental concepts of computer security and apply to different components of computing systems.
CO2: Understand basic cryptographic techniques.
CO3: Understand how malicious attacks, threats, security and protocol vulnerabilities impact a system's Infrastructure.
CO4: Demonstrate knowledge in terms of relevance and potential of computer security for a given application.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1										3	2
CO2	3	3	3	1	2								3	2
CO3	3	3	3	2		2		3					3	2
CO4	3	3	1	2	3	2		2					3	2

Syllabus

Unit 1
Basics of Computer Security: Overview – Definition of terms – Security goals – Shortcomings – Attack and defense – Malicious code – Worms – Intruders – Error detection and correction Encryption and Cryptography: Ciphers and codes – Public key algorithms – Key distribution – Digital signatures.

Unit 2

Security Services: Authentication and Key Exchange Protocols - Access control matrix – User authentication – Directory authentication service – Diffie-Hellman key exchange – Kerberos.

Unit 3
System security and Security models: Disaster recovery - Protection policies. E-mail Security: Pretty good privacy - Database Security: Integrity constraints - Multi-phase commit protocols - Networks Security: Threats in networks - DS authentication -Web and Electronic Commerce: Secure socket layer - Client-side certificates - Trusted Systems : Memory protection.

Text Book(s)
Stallings William, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson/Prentice- Hall, 2018.

Reference(s)

Forouzan B A, Cryptography and Network Security, Special Indian Edition, Tata McGraw Hill, 2007.
Padmanabhan TR, Shyamala C K, and Harini N, Cryptography and Security, First Edition, Wiley India Publications, 2011.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK311	SOFT SKILLS III	L-T-P-C: 1-0-3-2

Course Outcomes:

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

CO # 2 - Soft Skills: At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO # 3 - Aptitude: At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.

CO # 4 – Verbal: At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.

CO # 5 - Verbal: At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.

CO # 6 – Verbal: At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience / recipient using their communication skills in English.

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation / knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics).

Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Data Interpretation by R. S. Aggarwal, S. Chand
Logical Reasoning and Data Interpretation – Niskit K Sinkha
Puzzles – Shakuntala Devi
Puzzles – George J. Summers.

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources

www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV490	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of CoDesign to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

Course Outcome

CO1: Learn co-design methodologies and engage participatorily to finalise a solution
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5. Prototype implementation of the solution

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3			1	3	3	3		3
CO2									3	3		
CO3									3	3	3	
CO4	3		3			3	1	3	3	3		3
CO5			1						3	3		

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [63 marks]	
1. Proposed Implementation	**2**
Presentation Round 1	
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii. Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii. Testing & Evaluation	4
iv. Sustenance Model Implementation	4
External [37 marks]	
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**
Attendance	5
Grand Total	**10**

SEMESTER VII

19CSE401	COMPILER DESIGN	L-T-P-C: 2-0-3-3

Pre-Requisite(s): 19CSE214 Theory of Computation

Course Objectives

- This course aims at introducing the major concepts in the areas of programming language translation and compiler construction.
- The course emphasizes techniques that have direct application to the construction of compilers.

Course Outcomes

CO1: Apply theoretical concepts for the analysis of program structure.
CO2: Apply theoretical concepts and ad hoc techniques to translate high level structures to intermediate representations.
CO3: Analyze the design of data structures for compile-time code generation.
CO4: Analyze the design of data structures for run-time code generation.
CO5: Apply algorithms to improve the performance of the translated code.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2								3	2
CO2	2	3	2		2								3	2
CO3	2	3	3										3	2
CO4	2	3	3										3	2
CO5	2	2	1	1				2					3	2

Syllabus

Unit 1
Compiler: Definition, Objectives, Structure – Overview of Translation. Scanners: Table-Driven. Parsers: LL(1), LALR(1).

Unit 2
Context-Sensitive Analysis: Attribute Grammar – Ad Hoc Syntax Directed Translation. Intermediate Representations: Abstract Syntax Tree, Three Address Code. Symbol Tables: Hash Table.

Unit 3
Procedure Abstraction: Access Links. Optimization: Local Value Numbering, Superlocal Value Numbering, Liveness Analysis.

Text Book(s)
Cooper, Keith, and Linda Torczon, Engineering a Compiler, Second Edition, Morgan Kaufman, 2011.

Reference(s)

Parr T. Language implementation patterns: create your own domain-specific and general programming languages. Pragmatic Bookshelf; First Edition, 2010.
Mak R. Writing compilers and interpreters: a software engineering approach. John Wiley & Sons; Third Edition, 2009.
Appel W Andrew and Jens Palesberg, Modern Compiler Implementation in Java, Cambridge University Press, Second Edition, 2002.
Aho, Alfred V., Monica S. Lam, Ravi Sethi, and Jeffrey Ullman, Compilers: Principles, Techniques and Tools, Prentice Hall, Second Edition, 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE495/19CSE491	PROJECT - PHASE – 1 / SEMINAR	L-T-P-C: 0-0-6-2

Couse Objectives

- First phase of academic project covers problem formulation, study of relevant literature and presentation of findings.
- Gives an opportunity for practical application of computer science and help the students to innovate.
- This in turn supports publications, patenting and entrepreneurship

Course Outcomes

CO1: Ability to formulate scientific problem and prepare project execution plan.
CO2: Ability to find and analyse related literature.
CO3: Ability to present, articulate and defend the findings.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3				3	3		2	3	3	3
CO2			3		3			3	3		2	3	3	3
CO3		3	3		3			3	3	3	2	3	3	3

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	60	
End Semester		40

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER VIII

19CSE499	PROJECT - PHASE – 2	L-T-P-C: 0-0-30-10

Course Objectives

- Second phase of academic project covers implementation, testing, scientific knowledge dissemination through research articles, and documentation.
- Gives an opportunity for practical application of computer science and help the students to innovate.
- This in turn supports scientific/research publications, patenting and entrepreneurship.

Course Outcomes

CO1: Fine-tune the scientific problem and prepare project execution plan
CO2: Design and develop the prototype
CO3: Implement, analyze the findings of the proposed problem
CO4: Present, articulate and defend the solution

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3				3	3		2	3	3	3
CO2			3		3			3	3		2	3	3	3
CO3		3	3		3			3	3	3	2	3	3	3
CO4					3	3		3	3	3	2	3	3	3

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	60	
End Semester		40

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PROFESSIONAL ELECTIVES

Electives in Cyber Security

19CSE331	CRYPTOGRAPHY	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19MAT115 Discrete Mathematics

Course Objectives

- The course will cover how cryptography (symmetric and asymmetric) work, how security is analyzed theoretically, and how exploits work in practice.
- It will also present Cryptanalysis attacks against the cryptographic techniques, and attack models.

Course Outcomes

CO1: Understand classical cryptography techniques and apply cryptanalysis
CO2: Analyze measures for securing cryptosystem
CO3: Apply and analyze operations on Feistel and non-Feistel structures
CO4: Apply asymmetric encryption techniques for securing messages

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		2	2								2	1
CO2	3	2	1	1		2							2	2
CO3	3	2	2	2	2								2	2
CO4	3	2	2	2	2								3	2

Syllabus
Unit 1
Basics of number theory: Integers and operations on integers - Modular arithmetic - Prime Numbers - Primality related properties. Basic conventions and Terminology - Substitution Ciphers -Transposition ciphers - Rotor machines - Cryptanalysis.
Unit 2
Foundations of Modern Cryptography: Perfect Secrecy-Information and Entropy - Source Coding, Channel Coding, and Cryptography - Product cryptosystems. Symmetric Cryptosystems: Substitution Permutation Networks - DES and Enhancements - AES and its Modes.
Unit 3
Asymmetric Key Cryptography: Basic ideas of Asymmetric Key Cryptography - RSA Cryptosystem - Attacks on RSA Discrete Logarithm Problem and related algorithms – El-Gamal Cryptosystem – ECC. Digital Signatures and hash functions properties.

Text Book(s)

Stallings W. Cryptography and network security: principles and practice. Upper Saddle River: Pearson; 2018.
Padmanabhan TR, Shyamala C K, and Harini N. Cryptography and Security, First Edition, Wiley India Publications; 2011.

Reference(s)

Forouzan BA. Cryptography & network security. McGraw-Hill, Inc.; 2007 Feb 28.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE332	INFORMATION SECURITY	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE331 Cryptography

Course Objectives

- This course will help students understand basic principles of information security
- This course equip students sufficient knowledge on digital signature and email security
- This course will cover fundamentals of web security

Course Outcomes

CO1: Understand information security models and analyze authentication mechanisms for challenge response scenarios.
CO2: Understand e-mail architecture and standards for securing mail communication.
CO3: Understand Internet Security Protocol and explore common solutions for security issues.
CO4: Apply and analyze Web security protocols for E-Commerce applications

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	2									3	2
CO2	2			2									3	2
CO3	2			2									3	2
CO4	2	3	1	2									3	2

Syllabus

Unit 1
Digital Signature and Authentication Schemes: Digital signature-Digital Signature Schemes and their Variants- Digital Signature Standards-Authentication: Overview- Requirements Protocols -Applications - Kerberos -X.509 Directory Services

Unit 2
E-mail and IP Security: Electronic mail security: Email Architecture -PGP – Operational Descriptions- Key management- Trust Model- S/MIME.IP Security: Overview- Architecture - ESP, AH Protocols IPSec Modes – Security association - Key management.

Unit 3
Web Security: Requirements- Secure Sockets Layer- Objectives-Layers -SSL secure communication-Protocols - Transport Level Security. Secure Electronic Transaction- Entities DS Verification-SET processing.

Text Book(s)

Stallings William. Cryptography and Network Security: Principles and Practice, Seventh Edition, Pearson/Prentice-Hal; 2018.

Reference(s)

Forouzan BA. Cryptography & network security. McGraw-Hill, Inc.; 2007 Feb 28.

Padmanabhan TR, Shyamala C K, and Harini N. Cryptography and Security, First Edition, Wiley India Publications; 2011.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE333	SECURE CODING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE102 Computer Programming

Course Objectives

- This course will introduce a variety of topics pertaining to writing secure code.
- It facilitates learning and experiencing intermediate and advanced techniques that systems and applications programmers can use to write new code securely, as well as to find and mitigate vulnerabilities in existing code.

Course Outcomes

CO1: Understand the need for secure coding and S-SDLC
CO2: Understand and analyze the cause of security vulnerabilities and how they are exploited
CO3: Apply various testing methods to find and correct security defects in software
CO4: Develop skills in using security-oriented software techniques

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	2
CO2	3	3	2	3		1		3				3	3	3
CO3	3	2	3	3	2	2		2				2	3	2
CO4	3	2	3	2	2	2		3				3	3	2

Syllabus

Unit 1
Need for secure systems: Proactive Security development process, Secure Software Development Cycle (S-SDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code – Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline.

Unit 2
Threat modelling process and its benefits: Identifying the Threats by Using Attack Trees and rating threats using DREAD, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization. Defense in Depth and Principle of Least Privilege. Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks.

Unit 3
Secure Coding Techniques: Insecure Coding Practices in Java Technology. ARP Spoofing and its countermeasures. Buffer Overrun- Stack overrun, Heap Overrun, Array Indexing Errors, Format String Bugs. Security Issues in C

Language: String Handling, Avoiding Integer Overflows and Underflows and Type Conversion Issues- Memory Management Issues, Code Injection Attacks, Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check Versus Time of Use and its protection mechanisms. Validating Input and Inter-process Communication. XSS scripting attack and its types – Persistent and Non persistent attack XSS Countermeasures and Bypassing the XSS Filters.

Text Book(s)

Robert C.Seacord. Secure Coding in C and C++, Pearson Education, Second Edition; 2013.
Michael Howard , David LeBlanc. Writing Secure Code, Microsoft Press, Second Edition; 2003.

Reference(s)

Mead NR, Allen JH, Barnum S, Ellison RJ, McGraw GR. Software security engineering: a guide for project managers. Addison-Wesley Professional; 2004 Apr 21.
Deckard J. Buffer overflow attacks: detect, exploit, prevent. Elsevier; 2005 Jan 29.
Shostack A. Threat modeling: Designing for security. John Wiley & Sons; 2014 Feb 12.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE334	CYBER FORENSICS AND MALWARE	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19MAT115 Discrete Mathematics, **19CSE331** Cryptography

Course Objectives

- The course focuses on the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered, and preparation of expert testimonial evidence.

Course Outcomes

CO1: Understand stages of cyber forensic investigation - detection, initial response and management interaction.
CO2: Understand the process of investigating attacks and importance of evidence handling and storage
CO3: Understand and identify appropriate method for data recovery
CO4: Summarize and preserve digital evidence from various sources

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1										3	2
CO2	2	3	3	1									3	2
CO3	3	2	3										3	2
CO4	3	2	2	2	2								3	2

Syllabus

Unit 1
Forensics Overview: Computer Forensics Fundamentals, Benefits of Computer Forensics, Computer Crimes, Computer Forensics Evidence and the Courts, Legal Concerns and Privacy Issues. Forensics Process: Forensics Investigation Process, Securing the Evidence and Crime Scene, Chain of Custody, Law Enforcement Methodologies, Forensics Evidence, Evidence Sources. Evidence Duplication, Preservation, Handling, and Security, Forensics Soundness, Order of Volatility of Evidence, Collection of Evidence on a Live System, Court Admissibility of Volatile Evidence.

Unit 2
Acquisition and duplication: Sterilizing Evidence Media, Acquiring Forensics Images, Acquiring Live Volatile Data, Data Analysis, Metadata Extraction, File System Analysis, Performing Searches, Recovering Deleted, Encrypted, and Hidden files, Internet Forensics, Reconstructing Past Internet Activities and Events, E-mail Analysis, Messenger Analysis: AOL, Yahoo, MSN, and Chat.

Unit 3

Mobile Device Forensics: Evidence in Cell Phone, PDA, Blackberry, iPhone, iPod, and MP3. Evidence in CD, DVD, Tape Drive, USB, Flash Memory, Digital Camera, Court Testimony, Testifying in Court, Expert Witness Testimony, Evidence Admissibility.

Text Book(s)

Prosise C, Mandia K, Pepe M. Incident response & computer forensics;2014.

Reference(s)

Jones KJ, Bejtlich R, Rose CW. Real digital forensics: computer security and incident response. Addison-Wesley; 2005.

Sammons J. The basics of digital forensics: the primer for getting started in digital forensics. Elsevier; 2012. McClure S, Scambray J, Kurtz G, Kurtz. Hacking exposed: network security secrets and solutions;2005.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE335	ETHICAL HACKING	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19MAT115 Discrete Mathematics, 19CSE102 Computer Programming, **19CSE331** Cryptography

Course Objectives

- This course introduces the concepts of Ethical Hacking and gives opportunity to learn about different tools and techniques in Ethical hacking and security.

Course Outcomes

CO1: Understand and apply the core concepts related to malware and software vulnerabilities and their causes
CO2: Appreciate the Cyber Laws and ethics behind hacking and vulnerability disclosure
CO3: Exploit the vulnerabilities related to data and storage systems using state of the art tools and technologies
CO4: Exploit the vulnerabilities related to computer system and networks using state of the art tools and technologies

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1										3	2
CO2	1	2	2	1									3	2
CO3	1	2	2	2	2			2					3	2
CO4	3	3	2	2	2	2		2					3	2

Syllabus

Unit 1
Introduction: Understanding the importance of security, Concept of ethical hacking and essential Terminologies- Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit.

Unit 2
Phases involved in hacking: Foot printing, Scanning, System Hacking, Session Hijacking. Buffer Overflows: Significance of Buffer Overflow Vulnerability, Why Programs/Applications are vulnerable. Reasons for Buffer Overflow Attacks. Methods of ensuring that buffer overflows are trapped. Sniffers: Active and passive sniffing. ARP poisoning and countermeasures. Man in the middle attacks, Spoofing and Sniffing attacks. Sniffing countermeasures. SQL Injection: Attacking SQL Servers, Sniffing, Brute Forcing and finding Application Configuration Files, Input validation attacks. Preventive Measures. Web Application Threats, Web Application Hacking, Cross Site Scripting / XSS Flaws / Countermeasures Correct Web Application Set-up.

Unit 3
Web Application Security: Core Defence Mechanisms. Handling User Access, Authentication, Session Management, Access Control. Web Application Technologies: HTTP Protocol, Requests, Responses and Methods. Encoding schemes. Server side functionality technologies (Java, ASP, PHP). Attacking Authentication: Attacking Session Management, Design Flaws in Authentication Mechanisms Attacking Forgotten Password Functionality, attacking Password change functions. Countermeasures to authentication attacks. Attacking other users: Reflected XSS

Vulnerabilities, Stored XSS Vulnerabilities, DOM-Based XSS Vulnerabilities, HTTP Header Injection. Countermeasures to XSS.

Text Book(s)

Patrick Engebretson. The Basics of Hacking and Penetration Testing, Elsevier; 2013.
Graves K. Ceh: Official certified ethical hacker review guide: Exam 312-50. John Wiley & Sons; 2007..

Reference(s)

Ali S, Heriyanto T. BackTrack 4: Assuring Security by Penetration Testing: Master the Art of Penetration Testing with BackTrack. Packt Publishing Ltd; 2011 Apr 14.
Khare R. Network Security and Ethical Hacking. Luniver Press; 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE336	DIGITAL CURRENCY PROGRAMMING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE102 Computer Programming, **19CSE331** Cryptography, 19CSE332 Information Security

Course Objectives

- This course examines the foundations of Blockchain technology from multiple perspectives. It is designed to provide students with an understanding of key concepts and developments around cryptocurrencies and distributed ledger systems.

Course Outcomes

CO1: Understand the concepts of cryptocurrency, blockchain, and distributed ledger technologies
CO2: Analyze the application and impact of blockchain technology in the financial industry and other industries
CO3: Evaluate security issues relating to blockchain and cryptocurrency
CO4: Design and analyse the impact of blockchain technology

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1										3	2
CO2	3	3	3										3	2
CO3	3	3	3	3	2			2					3	2
CO4	3	3	3	2	3			2					3	2

Syllabus

Unit 1

The story of a transaction: From Transactions to Blocks -Blocks and Distributed Consensus - Basic interaction with a Bitcoin node. Keys and Addresses: Basic cryptography - From private keys to addresses. The Bitcoin Script language : Introduction to the Bitcoin Script language - Script writing and execution -Tools and libraries to access Bitcoin's API and scripting capabilities.

Unit 2

Blockchain deployment: Mining and forking - Upgrading the network - Related BIPs - Segregated Witness (SegWit). Blockchain architectures: Abstract Architecture - Ways to dive deeper - Introduction to major blockchain platforms.

Unit 3

Smart contracts and Ethereum: Technical introduction to smart contracts – Ethereum overview - Web3 proposition for a decentralized internet - Using Ethereum sub-protocols, storage and ways of interacting with the external world. Comparing Bitcoin and Ethereum - Historical comparison - Conceptual distinction between a payment system and a decentralized applications platform - Differences in their architectures from security-first aspect to a rich feature set - Future roadmap for them, following their own paths with probable interconnections. Contract code walk-through: Demonstration of smart contract -Introduction to Solidity - Contract lifecycle - Solidity Building blocks - Popular contracts already in deployment.

Text Book(s)

Narayanan A, Bonneau J, Felten E, Miller A, Goldfeder S. Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton University Press; 2016 Jul 19.

Reference(s)

Antonopoulos AM. Mastering Bitcoin: unlocking digital cryptocurrencies. " O'Reilly Media, Inc."; 2014 Dec 3.
Mougayar W. The business blockchain: promise, practice, and application of the next Internet technology. John Wiley & Sons; 2016 May 9.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE337	SOCIAL NETWORKING SECURITY	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE102 Computer Programming, 19CSE331 Cryptography, 19CSE332 Information Security

Course Objectives

- This course will examine several topics in social media analysis, including social network analysis, information flow and learning from tagging, and show how AI, linguistic and statistical methods can be used to study these topics.

Course Outcomes

CO1: Understand the Graph theoretic concepts of Social Networks
CO2: Apply network concepts to generate hypotheses and inferences about social dynamics, formation of relationships, spread of information, and transfer of resources through social networks
CO3: Critically examine literature on applications of SNA to a research domain, synthesizing diverse theoretical approaches and methodologies to identify new opportunities for innovative research
CO4: Analyse social network data and identify possible security flaws

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1		2								3	2
CO2	2	2	3	2	3								3	2
CO3	3	3	3	2		2		2					3	2
CO4	3	3	3	2	3	2		2					3	2

Syllabus

Unit 1
Introduction to Biological, Social, Economic and Communication Networks - Historical developments in computer science, culminating now in ubiquitous social-technological networks.

Unit 2
Graph Theory and Evolving Social Networks: Nodes, Edges, Adjacency matrix, One and Two-Mode Networks, Node Degree). Network centrality: Betweenness, Closeness, Eigenvector centrality (PageRank), Network centralization. Community: Clustering, Community Structure, Modularity, Overlapping communities. Contagion, opinion formation, coordination and cooperation: Simple contagion, Threshold models, Opinion formation, Unusual applications of SNA.

Unit 3
SNA and online social networks: Services such as Facebook, LinkedIn, Twitter, Couch Surfing, etc. Help to understand users and security risks and understand providing security solutions, Data collection from social networks (API's).

Text Book(s)

Scott J, Carrington PJ. The SAGE handbook of social network analysis. SAGE publications; 2011 May 25.
Patrick Doreian, Frans Stokman.Evolution of Social Networks, Routledge;2013.

Reference(s)

De Nooy W, Mrvar A, Batagelj V. Exploratory social network analysis with Pajek: Revised and expanded edition for updated software. Cambridge University Press; 2018 Jul 19.
Easley D, Kleinberg J. Networks, crowds, and markets: Reasoning about a highly connected world. Significance; 2010.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE338	MOBILE AND WIRELESS SECURITY	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE301 Computer Networks, 19CSE332 Information Security

Course Objectives

- The focus of this course is to enable students to understand the aspects of information and network security that arise in this challenging and ever-evolving space of mobile communication systems
- The topics covered includes mobile/cellular telephony, and wireless network with physical layer considerations.

Course Outcomes

CO1: Understand relevant aspects of information security in mobile and wireless networks
CO2: Understand the physical layer security mechanisms and protocols in wireless communication
CO3: Understand the authentication and key transport protocol mechanisms used in wireless network security
CO4: Understand security issues and provide solutions for practical wireless systems

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	3	3	3	2	2		2				2	2	1
CO3	3	2	3	3	2	2		2				2	2	1
CO4	3	3	3	3	2	2		2				2	2	1

Syllabus

Unit 1
Fundamentals of Physical layer security – Information theoretic secrecy metrics – channel models - Secret Communication - Coding for Security - Asymptotic Analysis - Key 20 Generation from wireless channels Key agreement techniques.

Unit 2
Secrecy with Feedback - Achieving Secrecy through Discussion and Jamming. MIMO Signal Processing Algorithms for Enhanced Physical Layer Security - Secrecy Performance Metrics.

Unit 3
Physical Layer Security in OFDMA Networks -Power Allocation Law for Secrecy - Multiple Eavesdroppers. Resource Allocation for Physical Layer Security in OFDMA Networks- Application of Cooperative Transmissions to Secrecy Communications - Stochastic Geometry Approaches to Secrecy in Large Wireless Networks.

Text Book(s)

Zhou X, Song L, Zhang Y. Physical layer security in wireless communications. Crc Press; 2013.

Reference(s)

Chen L, Gong G. Communication system security. Chapman and Hall/CRC; 2012 May 29.
Edney J, Arbaugh WA. Real 802.11 security: Wi-Fi protected access and 802.11 i. Addison-Wesley Professional; 2004.
Chaouchi H, Laurent-Maknavicius M. Wireless and Mobile Networks Security. John Wiley & Sons; 2009.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electives in Networks

19CSE339	WIRELESS SENSOR NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE301 Computer Networks

Course Objectives

- This course introduces the features of Wireless Sensor Networks and their architecture.
- The protocols of MAC and Network layer are discussed in detail.
- The course emphasizes on localization and positioning scheme for real time applications.

Course Outcomes

CO1: Understand the basic features of Wireless Sensor networks
CO2: Understand and apply the features of different Wireless sensor Architectures for real world scenarios.
CO3: Understand and apply the protocols of MAC and Network layer for real world Wireless sensor networks
CO4: Understand and Apply Localization and Positioning schemes
CO5: Design Wireless sensor network for Real time Applications

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	3	3	3	2	2	2	2	2	2	2		3	2
CO3	3	3	3	3	3	2	2	2	2	2	2		3	2
CO4	3	2	3	2	2	2	2	2	2	2	2		3	2
CO5	3	3	3	3	3	2	2	2	2	2	2		3	2

Syllabus

Unit 1
Overview of WSN: Introduction, Applications, Unique Constraints and challenges. Platforms for WSN: Sensor Node Hardwares (Introduction): Mica2, TelosB, Cricket, i-Mote2, TMote, BTnode, Wasp mote, Comparisons of these based on the specifications. Sensor Node Software's (Introduction): TinyOS and Contiki .Programming Tools: C, nesC. Single node architecture – Energy consumption of sensor nodes.

Unit 2
Network Architecture – Sensor network scenario-Design principles of WSN-Physical layer and transceiver design considerations in WSNs.MAC Protocols: Fundamentals of MAC protocols, Low Duty cycle Protocols and wake up concepts: SMAC, STEM, Contention Based Protocols: CSMA, PAMAS, Scheduling based Protocols: LEACH, SMACS, TRAMA.

Unit 3

Routing: Gossiping and agent –based unicast forwarding – Energy efficient unicast – Broadcast and multicast – geographic routing -. Localization and Positioning: GPS based localization; Event Driven Localization- Overview of data aggregation -Wireless Sensor Network for Specific use case.

Text Book(s)

Karl H, Willig A. Protocols and architectures for Wireless Sensor Networks. John Wiley & Sons; 2005.

Reference(s)

Dargie W, Poellabauer C. Fundamentals of Wireless Sensor Networks: theory and practice. John Wiley & Sons; 2010 Nov 5.

Zhao F, Guibas LJ, Guibas L. Wireless Sensor Networks: an information processing approach. Morgan Kaufmann; 2004 Jul 20.

Anna Hac. Wireless Sensor Networks Designs, John Wiley and Sons; 2004.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE340	ADVANCED COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE301 Computer Networks

Course Objectives

- This course focuses on advanced networking concepts for next generation network architecture and design
- It covers SDN and virtualization for designing next generation networks

Course Outcomes

CO1: Understand advanced concepts and next generation networks
CO2: Analyze TCP/IP variants, network Algorithm's, Protocols and their functionalities
CO3: Comprehend features of SDN and its application to next generation systems
CO4: Analyze the performance of various server implementations

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2		2	2						3	2
CO2	3	3	2	2	3			2					3	2
CO3	2	2	2		3	2	2	2					3	2
CO4	3	3	2	2	3	2	2	2					3	2

Syllabus

Unit 1
Overview of data communication model - Internet Multicasting, NAT, VPN - Routing Algorithms - BGP, RIP, OSPF – Differentiated and Integrated Services - SONET, ATM – MPLS -Next generation Internet architectures, Green Communication Networks, and Data Center Networking.

Unit 2
Analysis of Network congestion Mechanism, Routing algorithms, ARQ protocols Multimedia Networking; Implementation of multi-threaded Web Server/Web Proxy with Caching/Filtering features, Sliding Window protocol implementation, performance study of various TCP/IP variants.

Unit 3
Software Defined Network -Comparison between SDN and traditional networks -SDN controller, Switch design, SDN Controller-Switch Protocols, Open Flow Protocol, Control Overhead & Handoff algorithms. Network Function Virtualization -NFV Architecture, Use cases, NFV Orchestration and NFV for 5G.

Text Book(s)
Tanenbaum AS, Wetherall DJ. Computer Networks. Fifth edition, Pearson Education, Inc. 2011.

Reference(s)

Stallings W. Data and Computer Communications. Pearson Education India; 2006.
Douglas E Comer. Internet Working with TCP/IP Volume -1, Sixth Edition, Addison-Wesley Professional;2013.
Goransson P, Black C, Culver T. Software Defined Networks: a Comprehensive Approach. Morgan Kaufmann; 2014.
Chayapathi R, Hassan SF, Shah P. Network Functions Virtualization (NFV) with a Touch of SDN: Netw Fun Vir (NFV ePub_1. Addison-Wesley Professional; 2016 Nov 14.
Marschke D, Doyle J, Moyer P. Software Defined Networking (SDN): Anatomy of OpenFlow Volume 1. 2015.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE341	MOBILE AD HOC NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE301 Computer Networks

Course Objectives

- This course provides fundamentals of mobile Adhoc and Mesh networks.
- This enables students to comprehend energy management schemes and understand routing protocols.
- This course also focusses on imparting necessary skills to build real-time Adhoc system and analyze QoS metrics.

Course Outcomes

CO1: Understand the foundations of Adhoc and Mesh networks
CO2: Analyze MAC and transport protocols of Adhoc Networks
CO3: Analyze routing protocols of Adhoc Networks
CO4: Comprehend various Energy management Schemes and security aspects
CO5: Analyze QOS metrics of Adhoc system

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	3	3	3	2								3	2
CO3	3	3	3	3	2								3	2
CO4	3	2		2									3	2
CO5	3	3	3	3	2				2	2			3	2

Syllabus

Unit 1
Introduction : Cellular and Ad Hoc wireless networks, Applications of ad hoc wireless networks. Issues in ad hoc wireless networks-medium access scheme, routing, transport layer protocols, security and energy management. Adhoc wireless internet. Design goals of a MAC protocol, Contention based protocols; Contention based protocols with reservation mechanisms and scheduling mechanisms.

Unit 2
Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing protocols, Tree based and mesh based multicast routing protocols.

Unit 3

Energy Management Schemes - Battery management, transmission power management, system power management schemes. Necessity for Mesh Networks- Heterogeneous meshes Networks – Vehicular Mesh Networks- Quality of Service solutions in ad hoc wireless networks.

Text Book(s)

Murthy CS, Manoj BS. Adhoc Wireless Networks: Architectures and Protocols. First Edition, Pearson Education India; 2006.

Reference(s)

Xiuzhen Cheng, Xiao Huang ,Ding Zhu DU.Ad hoc wireless networking. Kluwer Academic Publishers;2004.
Aggelou G. Mobile ad hoc networks: from wireless LANs to 4G networks. McGraw-Hill Professional; 2005
Basagni S, Conti M, Giordano S, Stojmenovic I, editors. Mobile ad hoc networking. John Wiley & Sons; 2004.
Perkins CE. Ad hoc networking. Reading: Addison-wesley; 2001.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE342	WIRELESS AND MOBILE COMMUNICATION	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE301 Computer Networks

Course Objectives

- This course provides an overview on the dynamics of wireless environment and means of communication across heterogeneous networks.

Course Outcomes

CO1: Understand the principles of mobile and wireless systems
CO2: Understand multiple access schemes of wireless and mobile networks
CO3: Analyze the working of various transport layer protocols in heterogeneous networks
CO4: Analyze routing aspects of mobile hosts in wireless systems

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2		2	2	2					3	2
CO2	3	2		2			2	2		2			3	2
CO3	3	2	3	2	3								3	2
CO4	3	2	3	2	3	2	2			2			3	2
CO5	3	3	3	3	2								3	2

Syllabus

Unit 1
Introduction to wireless communications: Evolution of mobile radio communications. Cellular telephone system, Modern wireless communication systems: 2G, 3G, 4G wireless system and standards, Bluetooth and wireless personal area networks. Basic wireless propagation mechanisms-Reflection, diffraction and scattering.

Unit 2
Digital Cellular Transmission, Spread Spectrum , Multiple Access techniques - frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), space division multiple access (SDMA), Diversity and multiplexing -Time diversity, frequency diversity and space diversity, Evolution of wireless LAN, IEEE802.11,physical layer, MAC sub-layer, CSMA/CA, Adhoc networks: Characteristics – performance issues.

Unit 3

Cellular Concept: Frequency reuse, channel assignment strategies, handoff strategies, improving coverage and capacity in cellular systems, routing in mobile hosts. Mobile IP – DHCP – Mobile transport layer – Indirect TCP – Snooping TCP – Transmission/time-out freezing – selective retransmission –Transaction oriented TCP.

Text Book(s)

Stallings W. Wireless Communications & Networks. Pearson Education India; 2009.

Reference(s)

Jochen.S. Mobile Communications, Pearson Education Limited;2004.

Lee W C Y. Wireless and Cellular Communications, Third Edition, Tata McGraw Hill Publishing Company Limited; 2006.

Rappaport T.S. Wireless Communication: Principles and Practice, Second Edition, Pearson Education;2009.

Pahlavan K, Krishnamurthy P. Networking Fundamentals: Wide, Local and Personal Area Communications. John Wiley & Sons; 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electives in Data Science

19CSE351	COMPUTATIONAL STATISTICS AND INFERENCE THEORY	L-T-P-C: 3-0-0-3

Course Objectives

- This course focuses on applying probability and inferential statistics knowledge for data analysis
- The methods of computational statistics taught in this course provide assistance ranging from preliminary exploratory data analysis to sophisticated probability density estimation techniques, Monte Carlo methods, and powerful multi-dimensional visualization.

Course Outcomes

CO1: Apply probability and inferential statistics knowledge for Exploratory Data Analysis.
CO2: Analyse and form representative models for the given dataset.
CO3: Apply feature extraction methods and design a solution for a classification problem employing Regression and Decision trees and its variants.
CO4: Apply knowledge of A-Priori algorithm to implement Market Basket Analysis.

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2		2		2	2	2		2	3	2
CO2	3	3	2	2	3	2		3	3	3		2	3	2
CO3	2	3	3	2	2	2		3	3	3		2	3	2
CO4	2	2	2	2	2	1		2	2	2		1	3	2

Syllabus

Unit 1
Computational Statistics- Probability concepts, Sampling Concepts, Generating Random Variables, Exploratory Data Analysis, Monte Carlo Methods for Inferential Statistics, Data Partitioning, Probability Density Estimation, Statistical Pattern Recognition, Nonparametric Regression.

Unit 2
Data Mining- data mining algorithms-Instance and Features, Types of Features (data), Concept Learning and Concept Description, Output of data mining Knowledge Representation; Decision Trees- Classification and Regression trees constructing.

Unit 3
Classification trees, Algorithm for Normal Attributes, Information Theory and Information. Entropy, Building tree, Highly-Branching Attributes, ID3 to c4.5, CHAID, CART, Regression Trees, Model Trees, Pruning. Preprocessing and Post processing in data mining – Steps in Preprocessing, Discretization, Manual Approach, Binning, Entropy-based Discretization, Gaussian Approximation, K-tile method, Chi Merge, Feature extraction, selection and construction, Feature extraction, Algorithms, Feature selection, Feature construction, Missing Data, Post processing.

Association Rule Mining- The Apriori Algorithm. Multiple Regression Analysis, Logistic Regression, k- Nearest Neighbor Classification, Constructing new attributes for algorithms of decision trees. Induction, Quick, Unbiased and Efficient Statistical tree.

Text Books:

Wendy L. Martinez and Angel R.Martinez Computational Statistics,Chapman &Hall/CRC;2002.
Han J, Kamber M, Mining D. Concepts and techniques. Morgan Kaufmann;2001.

Reference Books:

Witten IH, Frank E, Hall MA, Pal CJ. Data Mining: Practical machine learning tools and techniques. Morgan Kaufmann; 2016.
Soman KP, Diwakar S, Ajay V. Data mining: theory and practice. PHI Learning Pvt. Ltd.; 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE352	BUSINESS ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- The course presents an applied approach to data mining concepts and methods, using Python software for illustration.
- Students will learn how to implement a variety of popular data mining algorithms to tackle business problems and opportunities.
- It covers both statistical and machine learning algorithms for prediction, classification, visualization, dimension reduction, recommender systems, clustering, text mining and network analysis.

Course Outcomes

CO1: Apply data mining processes, visualize data spread, employ various techniques of data reduction such as PCA build predictive models, and evaluate the models
CO2: Apply feature extraction techniques and design a solution for a classification problem employing Regression, NB Classifier and Decision trees and its variants
CO3: Apply ARIMA and other forecasting methods in business
CO4: Implement Data Analytics on social networks
CO5: Apply knowledge of text representation for extraction and display of embedded information

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3	1			3	2	1		3	2
CO2	3		3			2		1	3	2	2		3	2
CO3	3		3	3	2	2		1	3	3	2		3	2
CO4	3	1	2		2	2		3	3	3	2		3	2
CO5	3	2				2		3	2	3	2		3	2

Syllabus

Unit 1
Introduction - Overview of the Data Mining Process - The Steps in Data Mining - Preliminary Steps - Predictive Power and Over fitting - Building a Predictive Model - Data Exploration and Dimension Reduction - Data Visualization - Dimension Reduction - Correlation Analysis - Reducing the Number of Categories in Categorical Variables - Converting a Categorical Variable to a Numerical Variable -Principal Components Analysis - Performance Evaluation - Evaluating Predictive Performance - Judging Classifier Performance.

Unit 2

Prediction and Classification Methods - Multiple Linear Regression - Explanatory vs. Predictive Modeling - Estimating the Regression Equation and Prediction - The k-NN Classifier (Categorical Outcome) - The Naive Bayes Classifier - Classification and Regression Trees - Evaluating the Performance of a Classification Tree - Avoiding Overfitting - Logistic Regression - Neural Nets - Fitting a Network to Data - Discriminant Analysis - Classification Performance of Discriminant Analysis - Combining Methods: Ensembles and Uplift Modeling - Association Rules and Collaborative Filtering - Cluster Analysis - Measuring Distance - Hierarchical (Agglomerative) Clustering - The k-Means Algorithm.

Unit 3

Forecasting Time Series - Descriptive vs. Predictive Modeling. Popular Forecasting Methods in Business - Regression-Based Forecasting - A Model with Trend - A Model with Seasonality - A Model with Trend and Seasonality - Autocorrelation and ARIMA Models - Smoothing Methods - Introduction - Moving Average - Simple Exponential Smoothing – Data Analytics - Social Network Analytics - Directed vs. Undirected Networks - Visualizing and Analyzing Networks - Using Network Metrics in Prediction and Classification -Text Mining - The Tabular Representation of Text: Term-Document Matrix and "Bag-of-Words" - Bag-of-Words vs. Meaning Extraction at Document Level - Preprocessing the Text - Implementing Data Mining Methods-Case Studies.

Text Book(s)

Shmueli G, Bruce PC, Yahav I, Patel NR, Lichtendahl Jr KC. Data mining for business analytics: concepts, techniques, and applications in R. John Wiley & Sons; 2017.

Reference(s)

VanderPlas J. Python data science handbook: essential tools for working with data. " O'Reilly Media, Inc."; 2016.
McKinney W. Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc."; 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE353	MINING OF MASSIVE DATASETS	L-T-P-C: 3-0-0-3

Course Objectives

- This course exposes the learner to meet industry requirements to handle large data.
- It will expose students to big data systems such as Hadoop, Spark and Hive
- This course will help students understand on the design of large scale machine learning algorithms

Course Outcomes

CO1: Understand the importance of data to business decisions, strategy and behavior. Predictive analytics, data mining and machine learning as tools give new methods for analyzing massive data sets.
CO2: Expose the students to Big data systems like Hadoop, Spark and Hive.
CO3: Explore means to deal with huge document databases and infinite streams of data to mining large social networks and web graphs. Also, learn Algorithms suitable for large scale mining.
CO4: Use of analytic tools, case-studies to provide first hand insight into how big-data problems and their solutions are commercially derived.
CO5: Design Large Scale Machine Learning algorithms with Practical hands-on experience for analyzing very large amounts of data.

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1											3	2
CO2	2				3				3	2			3	2
CO3	2		3	3	2				3	3			3	2
CO4	2	1	2		2						3		3	2
CO5	3	2	3		3				3			2	3	2

Syllabus

Unit 1
Concept of Machine Learning: Approaches to Modelling- Importance of Words in Documents - Hash Functions- Indexes - Secondary Storage -The Base of Natural Logarithms - Power Laws - MapReduce. Finding similar items: Shingling – LSH - Distance Measures. Mining Data Streams: Stream data model -Sampling data - Filtering streams. Link Analysis: Page Rank, Link Spam.

Unit 2
Frequent Item Sets: Market Basket Analysis, A-Priori Algorithm - PCY Algorithm, Clustering: Hierarchical clustering, K-Means, Clustering in Non-Euclidean Spaces, BFR, CURE. Recommendation Systems: Utility matrix - Content based - Collaborative filtering -UV Decomposition. Mining Social Network Graphs: Social networks as graphs–Clustering – Partitioning-Simrank. Dimensionality Reduction: Eigen Value Decomposition-PCA - SVD.

Unit 3

Large Scale Machine Learning: Neural Networks - The Support Vector Machines model and use of Kernels to produce separable data and non-linear classification boundaries. Overview - Deep learning; Tools for Data Ingestion; analytics and visualization.

Text Book(s)

Leskovec J, Rajaraman A, Ullman JD. Mining of massive datasets. Cambridge university press; 2014.

Reference(s)

Kevin PM. Machine Learning: A Probabilistic Perspective;2012.
Mitchell TM, Learning M. Mcgraw-hill science. Engineering/Math;1997.
Harrington P. Machine Learning in Action. Manning Publications Co.; 2012.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE354	WEB MINING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE305 Machine Learning, 19CSE304 Foundations of data Science, 19CSE352 Business Analytics

Course Objectives

- This course serves as an excellent introduction to web mining using different data mining/ML techniques
- The course enables the students to apply different tools and techniques to discover patterns hidden from innumerable webpages in terms of its structure, usage and content so as to design and build more intelligent applications for site management, automatic personalization, recommendation, and user profiling.

Course Outcomes

CO1: Understand the scope of Web mining, identifying the opportunities and the challenges
CO2: Learn to apply different data mining/ML techniques in web mining
CO3: Learn graph based representation of WWW
CO4: Understand techniques for web crawling for web contents to build useful statistics like page ranking

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										2	3	2
CO2	2	2	3	1				2					3	2
CO3	2	2	2				2					2	3	2
CO4	3	2	2	1	3			2				2	3	2
CO5	3	2	2	1	1	2							3	2

Syllabus

Unit 1
World Wide Web – Data Mining Vs Web Mining – Data Mining Foundations: Association rules and Sequential Patterns – Machine Learning in Data Mining, Web Mining: Web Structure Mining, Web Content Mining, and Web Usage Mining. Web Structure Mining: Web Graph - Extracting pattern from hyperlinks – Mining Document Structure – PageRank.

Unit 2
Web Content Mining: Text and Web Page Pre-processing – Inverted Indices – Latent Semantic Indexing – Web Spamming – Social Network Analysis – Web Crawlers – Structured Data Extraction – Opinion mining and Sentiment Analysis.

Unit 3
Web usage Mining: Data collection and Pre-processing – Data Modelling – Discovery and Analysis of Web Usage – Recommender System and Collaborative Filtering – Query log mining.

Text Book(s)

Liu B. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data. Springer Science & Business Media; 2007.

Reference(s)

Markov Z, Larose DT. Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage. John Wiley & Sons; 2007.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE355	TIME SERIES ANALYSIS AND FORECASTING	L-T-P-C: 2-0-3-3

Pre-Requisite(s): 19MAT205 Probability and Random Processes

Course Objectives

- This course introduces the principles and methods of forecasting.
- Various components of time series and time series models are introduced catering to the real world applications. Criteria used for performance evaluation are discussed.
- This course addresses both the aspects of descriptive and predictive analytics.

Course Outcomes

CO1: Understand the principles and process of forecasting
CO2: Apply and analyze Univariate ARIMA methods for real world problems
CO3: Apply and analyze Smoothing methods for real world problems
CO4: Apply various criteria for evaluating model quality
CO5: Apply and analyze multivariate methods for real world problems

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3		3				3	3			3	2
CO2	2		3										3	2
CO3	2		3	3	2				3	3			3	2
CO4	2	1	2		2	2	2						3	2
CO5	3	2				2	2						3	2

Syllabus

Unit 1

Planning and Forecasting – Forecasting process – Time Series patterns – Statistical fundamentals for forecasting – Descriptive statistics - Measuring errors – Correlation and Covariance – Autocorrelations – Linear Regression analysis – Dependent and independent variables - Method of least square deviations – Durbin-Watson Statistic – Univariate methods

Unit 2

Univariate ARIMA methods – ARIMA model identification – Time series examples – Integrated Stochastic process – Backward shift operator - Autoregressive processes – Yule-Walker equations - ARIMA prediction intervals - Multiple Regression models – Serial correlation – Elasticities and Logarithmic relationships - Heteroscedasticity – Intervention functions – Nonstationary series – ARIMA intervention analysis

Unit 3

Smoothing methods – Decomposition methods – Trend-Seasonal and Holt-Winters smoothing - SARIMA processes - SARIMA fitting - Akaike Information Criterion and Model Quality – Schwarz Bayesian Information Criterion – Multivariate ARIMA modeling – Cyclical forecasting methods

Reference(s)

Galit Shmueli, Kenneth C. Lichtendahl Jr., Axelrod. Practical Time Series Forecasting with R: A Hands-On Guide, Second Edition, Schnall Publishers; 2016

Stephen A. Delurgio. Forecasting Principles and Applications, McGraw-Hill International Editions; 1998.

George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung. Time Series Analysis: Forecasting and Control, Wiley, Fifth Edition; 2015.

Terence C. Mills. The Foundations of Modern Time Series Analysis, Palgrave Macmillan; 2011.

Kerry Patterson. An Introduction to Applied Econometrics - A Time Series Approach, Macmillan Press Limited;2000.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE356	SOCIAL NETWORK ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- This course introduces the basic concept and structure of social networks and its implications
- This course covers topics including sentiment analysis, topic modeling and community identification in social networks

Course Outcomes

CO1: Understand the concept and structure of social networks and its implications
CO2: Understand the measures and metrics used in social networks and its computation
CO3: Explore social media data and analyze it
CO4: Understand the concepts of topic modelling and agent based simulations in social networks
CO5: Perform sentiment analysis of social network data using machine learning techniques
CO6: Community identification and link prediction in social networks based on graph processing techniques in Python

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1		2							3	2
CO2	3	2	1										3	2
CO3	2	1	2	2									3	2
CO4	3	3	1	1	2		2						3	2
CO5	2	3	3	3	3	2	2	2		2			3	2
CO6	3	2	2	2	3			2	2	2			3	2

Syllabus

Unit 1
Online Social Networks (OSNs) - Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data. Techniques to study different aspects of OSNs -- Follower-followee dynamics, link farming, spam detection, hashtag popularity and prediction, linguistic styles of tweets. Case Study: An Analysis of Demographic and Behaviour Trends using Social Media: Facebook, Twitter and Instagram.

Unit 2
Fundamentals of Social Data Analytics: Introduction - Working with Social Media Data, Topic Models, Modelling social interactions on the Web – Agent Based Simulations, Random Walks and variants, Case Study: Social Network Influence on Mode Choice and Carpooling during Special Events: The Case of Purdue Game Day.

Unit 3
Applied Social Data Analytics - Application of Topic models, Information Diffusion, Opinions and Sentiments - Mining, Analysis and Summarization, Case Study: Sentiment Analysis on a set of Movie Reviews using Deep

Learning techniques, Recommendation Systems, Language dynamics and influence in online communities, Community identification, link prediction and topical search in social networks, Case Study: The Interplay of Identity and Social Network: A Methodological and Empirical Study.

Reference(s)

Cioffi-Revilla C. Introduction to Computational Social Science. London and Heidelberg: Springer. 2014.
Russell MA. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More. " O'Reilly Media, Inc."; 2013
Hanneman RA, Riddle M. Introduction to Social Network Methods;2005.
Jennifer G. Analyzing the Social Web. Waltham, MA: Morgan. 2013.
Castellano C, Fortunato S, Loreto V. Statistical Physics of Social Dynamics. Reviews of Modern Physics. 2009 May 11.
Fortunato S, Castellano C. Word of Mouth and Universal Voting Behaviour in Proportional Elections. 2006.
Heckathorn DD. The Dynamics and Dilemmas of Collective Action. American Sociological Review. 1996.
Macy MW, Willer R. From Factors to Actors: Computational Sociology and Agent-based Modeling. Annual review of sociology. 2002.
Dey N, Borah S, Babo R, Ashour AS. Social Network Analytics: Computational Research Methods and Techniques. Academic Press; 2018.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE357	BIG DATA ANALYTICS	L-T-P-C: 2-0-3-3

Course Objectives

- The aim of this course is to provide depth knowledge about Big data Technologies and tools used for Big data.
- The students will learn to implement and work on tools to handle large volume of data in parallel and distributed environments. Retrieval and analysis of unstructured data are done using NOSQL databases.

Course Outcomes

CO1: Understand fundamental concepts of Big Data and its technologies
CO2: Apply concepts of MapReduce framework for optimization
CO3: Analyze appropriate NoSQL database techniques for storing and processing large volumes of structured and unstructured data
CO4: Apply data analytics solutions using Hadoop ecosystems
CO5: Explore modern reporting tools for Machine learning

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1							1			3	2
CO2	3	3	2	2	3	2	2	2	2	2			3	2
CO3	3	3	2	2	3	2	2	2	2	2			3	2
CO4	3	3	2	2	3	2	2	2	2	2			3	2
CO5	2			2	3		2	3	2	2			3	2

Syllabus

Unit 1
Introduction to Big Data: Types of Digital Data - Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data-3Vs of Big Data - Non Definitional traits of Big Data - Business Intelligence vs. Big Data - Data warehouse and Hadoop environment - Coexistence. Big Data Analytics: Classification of analytics - Data Science - Terminologies in Big Data - CAP Theorem - BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vs NewSQL. Introduction to Hadoop: Features – Advantages – Versions - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs. Hadoop - Hadoop Components – Architecture – HDFS - Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting - Compression. Hadoop 2 (YARN): Architecture - Interacting with Hadoop Eco systems.

Unit 2
No SQL databases: Mongo DB: Introduction – Features - Data types - Mongo DB Query language - CRUD operations – Arrays - Functions: Count – Sort – Limit – Skip – Aggregate - Map Reduce. Cursors – Indexes - Mongo Import –

Mongo Export. Cassandra: Introduction – Features - Data types – CQLSH - Key spaces - CRUD operations – Collections – Counter – TTL - Alter commands - Import and Export - Querying System tables.

Unit 3

Hadoop Eco systems: Hive – Architecture - data type - File format – HQL – SerDe - User defined functions - Pig: Features – Anatomy - Pig on Hadoop - Pig Philosophy - Pig Latin overview - Data types - Running pig - Execution modes of Pig - HDFS commands - Relational operators - Eval Functions - Complex data type - Piggy Bank - User defined Functions - Parameter substitution - Diagnostic operator. Jasper Report: Introduction - Connecting to Mongo DB - Connecting to Cassandra - Introduction to Machine learning: Linear Regression- Clustering - Collaborative filtering - Association rule mining - Decision tree.

Text Book(s)

Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, 2015.

Reference(s)

Hurwitz JS, Nugent A, Halper F, Kaufman M. Big data for dummies. John Wiley & Sons; 2013.
Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.
Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.
Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach ", Pearson Education, 2014.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electives in Computer Vision

19CSE431	DIGITAL IMAGE PROCESSING	L-T-P-C: 2-0-3-3

Course Objectives

- This course introduces the basics of image processing and explores the algorithms in spatial and frequency domain relevant to image enhancement, restoration and segmentation applications.
- This course introduces binary, gray scale and color image processing.

Course Outcomes

CO1: Understand fundamental principles of image processing and perform basic operations on pixels.
CO2: Apply the image processing algorithms and filters in spatial domain for image enhancement and restoration.
CO3: Analyze images in the frequency domain and explore the frequency domain filters for image enhancement and restoration.
CO4: Apply segmentation algorithms on Images and analyze their performance.
CO5: Apply morphological processing on images for simple image processing applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	2
CO2							2	2					3	2
CO3		3		2									3	2
CO4			3			2							3	2
CO5					3				2	2			3	2

Syllabus

Unit 1
Digital Image Fundamentals: Elements of Visual Perception- Image Sensing and Acquisition-Image Sampling and Quantization – Basic Relationships between Pixels - Image interpolation. Intensity Transformations and Spatial Filtering: Basic Intensity transformation Functions – Histogram Processing – Fundamentals of Spatial Filtering – Smoothing and Sharpening Spatial Filters.

Unit 2
Filtering in Frequency Domain: 2D Discrete Fourier Transforms - Basics of filtering - Image Smoothing and Image Sharpening Using Frequency Domain Filters - Selective Filtering, Image Restoration: Noise Models – Restoration using Spatial Filters – Periodic Noise Reduction by Frequency Domain Filters.

Unit 3
Morphological Image Processing: Erosion – Dilation – Opening – Closing – Hit-or-Miss Transform - Extraction of Connected Components. Image Segmentation: Fundamentals – Point, Line and Edge Detection – Thresholding-Region Based Segmentation – Region Growing – Region Splitting and Merging. Color image processing.

Text Book(s)
Gonzalez RC, Woods RE. Digital Image Processing. Third edition;2008.

Reference(s)

Pratt W K.Digital Image Processing, Fourth Edition, John Wiley & Sons;2007.
Castleman K R. Digital Image Processing, Prentice Hall;1996.
Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins. Digital Image Processing Using MATLAB®. Prentice Hall; 2004.
Russ JC, Russ JC. Introduction to Image Processing and Analysis. CRC press; 2007.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE432	PATTERN RECOGNITION	L-T-P-C: 3-0-0-3

Course Objectives

- The course introduces basic concepts of Pattern recognition and explores statistical pattern recognition algorithms.
- The course gives an overview of supervised and unsupervised learning techniques.

Course Outcomes

CO1: Understand basic concepts in pattern recognition.
CO2: Understand discriminant functions and apply them for applications.
CO3: Understand and apply Parametric techniques of Pattern recognition.
CO4: Apply Non parametric techniques of PR and analyze their performance.
CO5: Understand the supervised and unsupervised learning algorithms and apply them for real world problems

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1										3	2
CO2	3	2	2	1									3	2
CO3	3	2	2	1									3	2
CO4	3	3	3	2				3	3	3			3	2
CO5	2	3	3	2				3	3	3			3	2

Syllabus

Unit 1
Introduction: Machine perception – Pattern recognition systems – Design cycle – Learning and adaptation - Bayesian decision theory – discriminant functions – decision surfaces – normal density based discriminant functions -Maximum likelihood estimation – Bayesian estimation.

Unit 2
Bayesian parameter estimation – Gaussian case – problems of dimensionality - Components analysis and discriminants – hidden Markov models, Non-parametric Techniques: density estimation – parzen windows – nearest neighbourhood estimation – linear discriminant functions and decision surfaces – two category linearly separable case – perception criterion function.

Unit 3
Non-Metric Methods: decision trees – CART methods – algorithm independent machine learning - bias and variance – regression and classification - classifiers – Unsupervised learning and clustering – mixture densities and identifiably – hierarchical clustering – low dimensional representation – multidimensional scaling.

Text Book(s)
Duda RO, Hart PE, Stork DG. Pattern Classification. John Wiley & Sons; 2012.

Reference(s)

Gose E, Johnsonbaugh R and Jost S. Pattern Recognition and Image Analysis, Prentice Hall of India;2002.
Bishop CM. Pattern Recognition and Machine Learning. Springer; 2006.
Bishop CM. Neural Networks for Pattern Recognition. Oxford University Press; 1995.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE433	COMPUTER GRAPHICS AND VISUALIZATION	L-T-P-C: 2-0-3-3

Course Objectives

- This course aims at teaching students about computer graphic application and standard algorithms involved in 2D and 3D graphics.
- It gives a clear foundation of the graphic operations performed on 2D objects thereby enabling creation of animations.

Course Outcomes

CO1: Understand the working principles of I/O devices and lighting of objects.
CO2: Understand standard graphic design algorithms and generate 2D primitives for raster graphics.
CO3: Apply modeling algorithms to represent polygonal objects and surfaces.
CO4: Perform geometric transformations on objects.
CO5: Apply state-of-the-art algorithms to create view of objects and surfaces.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1											3	2
CO2	2	2	1										3	2
CO3	3	2	1										3	2
CO4	3	3	2										3	2
CO5	2	2	1										3	2

Syllabus

Unit 1
Computer graphics fundamentals –overview of CG: video displays –output primitives: points, lines –line drawing algorithms–circle generation algorithm- filled area primitives. Geometric transformations.

Unit 2
Three-dimensional (3D) object representation: geometrical transformation for 3D objects. Viewing and clipping: two-dimensional viewing clipping operations – three-dimensional viewing: viewing pipeline, viewing coordinates – projections: parallel projections, perspective projections.

Unit 3
Visible surface detection and illumination models: visible surface detection methods – illumination models and surface rendering – polygon rendering methods: constant intensity shading, Gouraud shading, Phong shading.– color models – computer animation.

Text Book(s)
Hearn D and Baker P. Computer Graphics Open GL Version, Second Edition, Prentice Hall of India; 2013.

Reference(s)
Plastook R A and Kalley G. Theory and Problems of Computer Graphics, Schaum's Outline Series, TMH;1985.
Foley J D D, Eiener S K and Hughes J.F. Computer Graphics Principles and Practice, Second Edition, Pearson Education;1996.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE434	IMAGE AND VIDEO ANALYSIS	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19CSE431 Digital image processing

Course Objectives

- This course covers the extraction, representation and analysis of Image features.
- It introduces basic video analysis techniques related to segmentation, object detection and tracking.

Course Outcomes

CO1: Understand the image features and apply algorithms to extract them.
CO2: Apply suitable representation for the features in the image.
CO3: Understand and implement algorithms for video segmentation.
CO4: Understand and apply the approaches for identifying and tracking objects with motion based algorithms.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3									2			3	2
CO2							2		2				3	2
CO3		2		2	3								3	2
CO4			2			3		2					3	2

Syllabus

Unit 1
Representation and Description: Region Identification – Contour Based and Region Based. Shape Representation and Description – Shape Classes. Harris corner detection, Invariance, blob detection, Flexible shape extraction: active contours, Flexible shape models: active shape and active appearance. Texture representation and analysis.

Unit 2
Video Segmentation and Keyframe Extraction. Motion estimation and Compensation- Motion Segmentation - Optical Flow Segmentation- Segmentation for Layered Video Representation. Background Modeling-Shadow Detection - Object Detection -Local Features-Mean Shift: Clustering.

Unit 3
Video object tracking: Template matching, Mean-shift tracking, Kalman and Particle Filters, Tracking by detection.

Text Book(s)
Sonka M, Hlavac V, Boyle R. Image processing, analysis, and machine vision. Cengage Learning; 2014 Jan 21.
Richard Szeliski. Computer Vision: Algorithms and Applications, Springer; 2011.

Reference(s)
A.MuratTekalp.Digital Video Processing, Pearson;1995.
Thierry Bouwmans, FatihPorikli, Benjamin Höferlin and Antoine Vacavant .Background Modeling and Foreground Detection for Video Surveillance: Traditional and Recent Approaches, Implementations, Benchmarking and Evaluation, CRC Press, Taylor and Francis Group; 2014.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE435	COMPUTER VISION	L-T-P-C: 3-0-0-3

Course Objectives

- This course introduces the geometry of image formation and its use for 3D reconstruction and calibration.
- It introduces the analysis of patterns in visual images that are used to reconstruct and understand the objects and scenes.

Course Outcomes

CO1: Understand image formation and camera calibration.
CO2: Analyze and select image features and apply for image matching.
CO3: Understand recognition algorithms through case studies.
CO4: Understand the basics of stereo vision.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2	2	1	1	1				3	2
CO2	3	3	2	3	3	3	2	1	2	1			3	2
CO3	3	3	3	3	3	3	2	3	3	3			3	2
CO4	3	3	1	2	3	2	1	1	1	1			3	2

Syllabus

Unit 1
Introduction, Image Formation – geometric primitives and transformations, photometric image formation, digital camera, Camera calibration.

Unit 2
Feature Detection and Matching – points and patches, edges, lines, Feature-Based Alignment - 2D, 3D feature-based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit 3
Recognition – object detection, face recognition, instance recognition, category recognition, Stereo Correspondence – Epipolar geometry, 3D reconstruction.

Text Book(s)
Szeliski R. Computer Vision: Algorithms and Applications Springer. New York. 2010.

Reference(s)
Shapiro LG, Stockman GC. Computer Vision: Theory and Applications. 2001.
Forsyth DA, Ponce J. Computer Vision: a modern approach;2012.
Davies ER. Machine vision: theory, algorithms, practicalities. Elsevier; 2004 Dec 22.
Jain R, Kasturi R, Schunck BG. Machine vision. New York: McGraw-Hill; 1995 Mar 1.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE436	MACHINE VISION	L-T-P-C: 3-0-0-3

Course Objectives

- The course focuses on the geometric aspects of computer vision. The objective of the course is to introduce multi-view Camera calibration
- This course explores algorithms relevant to multi camera object detection and tracking.

Course Outcomes

CO1: Understand image formation and camera calibration.
CO2: Analyze and select image features and apply for matching images and video.
CO3: Understand object detection algorithm and apply them to track from multiple views.
CO4: Understand and apply multi target tracking techniques in videos.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2		2	1	1	1	1				3	2
CO2	3	3	3	3	3	3	2	1	2	1			3	2
CO3	3	3	3	3	3	3	2	3	3	3			3	2
CO4	3	1	2	2	3	1	1	1	1	1			3	2

Syllabus

Unit 1
Introduction to projection, Fundamentals of Projective Geometry, Calibration of a single camera, Binocular vision, Pyramids and scale-space theory.

Unit 2
Detection, description and matching of reference points in images and video. Comparison and searching strategies for the matching of local descriptions, Photogrammetry.

Unit 3
Analysis in multi-camera scenarios-Calibration in camera networks, Motion Estimation from Multiple Views, Collaborative objects detection, Multi-target tracking.

Text Book(s)
Hartley R, Zisserman A. Multiple view geometry in computer vision. Cambridge university press; 2003.
T. Lindeberg.Scale-Space Theory, Kluwer Academic Publishers;1997.

Reference(s)
Awad A., Hassaballah M. (eds) Image Feature Detectors and Descriptors. Studies in Computational Intelligence, vol 630. Springer, Cham.
Javed O, Shah M. Automated multi-camera surveillance: algorithms and practice. Springer Science & Business Media; 2008.
Aghajan H, Cavallaro A, editors. Multi-camera networks: principles and applications. Academic press; 2009.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE437	DEEP LEARNING FOR COMPUTER VISION	L-T-P-C: 2-0-3-3

Course Objectives

- This course gives an exposure to neural networks and deep learning architectures
- This course focuses on implementing, training and debugging deep feedforward neural networks. This course enables the application of Convolutional neural networks and RNN for Images and image sequences.

Course Outcomes

CO1: Understand the architecture and parameters involved in deep neural nets.
CO2: Understand the design and usage of Convolutional Neural networks.
CO3: Understand and apply neural networks for sequential models.
CO4: Design Neural networks and implement for real time applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	2	3								3	2
CO2	2	3	3	3	3								3	2
CO3	2	3	3	2	3			3	3	3	2		3	2
CO4	2	3	3	3	3			3	3	3	2		3	2

Syllabus

Unit 1
Deep Feedforward Networks Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms Dataset Augmentation, Noise Robustness Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training.

Unit 2
Convolutional Networks the Convolution Operation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features.

Unit 3
Sequence Modeling: Recurrent and Recursive Nets Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory.

Text Book(s)
Goodfellow I, Bengio Y, Courville A. Deep learning. MIT press; 2016.
Patterson J, Gibson A. Deep learning: A practitioner's approach. " O'Reilly Media, Inc."; 2017.

Reference(s)

Chollet F. Deep Learning mit Python und Keras: Das Praxis-Handbuch vom Entwickler der Keras-Bibliothek. MITP-Verlags GmbH & Co. KG; 2018.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE438	MEDICAL IMAGE PROCESSING	L-T-P-C:2-0-3-3

Pre-Requisite(s):19CSE431 Digital image processing

Course Objectives

- The course introduces various modalities of medical imaging and covers image processing algorithms specific for medical imaging such as registration and fusion.

Course Outcomes

CO1: Understand various medical imaging modalities.
CO2: Understand the image registration techniques and Apply for the medical images.
CO3: Understand the algorithms used for image fusion and apply for medical images.
CO4: Apply image processing algorithms to medical images and analyze the performance.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		2									3	2
CO2	3	2	2	1	2			2	3				3	2
CO3	3	2	3	1	2			2	3				3	2
CO4	3	3	3	1	2			2	3				3	2

Syllabus

Unit 1
Basics of Medical Image Source, Medical Image Representation, Image Quality and Information Content, Operations In Intensity Space, Registration.

Unit 2
Image Fusion, Analysis of Texture, Analysis of Oriented Patterns, Image Reconstruction from Projections.

Unit 3
Removal of Artifacts, Image Enhancement, Detection of Regions of Interest, Deconvolution, Deblurring, And Restoration; Analysis Of Shape-Applications In Medical Images.

Text Book(s)
Birkfellner W. Applied medical image processing: a basic course. CRC Press; 2016.

Reference(s)
Rangaraj M. Rangayyan.Biomedical Image Analysis,First Edition,CRC Press;2004.
Jan J. Medical image processing, reconstruction and restoration: concepts and methods. Crc Press; 2005.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE439	AUGMENTED AND VIRTUAL REALITY	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE433 Computer Graphics and Visualization

Course Objectives

- This course introduces basic concepts in augmented and virtual reality.
- The course exposes the students to hardware used for AR/VR, animation algorithms that could be combined with VR applications.

Course Outcomes
CO1: Understand the working principles of AR/VR input and output devices.
CO2: Understand the software used for interacting with the devices.
CO3: Understand the animation algorithms used for virtual reality.
CO4: Understand the applications of AR/VR and factors involved in the usage.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1										3	2
CO2	3	3	2	3	2								3	2
CO3	3	3	2	3	1				1				3	2
CO4	2	1	2			1	2	2	2	2			3	2

Syllabus

Unit 1
Introduction to Augmented and Virtual Reality, Understanding Virtual Space, Understanding the Human Senses and their Relationship to Output / Input Devices: Component Technologies of Head-Mounted, Augmenting Displays, Binocular Augmenting Displays, Monocular Augmenting Displays, Fully Immersive Displays. Audio Displays, Tactile and Force Feedback Devices, Sensors for Tracking Position, Orientation, and Motion, Devices to Enable Navigation and Interaction.

Unit 2
Animation Principles, Keyframing, Motion Capture, Particle, Constraints, Optimization, Rigid .Bodies, Control of Rigid-Body Dynamics, Automated Learning of Muscle Control, Natural and Expressive Motion,, Flexible Bodies, Cloth, Interactive Synthetic Characters.

Unit 3
Applications of Augmented and Virtual Reality, Human Factors, Legal, and Social Considerations.

Text Book(s)
Aukstakalnis S. Practical Augmented Reality: A guide to the technologies, applications, and human factors for AR and VR. Addison-Wesley Professional; 2016.

Reference(s)

Schmalstieg/Hollerer.Augmented Reality: Principles & Practice.
Kerawalla L, Luckin R, Seljeflot S, Woolard A. "Making it real": exploring the potential of augmented reality for teaching primary school science. Virtual reality. 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE440	BIOMETRICS	L-T-P-C: 3-0-0-3

Course Objectives

- This course covers fundamental concepts, characteristics and processes of biometrics including identity management system and performance of traits for verification recognition.
- It helps students explore software tools for verification and recognition of biometrics standards

Course Outcomes

CO1: Understand the fundamental concepts, characteristics and processes of biometrics.
CO2: Apply physiological and behavioral modalities for real world problems towards identity management system.
CO3: Analyze the performance of various traits / indicators or identifiers for verification and recognition.
CO4: Design a pattern recognition system based on multibiometric system by applying various fusion techniques and evaluate the performance.
CO5: Explore software tools for verification and recognition with biometric standards

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	2
CO2							1	1					3	2
CO3		2		2									3	2
CO4			3			1							3	2
CO5					1				1	1			3	2

Syllabus

Unit 1
Introduction - Biometric fundamentals – Biometric technologies – Biometrics vs traditional techniques – Characteristics of a good biometric system – Benefits of biometrics – Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems. Basics in biometric errors estimation. Enrollment, verification and identification.

Unit 2
Physiological Biometrics - Leading technologies: Finger-scan – Face Recognition – face detection, alignment, feature extraction, matching. Classic subspace methods. Hand-tuned feature descriptors. Iris-scan Eye and iris morphogenesis, genetic penetrance. Iris image preprocessing, segmentation, formatting and filtering. Daugman's method, iris code, statistical properties of the iris code. Behavioural Biometrics: Leading technologies: Signature-scan – Keystroke scan – components, working principles, strengths and weaknesses.

Unit 3
Multi-Biometric Fusion. Levels of fusion: sensor, feature, rank, decision. Score normalization and fusion rules. Quality-based fusion and failure prediction.
Standards in Biometrics - Assessing the Privacy Risks of Biometrics – Designing Privacy - Sympathetic Biometric Systems – Need for standards – different biometric standards - Categorizing biometric applications. Secure transfer of biometric data. Secure storage, use of smart cards, principles of match-off-card and match-on-card techniques.Biometrics in the cloud.Points of attack.Privacy models.

Text Book(s)

Flynn PJ, Jain AK, Ross AA, editors. Handbook of biometrics. Springer; 2008.

Reference(s)

Paul Reid, Samir Nanavati, Michael Thieme and Raj Nanavati. Biometrics – Identity Verification in a Networked World, Wiley-dreamtech India Private Limited, New Delhi; 2003.

John R Vacca. Biometric Technologies and Verification Systems, Elsevier Inc;2007.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electives in Cyber-Physical Systems

19CSE441	INTRODUCTION TO CYBER-PHYSICAL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE303 Embedded Systems, 19MAT115 Discrete Mathematics

Course Objectives

- This course provides an introduction to CPS, CPS foundations including the symbolic synthesis and modeling paradigms, engineering problems in CPS and applications from various domains.

Course Outcomes

CO1: Understand the fundamentals of cyber-physical systems and analyze their design in different applications.
CO2: Understand the foundations of modeling in CPSs, software based feedback control and apply them in the context of sample CPS systems.
CO3: Understand the design of distributed CPS systems with respect to synchronization, real-time scheduling and management and security issues.
CO4: Understand the techniques for formal verification and model integration in CPS and apply them in different domain applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3										3	2
CO2	3	2	3										3	2
CO3	3	2	3	2									3	2
CO4	3	2	3	2	2	2	2	2				2	3	2

Syllabus

Unit 1
Introduction to Cyber-Physical Systems(CPS): Definition, features. CPS Application Domains: Introduction and Motivation, System Description, Operational Scenarios, Design Drivers and Attributes in Medical CPS, Energy CPS, CPS built on WSNs, Robotics and Autonomous Vehicles.

Unit 2
Symbolic Synthesis for CPS: Introduction and Techniques, Temporal Logic, Symbolic Models. Software and Platform issues in Feedback Control Systems: Basic Techniques for Controller design and timing, Event-Based Control, Controller Software Structures, Sharing of Computing Resources, Analysis and Simulation. Model Integration in CPS: Causality, Semantic Domains for Time, Interaction Models for Computational Processes, Semantics of CPS DSMLs, ForSpec, The Syntax of CyPhyML, Formalization of Semantics, Formalization of Language Integration.

Unit 3

Distributed CPS: Synchronization needs in CPS, Distributed Consensus Algorithms, 3 Synchronous Lockstep Executions, Time-Triggered Architecture, Physically Asynchronous, Logically Synchronous Systems. Real-time Scheduling: Scheduling with Fixed Timing Parameters, Memory Effects, Multiprocessor/Multicore Scheduling, Accommodating Variability and Uncertainty, Managing Other Resources, Rhythmic Tasks Scheduling. Logical Correctness for Hybrid Systems: Introduction and Motivation, Basic Techniques, Discrete Verification, Advanced Techniques, Real-Time Verification, Hybrid Verification. Security of CPS: Introduction and Motivation, Attack Model and Counter Measures, System Theoretic Approaches.

Text Book(s)

Rajkumar R, De Niz D, Klein M. Cyber-physical systems. Addison-Wesley Professional; 2016 Dec 23.

Reference(s)

Alur R. Principles of cyber-physical systems. MIT Press; 2015 Apr 10.
Lee EA, Seshia SA. Introduction to embedded systems: A cyber-physical systems approach. MIT Press; 2017.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE442	PERVASIVE AND UBIQUITOUS SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE301 Computer Networks

Course Objectives

- This course is an introduction to the fundamental concepts and theories in pervasive computing as well as the technologies and applications. The course also covers various aspects of design and implementation of pervasive middleware and real application systems.

Course Outcomes

CO1: Understand the foundations and design of pervasive computing systems and its applications.
CO2: Understand the design of middleware for pervasive systems and the different functionalities and algorithms in the middleware.
CO3: Understand the human computing paradigms in pervasive and ubiquitous systems and apply different techniques for context awareness.
CO4: Analyze the pervasive system design and techniques in specific applications and real-world pervasive systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3										3	2
CO2	3	2	3										3	2
CO 3	3	2	3	2		2	2	2					3	2
CO4	3	2	3	2	2	2	2	2					3	2

Syllabus

Unit 1
Introduction and Background: Perspectives of Pervasive Computing, Challenges, Technology, Introduction to ubiquitous computing, Modeling, Architectures. Disappearing Hardware: invisibility, evolving hardware, building ubiquitous systems, problems and limits. Wireless technologies for pervasive systems: Wireless Data Transmission, Bluetooth, WiFi, RFID, Lora, comparison of technologies.

Unit 2
Middleware for Pervasive Systems: Resource Management, User Tracking, Context Management, Service Management, Data Management, Security Management, Example middleware and applications. Context Collection, User Tracking, and Context Reasoning: context category, context collection framework, user tracking and localization, position identification, positioning systems and technologies, context reasoning, sensors and sensor networks.

Unit 3
HCI in Pervasive Environments: Wearable Computing, Basic concepts, Techniques, HCI Service and Interaction Migration, Context-Driven HCI Service Selection, Case Studies. Service Discovery: Data Transmission, Disk and Server Scheduling Algorithms, Pervasive Computing Applications - iCampus Prototype, iSensorium, IPSpace: An IPv6-Enabled Intelligent Space etc.

Text Book(s)
Genco, S. Sorce. Pervasive Systems and Ubiquitous Computing, WIT Press; 2010.

Reference(s)

Yao Shen, Feilong Tang, Jingyu Zhou, Minyi Guo. Pervasive Computing, CRC Press ;2016.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE443	SPATIOTEMPORAL DATA MANAGEMENT	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE212 Data Structures and Algorithms, 19CSE202 Database Management System

Course Objectives

- This course introduces the students to spatial and temporal databases, models of spatial and temporal data and indexing and operation over spatio-temporal data.
- It helps students use GIS tools and spatio-temporal databases and apply the concepts of modeling, indexing and querying using these tools.

Course Outcomes

CO1: Understand the concept and modelling of spatial, temporal and spatio-temporal data and map them to real world applications.
CO2: Apply different spatial, temporal and spatio-temporal indexing schemes to real world scenarios.
CO3: Understand and apply the spatio-temporal query processing techniques.
CO4: Use different GIS tools and spatio-temporal databases and apply the concepts of modeling, indexing and querying using these tools.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3		3	2	1						3	2
CO2	3	2	3			2	3						3	2
CO3	3	2	3	2									3	2
CO4	3	2	3	2	3	1							3	2

Syllabus

Unit 1
Introduction to Spatial Databases: Requirements, Principles, and Concepts for Spatial Database Management Systems (SDBMS) – Concept of Space and Time, Spatial Databases and Geographic Information Systems SDBMS and GIS Applications.

Unit 2
Models for Spatial Data: Geographic Space Modelling - Representation Models - Geometry of Collection of Objects - Vector Data - Raster Data - Modelling Spatial Data. Spatial Access Methods (SAM): Issues in SAM Design - Space Driven Structures versus Data Driven Structures - The Grid File – Quad tree and Variants - R-Tree and Variants - k-d-B Tree - Other common and useful SAM - Cost Models.

Unit 3
Query Processing: Algebras and Query Languages for Spatial Data - Spatial Join Queries - Nearest Neighbour Queries - Queries over Raster Data (Map Algebra) - Cost Models. Spatio-Temporal Databases: Introduction to Temporal Databases - Specialized Index Structures - Query Processing. Spatial DBMS and GIS - GRASS – Post GIS, Advanced Topics: Geographic Data Mining - Streaming (remotely-sensed) Data - Mobile Objects and Location Aware Services.

Text Book(s)

Scholl MO, Voisard A. Spatial Databases [electronic resource]: with application to GIS. Morgan Kaufmann Publishers; 2002.

Shekhar S, Chawla S. Spatial Databases: a tour. Pearson; 2003.

Reference(s)

Samet H. Foundations of Multidimensional and Metric Data Structures. Morgan Kaufmann; 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE444	REAL-TIME SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE213 Operating Systems, 19CSE303 Embedded Systems

Course Objectives

- This course introduces the student to real-time systems, its foundations, models, and design with respect to real-time operating systems.
- The course also aims to provide a practical exposure into design and functioning of state-of-the-art real-time systems.

Course Outcomes

CO1: Understand the foundation of real-time systems and apply the concept of time and time synchronization in their modelling.
CO2: Apply the concepts of temporal relations and determinism in RTSs, and design and functionalities of RTOSs.
CO3: Analyze different algorithms for real-time scheduling, resource sharing and fault tolerance in RTSs.
CO4: Analyze the design and functioning of existing real-time systems and real-time operating systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3										3	2
CO2	3	2	3										3	2
CO3	3	2	3	2									3	2
CO4	3	2	3	2	2	2							3	2

Syllabus

Unit 1
Introduction: What is real-time?, applications, models of real-time systems (RTS), characteristics, safety and reliability, types, timing constraints, examples of RTSs. Global Times: time and order, time measurement, dense time vs sparse time, internal clock synchronization, external clock synchronization. Real-time model: components and messages, component state, gateway component, linking interface specification, component integration.

Unit 2
Temporal relations: real-time entities, observations (untimed, indirect, state and event), real-time images and objects, temporal accuracy, permanence and idempotency, determinism. Real-time task scheduling : types of real-time tasks, task scheduling, concepts and classification, algorithms – clock driven scheduling, hybrid schedulers, event driven scheduling, EDF scheduling, rate monotonic algorithm, multiprocessor task allocation, dynamic allocation of tasks. Resource sharing and Dependencies: resource sharing, priority inversion, basic concepts of faults, errors, failures, anomaly detection, fault tolerance, robustness.

Unit 3

Real-time communication: requirements, design issues, communication model, flow control, event triggered communication, rate constrained communication, time-triggered communication. Real-time operating systems: features, inter-component communication, task management, time as data, inter-task interactions, Process I/O, error detection, Unix as a RTOS, POSIX, Contemporary RTOSs like PSOS, RT Linux et, benchmarking realtime systems.

Text Book(s)

Kopetz H. Real-time Systems: Design Principles for Distributed Embedded Applications. Springer Science & Business Media; 2011 Apr 15.

Reference(s)

Rajib Mall. Real-Time Systems: Theory and Practice, Pearson, First Edition; 2006.
Laplante PA. Real-time Systems Design and Analysis: An Engineer's Handbook. Wiley-IEEE Press; 1996 Nov 1.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE445	CLOUD COMPUTING	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19CSE102 Computer Programming, 19CSE301 Computer Networks

Course Objectives

- This course introduces the basic principles of cloud computing, cloud native application development and deployment, containerization principles, micro-services and application scaling.
- It will also equip the students to understand major industry players in the public cloud domain for application development and deployment.

Course Outcomes

CO 1: Understand the basic principles of cloud computing.
CO 2: Apply cloud native application development for containerization and container orchestration.
CO 3: Analyze different types of cloud services – Delivery models, Deployment models.
CO 4: Implement different solution approaches in Cloud – containers in public cloud, setting up private cloud and convert monolithic applications to containers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1								1		3	2
CO2	3	2	2	2	3	2	3	2	2	2	2	2	3	2
CO3	3	2	2	2	3	2	3	2	1		2		3	2
CO4	3	2	2	2	3	2	3	2	2	2	2	2	3	2

Syllabus

Unit 1
Distributed Computing Taxonomy – Cluster, Grid, P2P, Utility, Cloud, Edge, Fog computing paradigms; Introduction to Cloud Computing – Cloud delivery models (XaaS), Cloud deployment models (Private, Public, Hybrid); Characteristics of Cloud, Major use cases of Cloud; disadvantages and best practices; Major public cloud players in the market; Security Issues and Challenges; Cloud Native application development – Introduction to JavaScript Cloud native application development

Unit 2
Public Cloud – Using public cloud for infrastructure management (compute and storage services), Web application deployment using public cloud services, and Deploying container images in public cloud, Overview of cognitive services, Case study on architecting cloud-based solutions for a chosen scenario

Unit 3
Virtualization – Basics, Cloud vs Virtualization, Types of virtualization, Hypervisor types; Containers – Introduction to dockers and containers, containerization vs virtualization, docker architecture, Use cases, Learn how to build container images, Operations on container images; Kubernetes – Need for orchestration, container orchestration methods, Introduction to Kubernetes, Kubernetes architecture, using YAML file, Running Kubernetes via minikube

Text Book(s)

Rajkumar Buyya et.al. Mastering cloud computing, McGraw Hill Education;2013.

Matthias K, Kane SP. Docker: Up & Running: Shipping Reliable Containers in Production. " O'Reilly Media, Inc."; 2018.

Reference(s)

Kocher PS. Microservices and Containers. Addison-Wesley Professional; 2018.

Sarkar A, Shah A. Learning AWS: Design, build, and deploy responsive applications using AWS Cloud components. Packt Publishing Ltd; 2018.

Menga J. Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale. Packt Publishing Ltd; 2018.

Bentley W. OpenStack Administration with Ansible 2. Packt Publishing Ltd; 2016.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE446	INTERNET OF THINGS	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19CSE102 Computer Programming, 19CSE303 Embedded Systems

Course Objectives

- This course covers the fundamentals of IoT and provides skills for IoT based product development.
- The skills students learn in this subject include the selection of sensors, protocols, hardware boards, interfacing, and implementation for product building. Real life case studies are introduced in this course.

Course Outcomes

CO1: Understand the key techniques and theory behind Internet of Things.
CO2: Apply effectively the various enabling technologies (both hardware and software) for IoT.
CO3: Understand the integration of Cloud and IoT , Edge and Fog Computing.
CO4: Apply various techniques for Data Accumulation, Storage and Analytics.
CO5: Design and build IoT system for any one interesting Use case

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2									2	2	3	2
CO2	3	3	2	2	3		3	2	2	2	2	2	3	2
CO3	3	3	2	3	3	2	3	2	2	2	2	2	3	2
CO4	3	3	2	3	3	2	3	2	2	2	2	2	3	2
CO5	3	3	2	3	3	2	3	2	2	2	2	2	3	2

Syllabus

Unit 1
Introduction to loT - loT definition - Characteristics - Things in loT - loT Complete Architectural Stack - loT enabling Technologies - loT Challenges - loT Levels - A Case Study to realize the stack. Sensors and Hardware for loT - Accelerometer, Proximity Sensor, lR sensor, Gas Sensor, Temperature Sensor, Chemical Sensor, Motion Detection Sensor. Hardware Kits - Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

Unit 2
Protocols for loT - infrastructure protocol IPV4/V6|RPL), Identification (URLs), Transport (WiFi, LiFi, BLE), Discovery, Data Protocols, Device Management Protocols. - A Case Study with MQTT/CoAP usage. Cloud and Data analytics- Types of Cloud - loT with cloud challenges - Selection of cloud for loT applications - Fog computing for loT - Edge computing for loT - Cloud security aspects for loT applications - RFM for Data Analytics - Case study with AWS / AZURE / Adafruit / IBM Bluemix.

Unit 3
Case studies with architectural analysis: loT applications - Smart City - Smart Water - Smart Agriculture - Smart Energy - Smart Healthcare - Smart Transportation - Smart Retail -Smart waste management.

Text Book(s)

Bahga A, Madisetti V. Internet of Things: A hands-on approach; 2014.

Reference(s)

Shriram K Vasudevan, Abhishek SN and Sundaram RMD. Internet of Things, First Edition,Wiley India;2019.
Raj P, Raman AC. The Internet of things: Enabling Technologies, Platforms, and Use-cases. Auerbach Publications; 2017.
Adrian McEwen. Designing the Internet of Things, Wiley;2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electives in Artificial Intelligence

19CSE451	PRINCIPLES OF ARTIFICIAL INTELLIGENCE	L-T-P-C:2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course provides a comprehensive, graduate-level introduction to artificial intelligence, emphasizing advanced topics such as advanced search, reasoning and decision-making under uncertainty, and machine learning.

Course Outcomes

CO1: Develop fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO2: Develop fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
CO3: Understand the various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
CO4: Develop applications in AI language Prolog and Data Mining tool.
CO5: Apply scientific models to machine learning.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	1	1		1		2	3	2
CO2	3	2	3	2	3	2	2	2		2		2	3	2
CO3	3	2	3	2	3	2	2	2		2		2	3	2
CO4	3	1	2	2	3	2	2	2		2		2	3	2
CO5	3	1	2	2	3	2	2	2		2		2	3	2

Syllabus

Unit 1
Introduction to AI and systems - Problem formulation, problem definition, control strategies, search strategies, problem characteristics, system characteristics, problem solving methods - problem graphs, matching, indexing, heuristic functions, Hill climbing - depth first, breadth first, Constraint satisfaction - related algorithms, measure of performance.

Unit 2
Knowledge representation - Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge. Knowledge inference - Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

Unit 3
Planning and machine learning - Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations, Learning
.

Text Book(s)
Stuart Russell, Peter Norvig. Artificial Intelligence:A Modern Approach;2009.

Reference(s)
Hawkins J, Blakeslee S. On intelligence: How a new understanding of the brain will lead to the creation of truly intelligent machines. Macmillan; 2004
Dean, T., Allen, J. & Aloimonos, Y.Artificial Intelligence theory and practice. New York: Benjamin Cummings;1995.
Ginsberg M. Essentials of artificial intelligence. Newnes; 2012.
Luger, G. F.,Stubblefield, W. A.Artificial Intelligence - Structures and Strategies for Complex Problem Solving. New York, NY: Addison Wesley, Fifth edition;2005.
Poole, D., Mackworth, A., and Goebel, R. Computational Intelligence - A Logical Approach. New York: Oxford University Press;1998.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE452	SEMANTIC WEB	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes, 19CSE305 Machine Learning

Course Objectives

- This course will cover the core concepts of Semantic Web that promises to dramatically improve World Wide Web (WWW) and its use.
- This course covers key technologies include explicit metadata, ontologies, logic, inferencing, and intelligent agents.

Course Outcomes

CO1: Understand and discuss fundamental concepts, advantages and limits of the semantic web.
CO2: Understand and use ontologies in the context of Computer Science and the semantic web.
CO3: Understand the relationship between Semantic Web and Web 2.0.
CO4: Apply the RDF framework for Semantic Web .
CO5: Understand the concepts of metadata, semantics of knowledge and resource, ontology, and their descriptions in XML-based syntax and web ontology language (OWL).

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2		2	2						3	2
CO2	3	2	2	2		2	2						3	2
CO3	3	2	2	2									3	2
CO4	3	2	2	2	3				2	2			3	2
CO5	3	1	2	1	3				2				3	2

Syllabus
Unit 1
The World Wide Web - Limitations of Today's Web – The Next Generation Web – Semantic Web - Layers –Semantic Web technologies – Semantics in Semantic Web – XML: Basics – Well-formed and valid Documents – Namespaces - XML schema – Addressing – Querying - Document Object Model (DOM) – XML Applications – XML limitations.

Unit 2
RDF Basic Ideas - RDF Specification – RDF Syntax: XML and Non- XML – RDF elements – RDF relationship: Reification, Container, and collaboration – RDF Schema – Editing, Parsing, and Browsing RDF/XML – Discovering Information – Querying (RQL, SPARQL) – Web Ontology Language (OWL) - Classes, Instances and Properties in OWL - Complex Classes - Property Restrictions - Role Inclusion.

Unit 3
Ontology - Ontology Types – Logic - Description Logics - Rules - Inference and Reasoning - Ontology Engineering : Introduction – Constructing ontologies – Tools used in building and storing ontologies (Sesame, Jena, Protégé, NeOn) – Reusing ontologies – ontology reasoning. The web of data - Data on the web - shallow and deep web - Linked open data - linked data principles - Linked data design - Publishing linked data - Consuming and aggregating linked data.

Text Book(s)

Paul Groth, Frank van Harmelen, Rinke Hoekstra. A Semantic Web Primer, Third Edition, MIT press; 2012.

Reference(s)

Gómez-Pérez, A. Fernández-López, M. Corcho, O. Ontological Engineering. Springer Verlag; 2003.
Michael C. Daconta, Leo J. Obrst, Kevin T. Smith. The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management, Fourth Edition, Willey Publishing; 2003.
John Davies, Rudi Studer, Paul Warren. Semantic Web Technologies: Trends and Research in Ontology-based Systems, Wiley & Sons; 2006.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE453	NATURAL LANGUAGE PROCESSING	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random processes

Course Objectives

- This course is devoted to the study of phonological, morphological and syntactic processing. These areas will be approached from both a linguistic and an algorithmic perspective.
- The course will focus on the computational properties of natural languages and of the algorithms used to process them, as well as the match between grammar formalisms and the linguistic data that needs to be covered.

Course Outcomes

CO1: Understand the models, methods, and algorithms of statistical Natural Language Processing (NLP) for common NLP tasks.
CO2: Understand mathematical and statistical models for NLP.
CO3: Understand linguistic phenomena and linguistic features relevant to each NLP task.
CO4: Apply probabilistic models in code.
CO5: Apply learning models to NLP tasks such as speech recognition, machine translation, spam filtering, text classification, and spell checking

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2									3	2
CO3	3	2	3	2									3	2
CO4	3	1	2	2	3								3	2
CO5	3	1	2	2	3								3	2

Syllabus

Unit 1
Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK. Regular expressions, Finite State Automata, word recognition, lexicon. Morphology, acquisition models, Finite State Transducer, N-grams, smoothing, entropy, HMM, ME, SVM, CRF.

Unit 2

Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions. A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax. Parsing- Unification, probabilistic parsing, TreeBank. Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary based approaches.

Unit 3

Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Applications of NLP- Spell-checking, Summarization Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation–EM algorithm - Discriminative learning - Deep representation learning - Generative learning.

Text Book(s)

Martin JH, Jurafsky D. Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition. Upper Saddle River: Pearson/Prentice Hall; 2009.

Reference(s)

James A.. Natural language Understanding,Second Edition, Pearson Education;1994.
Bharati A., Sangal R., Chaitanya V.. Natural language processing: a Paninian perspective, PHI; 2000.
Tiwary U S, Siddiqui T. Natural language processing and information retrieval. Oxford University Press, Inc.; 2008.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE454	INFORMATION RETRIEVAL	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes, 19CSE305 Machine Learning

Course Objectives

- This course aims at understanding the underlined problems related to IR and acquire the necessary experience to design, and implement real applications using word statistics, Vector space model (relevance feedback, query expansion, document normalization, document reranking), evaluation of retrieval, generalized VSM, latent semantic indexing, Web retrieval, data fusion, metasearch and multimodal retrieval.

Course Outcomes

CO1: Understand IR techniques for the web, including crawling, link-based algorithms, and metadata usage.
CO2: Understand Boolean and vector space methods for IR
CO3: Understand traditional machine learning based ranking approaches
CO4: Apply document clustering and classification

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	1			3								3	3
CO 2	3	2			3								3	3
CO 3	3	2	2		3	2	3	2	2	2			3	3
CO 4	3	1	1	2	3	2	3	2	2	2			3	3

Syllabus

Unit 1
Overview, architecture of a search engine, acquiring data - Crawling the Web, Document Conversion, Storing the Documents, Detecting Duplicates, Noise Detection and Removal, Processing text - Text Statistics, Document Parsing, Tokenizing, Stopping, Stemming, Phrases, Document Structure, Link Extraction, PageRank, Feature Extraction and Named Entity Recognition, Abstract Model of Ranking, Ranking with indexes - Inverted indexes, MapReduce, Query Processing, Document-at-a-time evaluation, Term-at-a-time evaluation, Optimization techniques, Structured queries, Distributed evaluation, Caching.

Unit 2
Queries and Interfaces - Information Needs and Queries, Query Transformation and Refinement - Stopping and Stemming, Spell Checking and Query Suggestions, Query Expansion, Relevance Feedback, Context and Personalization, Displaying the Results - Result Pages and Snippets, Advertising and Search, Clustering the Results, Translation, User Behavior Analysis
Retrieval Models - Overview - Boolean Retrieval, The Vector Space Model, Probabilistic Models - Information Retrieval as Classification, The BM25 Ranking Algorithm, Ranking based on Language Models - Query Likelihood Ranking, Relevance Models and Pseudo-Relevance Feedback, Complex Queries and Combining Evidence - The Inference Network Model, The Galago Query Language, Models for Web search.

Unit 3
Evaluating Search Engines - Effectiveness Metrics - Recall and Precision, Averaging and interpolation, Focusing on the top documents

Beyond Bag of Words - Feature-Based Retrieval Models, Term Dependence Models, Question Answering, Pictures, Pictures of Words, etc., XML Retrieval, Dimensionality Reduction and LSI.

Text Book(s)

Manning C, Raghavan P, Schütze H. Introduction to information retrieval. Natural Language Engineering;2010.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE455	ARTIFICIAL INTELLIGENCE AND ROBOTICS	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes, 19CSE305 Machine Learning

Course Objectives

- This course aims to make the learners understand the basic principles in AI and robotics technologies
- The learners will be able to apply machine learning algorithms for applications using AI and robotics

Course Outcomes

CO1: Understand ideas and techniques underlying Artificial Intelligence technologies.
CO2: Understand Robotic technologies.
CO3: Apply AI and Robotics technologies using basic programming and machine learning.
CO4: Develop applications using AI and Robotics.
CO5: Understand societal and business impact of AI and Robotics technologies

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1	1	1	2	1	1	3	2
CO2	3	2	3	2	2	2	1	2	1	2	2	2	3	2
CO3	3	2	3	2	3	2	2	2	2	2	2	2	3	2
CO4	3	1	2	3	3	2	2	2	2	2	2	2	3	2
CO5	3	1	2	2	3	1	2	2	2	2	2	2	3	2

Syllabus

Unit 1
Introduction, Actuators and drives, Control components, De-mining Robot: Embedded Robot Controller, I/O Interface, and PWM Amplifiers, control softwares, sensor inputs, sensors.

Unit 2
Kinematics, differential motion, statics, energy method, hybrid position force control, Non-holonomic systems, dynamics - Translational and Rotational, computed torque control, Transformation, Path Planning, and Trajectories, Time Response of Dynamic Systems, Dynamic Effects of Feedback Control, Control Systems - Artificial Intelligence based optimal control - Reinforcement learning.

Unit 3
Numerical Optimization, Dynamic Optimal Control, Parameter Estimation and Adaptive Control, Computer vision, Navigation, Tele-robotics and virtual reality.

Text Book(s)
Asada H, Slotine JJ. Robot analysis and control. John Wiley & Sons; 1986.

Reference(s)

Spong MW. Seth Hutchinson and Mathukumalli Vidyasagar. InRobot modeling and control; 2006.
Lynch KM, Park FC. Modern Robotics. Cambridge University Press; 2017.
John JC. Introduction to robotics: mechanics and control. Reading: Addison-Wesley. 1989.
Kelly A. Mobile robotics: mathematics, models, and methods. Cambridge University Press; 2013.
Thrun S, Burgard W, Fox D. Probabilistic robotics. MIT press; 2005.
Siciliano B, Khatib O. Handbook of robotics. Section kinematic loops;2008.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE456	NEURAL NETWORKS AND DEEP LEARNING	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes, 19CSE305 Machine Learning

Course Objectives

- This course provides an introduction to deep neural network models, and surveys some of the applications of these models in areas where they have been particularly successful.
- The course covers feedforward networks, convolutional networks, recurrent and recursive networks, as well as general topics such as input encoding and training techniques.

Course Outcomes

CO1: Understand the learning components of neural networks and apply standard neural network models to learning problems.
CO2: Analyze the learning strategies of deep learning – regularization, generalization, optimization, bias and variance.
CO3: Analyze regular deep learning models for training, testing and validation in standard datasets.
CO4: Apply neural networks for deep learning using standard tools.
CO5: Understand the mathematics for Deep learning.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2	2								3	2
CO3	3	2	3	2	3								3	2
CO4	3	1	2	1	2								3	2
CO5	3	1	2	1									3	2

Syllabus
Unit 1
Perceptrons – classification - limitations of linear nets and perceptrons - multi-Layer Perceptrons (MLP)- activation functions - linear, softmax, tanh, ReLU; error functions - feed-forward networks - Backpropagation - recursive chain rule (backpropagation) - Learning weights of a logistic output -Loss functions - learning via gradient descent - optimization – momentum method; Adaptive learning rates – RmsProp - mini-batch gradient descent - bias-variance trade off, regularization - overfitting - inductive bias – regularization - drop out - generalization.

Unit 2
Probabilistic Neural Network - Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Autoencoders; Conditional Random Fields - Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy.

Unit 3
Introduction to deep learning - Deep neural networks - convolutional nets – case studies using Keras/Tensorflow - neural nets for sequences - Recurrent Nets – Long-Short-Term-memory; Introduction to Deep unsupervised learning – PCA to autoencoders.

Text Book(s)

Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning, MIT Press, Second Edition; 2016.

Reference(s)

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

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE457	BAYESIAN MACHINE LEARNING	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes, 19CSE305 Machine Learning

Course Objectives

- This course will cover the basics of Bayesian methods, from how to define a probabilistic model to how to make predictions from it.

Course Outcomes

CO1: Understand Bayesian approach to regression.
CO2: Apply Bayesian models for machine learning.
CO3: Apply hypothesis testing to real world scenarios.
CO4: Analyze Bayesian linear models using Monte- Carlo methods.
CO5: Apply hierarchical Bayesian models to applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2	2								3	2
CO3	3	2	3	2	3								3	2
CO4	3	1	2	1	2								3	2
CO5	3	1	2	1									3	2

Syllabus
Unit 1
Probability Review, Bayes' Rule - Exponential Families, Likelihoods - Prior and Posterior Distributions - Conjugate Priors - Models for Normal Data - Multivariate Normal, Shrinkage - Bayesian Linear Models - Informative and Noninformative Priors - Subjective or Objective Bayes - Monte Carlo Integration - Rejection and Importance Sampling.

Unit 2
Markov Chains - The Gibbs Sampler - Hierarchical Models - Exchangeability; Linear Models - More Complicated MCMC Algorithms - Empirical Bayes - Sensitivity Analysis - Basics of decision theory, multi-parameter models - Multivariate models - Linear regression, asymptotic approximation to posterior distributions - Gibbs sampling, Metropolis-Hastings algorithm.

Unit 3
Hypothesis Testing - The Bayes Factor - Model Choice vs. Model Averaging - Stochastic Variable Selection - The Kalman Filter - Sequential Monte Carlo.

Text Book(s)
J. Gill. Bayesian Methods: A Social and Behavioral Sciences Approach, Second Edition. Chapman & Hall;2008.

Reference(s)
Gelman, J.B. Carlin, H.S. Stern and D.B. Rubin. Bayesian Data Analysis, Second Edition;2004

Chapman & Hall. W. J. Braun and D. J. Murdoch. A First Course in Statistical Programming with R. Cambridge University Press;2007.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE458	COMPUTATIONAL INTELLIGENCE	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course covers practical adaptation and self-organization concepts, paradigms, algorithms and implementations that enable or facilitate appropriate actions (intelligent behavior) in complex and changing environments.
- The course includes mainly bottom-up approaches to solutions of (hard) problems based on various heuristics (soft computing), rather than exact approaches of traditional artificial intelligence based on logic (hard computing) mainly nature-inspired methods.

Course Outcomes

CO1: Understand conventional artificial intelligence approaches, algorithms and methods.
CO2: Apply conventional artificial intelligence algorithms and approaches to real-life problems.
CO3: Analyze Fuzzy and swarm optimization systems in application scenarios.
CO4: Understand hybridization of conventional artificial intelligence algorithms.
CO5: Apply improved algorithmic approaches to application scenarios.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1						3	2
CO2	3	2	2	2	3	2	2						3	2
CO3	3	2	2	2	3	2	2						3	2
CO4	3	1	2	2	3	1	1						3	2
CO5	3	1	2	2	3	2	2						3	2

Syllabus
Unit 1
Fuzzy Systems, Fuzzy Sets, Fuzzy Logic, Fuzzy Relationships, Fuzzy Inference, Alternate fuzzy logic operations, Adaptation of fuzzy systems, Disjunctive versus conjunctive reasoning

Unit 2
Swarm Intelligence, Foundations Ants, Termites, Gnats, Birds Applications, Feedforward Neural Networks, Foundations of pattern classification & regression, Rosenblatt Perceptron, Training Neural networks

Unit 3
Smithing QwikNet, Software Applications, Evolutionary Computation, Genetic Algorithms, Boundary Marking, Particle Swarm, Search

Text Book(s)
Eberhart RC, Shi Y. Computational intelligence: concepts to implementations. Elsevier; 2007.

Reference(s)

Karray F, Karray FO, De Silva CW. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education; 2004.
Engelbrecht AP. Computational intelligence: an introduction. John Wiley & Sons; 2007.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electives General

19CSE459	ADVANCED ALGORITHMS AND ANALYSIS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE302 Design and Analysis of Algorithms

Course Objectives

- This course introduces students to advanced techniques for the design and analysis of algorithms and explores a variety of applications.

Course Outcomes

CO1: Understand various methodology for analyzing the algorithms.
CO2: Apply different graph algorithms and analyze its Complexity.
CO3: Analyze various algorithm design techniques and solve different problems using those techniques and analyse its Complexity.
CO4: Evaluate the performance of various Network flow algorithms.
CO5: Understand NP completeness and Polynomial Reduction Techniques.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			3		2			2			3	2
CO2	3	1	2	2	3	2		2		2			3	2
CO3	3	3	2	3		3	2	2		3			3	2
CO4	3	2	2	2	3	2		2		2			3	2
CO5	3	3	2	3		2				2			3	2

Syllabus

Unit 1
Algorithm Analysis - Methodologies for Analyzing Algorithms, Asymptotic growth rates, Amortized Analysis. Number Theory: Preliminaries, FLT, Euclid's algorithm (extended). Totient function, Sieve for primes, Inverse modulo n, Modular exponentiation, Applications of graph algorithms: Topological sort, Strongly Connected Components, Bi-connected Components, Bridges, Articulation points. All Pair Shortest Paths, Single Source Shortest Paths. Computational Geometry: Convex Hull, closest pair of points in 2D, the triangle with smallest perimeter in 2D, Determining whether a set of line segments have one or more intersections.

Unit 2
Applications of Divide-and-Conquer, Greedy techniques and Dynamic Programming - Knapsack, Median finding, Scheduling algorithms, Party planning, bitonic TSP etc., String matching algorithms: KMP, Rabin Karp, Aho-Corasick, 2D queries, efficient algorithms for longest palindrome, Longest Common Substring.

Unit 3
Flow Networks: Ford-Fulkerson, Edmonds Karp, Applications of maximum flows - Efficient algorithms for maximum bipartite matching, minimum cost matching. NP-Completeness: Important NP-Complete Problems, Polynomial time reductions, Approximation algorithms, Parallel Algorithms (overview): Tree Contraction - Divide and Conquer -

Maximal Independent Set. External-Memory Algorithms - Accounting for the Cost of Accessing Data from Slow Memory – Sorting - B-trees - Cache-oblivious Algorithms for Matrix Multiplication and Binary Search.

Text Book(s)

Goodrich M T and Tamassia R. Algorithm Design and Applications, John Wiley and Sons; 2014.

Reference(s)

Cormen T H, Leiserson C E, Rivest R L and Stein C. Introduction to Algorithms, Prentice Hall of India Private Limited, Third Edition; 2009.

Motwani R, Raghavan P. Randomized algorithms. Cambridge university press; 1995.

Vijay V. Vazirani. Approximation Algorithm, Springer; 2003.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE460	USER EXPERIENCE DESIGN	L-T-P-C: 2-0-3-3

Course Objectives

- This course provides a comprehensive overview of the user experience design process, and is intended to familiarize students with the methods, concepts, and techniques necessary to make user experience design an integral part of developing information interfaces.
- The course provides students with an opportunity to acquire the resources, skills, and hands-on experience they need to design, develop, and evaluate information interfaces from a user-centered design perspective.
- The students of this course will be able to apply the knowledge / learning's from this course to their own professional work as a user experience designer, UX Designers, Information Architects, Usability Engineers etc. in IT domain. They will able to apply learning's in designing the Website design, Mobile applications, Enterprise and consumer software products and applications.

Course Outcomes

CO1: Define the critical issues and theoretical underpinnings of User Experience (UX) design.
CO2: Establish requirements for UX design concepts.
CO3: Develop alternatives for UX design concepts and demonstrate the construction of UX design artifacts.
CO4: Evaluate Ux Design artifacts.
CO5: Learn how Ux design concepts are applied for real life problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1							2						
CO2	3	1						1						
CO3	3	1			3		2							
CO4	3	3	3	3	3		2		2	1			3	2
CO5	3	3	3		3	2	2	3	2	3		2	3	2

Syllabus

Unit 1
Ux Introduction: User Interaction with the products, applications and services – Cognitive Model/Mental Model, Principles of Ux Design, Elements of Ux design - Core elements of User Experience. How these elements work together; Ux Design Process - Defining the UX Design Process and Methodology, Research and Define – Importance of research, Research methods and tools, Understanding the User Needs and Goals, Understanding the Business Goals, Deliverables of the Research & Define phase, Insight on User Goals and Business Goals.

Unit 2
Ux Design Process Ideate and Design - Visual Design Principles, Information Design and Data Visualizatiion, Interaction Design, Information Architecture, Wireframing & Storyboarding, UI Elements and Widgets, Screen Design and Layouts, Prototype and Test – Need for design testing, Definition of Usability Testing, Types of Usability Testing, Usability Testing Process, Prepare and plan for the Usability Tests, Prototype Design to Test, Introduction of prototyping tools, Conducting Usability Tests, Communicating Usability Test Results.

Unit 3

Ux Design Process Iterate and Improve - Understanding the Usability Test findings, Applying the Usability Test feedback in improving the design, Deliver - Communication with implementation team, UX Deliverables to be given to implementation team, Ux Metrics – Overview, Types of metrics – CSAT, NPS, SUS, TPI, Choosing the right metrics, Future of Ux Design, Case studies: Commuter Rail Mobile App, Medical Patient portal, Ux Tools – Wireframing Ux Design tools such as Pencil, MockPlus, UxPin Usability Testing Tools – Optimizely, ClickHeat, Chalkmark

Text Book(s)

Platt D. The Joy of UX: User Experience and interactive design for developers. Addison-Wesley Professional; 2016.

Reference(s)

Garrett JJ. The elements of user experience: user-centered design for the Web and beyond (2. painos). Berkeley: New Riders; 2011.
Goodman E, Kuniavsky M, Moed A. Observing the user experience: A practitioner's guide to user research. Elsevier; 2012.
Buxton B. Sketching User Experiences: Getting the Design Right and the Right Design. Morgan Kaufmann; 2010.
Shneiderman B, Plaisant C. Designing the User Interface: Strategies for Effective Human-Computer Interaction. Pearson Education India; 2010.
Tenner E. The Design of Everyday Things by Donald Norman. Technology and Culture; 2015.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE461	NET CENTRIC PROGRAMMING	L-T-P-C: 2-0-3-3

Course Objectives

- This course gives an overview of technologies and standards for designing network based applications and solutions
- The course provides an insight on the mean stack development using suitable technologies.

Course Outcomes

CO1: Apply the concepts of responsive web design to customize pages for users need.
CO2: Apply markup and scripting languages to design and validate dynamic webpages.
CO3: Evaluate the appropriateness of client/server applications using mean stack architecture.
CO4: Design, develop and deploy client/server applications.
CO5: Implement the complete web application development cycle as a term project.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3								3	2
CO2	3	3	2		3								3	2
CO3	3	2		3		2							3	2
CO4	3	3	3	3	3	2	2	3				2	3	2
CO5	3	3	3	3	3	2	2	3	3	2	2	2	3	2

Syllabus

Unit 1
Responsive Web Design – Flexible layout – Flexible Grids – media queries – initializing media queries –Logical operators – responsive images and text - Media features in Media queries – aspect ratio – Resolution – other media features - Mobile First – view port – Flexible media – Flexible embedded media – Responsive Web Design Frameworks

Unit 2
Web Data representation –Semi-structured Data- XML: Comparison with HTML - DTD - XML Elements -Content Creation - Attributes - Entities – XML Schema - XPATH – XAxis – XSL- Namespaces - Applications - Integrating XML with other applications. JSON – Exchanging – sending and storing data. Comparison of XML and JSON

Unit 3
Mean Stack Architecture – Angular JS -introduction – expressions –modules – directives –model – data binding – controllers – scopes – scope -filters - services –http – tables – forms and validation. Node.js - modules - file system - events. ExpressJS - Routing - http methods - form data - database - cookies. Connectivity to MongoDB
Case Study : Web Application Framework- Flask- Flask and SQLite- Bootstrap

Text Book(s)

Bassett L. Introduction to Javascript Object Notation.1st edition, O'Reilly,2015.

Reference(s)

Williamson H. XML: The complete Reference. Mc-Graw Hill; 2001
Frain B. Responsive web design with HTML5 and CSS3. Packt Publishing Ltd; 2012.
Dayley B. Node.js, MongoDB, and AngularJS Web Development (Developer's Library). 1st edition, Addison Wesley; 2014.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE462	INTRODUCTION TO GAME THEORY	L-T-P-C: 3-0-0-3

Course Objectives

- The aim of this course is to introduce students to the novel concepts of game theory including cooperative games, non-cooperative games and mechanism design concepts.
- The course will also give a special emphasis on its applications in current day computer engineering domains including cloud computing systems, social media analytics, security mechanisms, Internet marketing strategies, wireless networks, communication systems, cyber physical systems etc.
- Students should also be able to model and solve problems in interdisciplinary domains.
- After this course the students should be able to model several real situations using game-theory and design solutions (mechanisms, algorithms, protocols etc.) that are robust even in presence of "self-centered" entities.

Course Outcomes

CO1: Understand various types of non-cooperative game theory concepts.
CO2: Understand various types of cooperative game theory concepts.
CO3: Understand various mechanism design concepts including auctions.
CO4: Design robust and efficient solutions (mechanisms, algorithms, protocols) that would work for agents that are rational and intelligent in interdisciplinary domains.
CO5: Ability to model real-world situations such as social media marketing, social analytics, cloud computing issues, wireless networks etc using game theory.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													1
CO2	3													1
CO3	3													1
CO4	3	2	2	2	2	2	2		3	2		2	3	3
CO5	2	2	2	2	2				3	2		2	3	3

Syllabus

Unit 1
Introduction to Game Theory, Current trends and modern applications, Non-Cooperative Games – Strategic form, Preferences, Utilities, Extensive Form Games, Strategic Form Games - Matching Pennies, Prisoners Dilemma, Coordination Game, Dominant Strategy Equilibria, Pure Strategy Nash Equilibria, Mixed strategies, Nixed strategy Nash Equilibria, Matrix Games

Unit 2
Cooperative Games - Correlated Equilibrium, Bargaining Games, Nash Bargaining Solution, Coalitional Games, Core of Coalitional Games, Shapely Value, Stable Matching – Matching problem, Evolutionary Games – Evolutionary stable strategy

Unit 3

Bayesian Games, Bayesian Nash Equilibria, Mechanism Design – Introduction, Examples, implementation of Social Choice functions by Mechanisms, Incentive Compatibility and Revelation theorem, VCG Mechanisms, Auctions, Mechanism design for Sponsored search auctions

Text Book(s)

Y. Narahari. Game Theory and Mechanism Design. IISc Press and the World Scientific Publishing Company, March 2014. (532 pages).

Reference(s)

Roger B. Myerson. Game Theory: Analysis of Conflict. Harvard University Press, Cambridge, Massachusetts, USA, 1997.

Martin J. Osborne. An Introduction to Game Theory. The MIT Press, 2003

Michael Maschler, Eilon Solan, and Shmuel Zamir. Game Theory. Cambridge University Press, 2013

Philip D. Straffin Jr. Game Theory and Strategy. The Mathematical Association of America, 1993.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Free Electives

19CSE358	SOFTWARE PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- This course describes the key aspects of a software project.
- It introduces the basic principles of Engineering Software Projects. Most, if not all, students' complete projects as part of assignments in various courses undertaken. These projects range in size, subject and complexity but there are basic project essentials that need to be understood and practiced for successful team project outcomes.
- The course provides an understanding of the purpose, methods and benefits of process management by exposing the student to the concepts, practices, processes, tools and techniques used in process management for software development.

Course Outcomes

CO 1: To understand the basic concepts, terminologies and issues of software project management.
CO 2: To apply appropriate methods and models for the development of solutions.
CO 3: To analyze the cost-benefits of calculations so as to optimize the selection strategy
CO 4: To evaluate methods, models and technologies towards achieving project success
CO 5: To design and evaluate network planning models with criticality

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													1
CO2	3													1
CO3	3													1
CO4	3	2	2	2	2	2	2		3	2		2	3	3
CO5	2	2	2	2	2				3	2		2	3	3

Syllabus

Unit 1
Introduction to Software Project Management- Software Projects - ways of categorizing software projects – problems with software projects - Project Life Cycle– Management -Setting objectives –Stakeholders - Project Team- Step-wise : An overview of project planning -project Evaluation –Selection Of Appropriate Project Objectives- Software Effort Estimation Techniques, Function Point Analysis-Object Point-COCOMO.

Unit 2
Activity planning-- project schedules - sequencing and scheduling projects - Network planning model – AON and AOA-identifying critical activities-Crashing And Fast Tracking-,Risk management—Categories , Risk planning, Management and Control - Evaluating risks to the schedule. PERT- Resource Allocation, Monitoring and Tracking - Monitoring and control - allocation - identifying resource requirements - scheduling resources - creating critical paths - publishing schedule - cost schedules- sequence schedule.

Unit 3

Monitoring and control – Visualizing Progress, Earned value analysis, managing people and organizing teams- organizational structures- Planning for small projects. Case Study: PMBOK , Agile Development

Text Book(s)

Mike Cotterell, Bob Hughes. Software Project Management, Fifth Edition, Tata McGraw-Hill; 2012.

Reference(s)

Roger S. Pressman. Software Engineering – A Practioner's Approach, Eighth Edition, Tata McGraw-Hill publishers; 2014.

Jalote P. Software Project Management in practice, Second edition, Person Education; 2003.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE359	FINANCIAL ENGINEERING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course serves as an introduction to financial engineering including cash flows, financial decision making etc
- It gives a thorough yet highly accessible mathematical coverage of standard and recent topics of introductory investments: fixed-income securities, modern portfolio theory, optimal portfolio growth and valuation of multi-period risky investments.

Course Outcomes

CO1: Apply basic concepts to understand and evaluate cash flows
CO2: Evaluate and arrive at a financial investment decision employing the underlying knowledge of stocks and derivatives
CO3: Analyse and design Portfolio selection methods
CO4: Understand capital market theory for stock performance evaluation

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			2								3	2
CO2	2	3	1										3	2
CO3	1	3			2								3	2
CO4	2	1											3	2

Syllabus

Unit 1
Cash Flows and Fixed income securities: Investments and markets - Principal and interest - Present and future values of streams - IRR. Fixed income securities - Market value for future cash - Bond value - Bond details – Yields – Convexity – Duration - Immunization. Bond portfolio management - Level of market interest rates, Term structure of interest-rate theories.

Unit 2
Stocks and Derivatives: Common stock valuation - Present value of cash dividends - Earnings approach - Value versus price - Efficient markets theory - Technical analysis. Analysis of financial statements. Derivatives - futures and options - Black Scholes formula - Utility functions - Applications in financial decision making.

Unit 3
Portfolio analysis and capital market theory: Covariance of returns – Correlation - Portfolio return - Portfolio standard deviation - Two asset case - Efficient frontier - Optimum portfolio. Capital market theory - Capital market line -

Sample diversifications to reduce risk - Characteristic line - Capital asset pricing model. Arbitrage price theory - Stock performance evaluation.

Text Book(s)

David Luenberger, Investment Science. Second Edition, Oxford University Press; 2013
Jack Clark Francis, Richard W. Taylor. Investments, Schaum's Outlines, Tata McGraw Hill ;2006.

Reference(s)

Lyuu YD. Financial Engineering and Computation. Cambridge University Press; 2004.
Perry H. Beaumont. Financial Engineering Principles. John Wiley and
Sons Inc, New Jersey; 2004.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE360	ENGINEERING ECONOMIC ANALYSIS	L-T-P-C: 3-0-0-3

Course Objectives

- Prepare engineering students to analyze and understand the business, impact of economic environment on business decisions

Course Outcomes

CO1: Understand and evaluate the economic theories, cost concepts and pricing policies and draw inferences for the investment decisions for appraisal and profitability

CO2: Appraise the dynamics of the market and market structures and portray implication for profit and revenue maximization

CO3: Employ operations research and allied techniques in managerial economics for an enhanced analysis and decision making

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2		2		2			3	2	3	2
CO2	1	3	2	1		2		2			3	2	3	2
CO3	2	3	2	2		2		2			3	2	3	2

Syllabus

Unit 1

Economics: Nature and scope of managerial economics. Economic theory and managerial economics, Cost Concepts: Types of costs - Cost functions. Cost controls: reduction – Tools & Areas. Pricing policies- methods. Capital budgeting - cost of capital. Appraising project profitability

Unit 2

The essentials of demand and supply: The law of demand. Market demand curve. Other determinants of market demand. The law of supply. Determinants of market supply. The market mechanism. Price elasticity of demand, Profit and revenue maximization: Optimal input combination. Total revenue maximization.

Unit 3

Market structure: Perfect competition and monopoly. Characteristics of monopolistic competition. Oligopoly Operations Research techniques in managerial economics: Inventory models. Theory of games. Decision theory, Risk and Uncertainty, Measuring risk, Consumer behavior and risk aversion, Decision making under uncertainty with complete ignorance

Text Book(s)

Webster, T.J. Managerial Economics- Theory and Practice, Elsevier; 2004.

Reference(s)

Panneerselvam, R. Engineering Economics, Second Edition, PHI; 2013.
R L Varshney,K L. Maheshwari. Managerial Economics, S Chand & Sons;2014.
Harrison.B, Smith.C., and Davis.B. Introductory Economics, Second Edition, Pr Macmillan; 2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19MNG331	FINANCIAL MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- The course would prepare engineering students to understand the overview of financial management; inculcate methods and concepts on valuation and familiarize with working capital management, financial analysis and planning

Course Outcomes

CO1: Understand the overview of financial management
CO2: Apply methods and concepts on valuation
CO3: Understand with working capital management, financial analysis and planning

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3					1	1		3	3	3	2
CO2	2	3	3					2	1		3	3	3	2
CO3	2	3	2					1	1		3	3	3	2

Syllabus

Unit 1
Introduction: Financial Management an overview – Financial Decisions in a firm – Goal of FM – Function of the financial system.

Unit 2
Fundamental Valuation Concepts:Time value of money – Risk and Return. Capital Budgeting: Techniques of capital budgeting investment criteria– NPV – Benefit Cost Ratio – IRR – Payback Period – ARR – Investment appraisal in Practice – Estimation of Project cost flows.

Unit 3
Working Capital Management: Current Assets – Financing Ruling – Profit Criterion. Cash and Liquidity Management. Working Capital Financing,Financial Analysis and Planning**:** financial instruments, sources of long-term, intermediate term and short term finance. Analyzing Financial Performance – Break – even analysis and Leverages – Financial Planning and Budgeting,Mergers and Takeovers-International trade.

Text Book(s)
Chandra, P. Financial Management: Theory and Practice, Ninth Edition, TMH; 2017.
Denzil Watson, Antony Head. Corporate Finance- Principles and Practice, Second Edition, Pearson Education Asia; 2016.
R L Varshney, K L. Maheshwari. Managerial Economics, S Chand & Sons; 2014.

Reference(s)

Stephen Blyth. An Introduction to Corporate Finance, McGraw Hill Book Company; 2014.
Brigham EF, Ehrhardt MC, Nason RR, Gessaroli J. Financial Managment: Theory&Practice, Canadian Edition. Nelson Education; 2016.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE362	INFORMATION SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- This course is to expose the students to the managerial issues relating to information systems and also understand the role of Business Process Reengineering technique in an organization.
- The course also focus on the management of information technology to provide efficiency and effectiveness or strategy decision making.

Course Outcomes

CO1: Understand the fundamental concepts of Information Systems in business.
CO2: Understand and analyse the strategic role played by Information Systems in e-commerce.
CO3: Analyse management challenges in Global Businesses predominantly dependent on IS functions.

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	2
CO2	2	2			2								3	2
CO3	1	3			2	2					2	1	3	2

Syllabus

Unit 1
Introduction to IS -Fundamental concepts-IS in Business- Role of IS –Information system and technologies – Components of IS –resources and acivities –Types of IS- E business Applications –Role of BI and Analytics in IS- Functional Business Systems - Marketing Systems, Manufacturing systems, Human Resource Systems, Accounting Systems and Financial Management Systems.-Cross-Functional Enterprise Systems Cross-Functional Enterprise Applications, Enterprise Application Integration, Transaction Processing Systems and Enterprise Collaboration Systems. Enterprice Business Systems CRM, ERP, SCM , Case Studies

Unit 2
Electronic Commerce Systems : Scope of e-Commerce, Essential e-Commerce Processes and Electronic Payment Processes - E-commerce Applications & Issues -Decision Support Systems- Business and Decision Support, Decision Support Trends, Management Information Systems, Online Analytical Processing, Decision Support Systems, Executive Information Systems, Enterprise Portals and Decision Support - Knowledge Management Systems. Artificial Intelligence Technologies and its application in Business- Strategic role of IT- Competing with IT, value chain ,reengineering, virtual organization ,knowledge creation-Organizational Planning, The Scenario Approach, Planning for Competitive Advantage, SWOT Business Models and Planning, Business IT Planning, -Business/ IT Strategies and Business Application Planning- Developing and Implementing Business Systems - Implementation Challenges- barriers - change management-: Case Studies

Unit 3

Management challenges-Security, Ethical and Societal Challenges- Ethical Responsibility of Business Professionals, Computer Crime, Privacy Issues, Health Issues, and Societal Solutions- Security Management of IT- Tools of security Management, Internetworked Security Defenses, other security measures –system controls and audits- Enterprise and Global Management of IT- Managing the IS Function and Failures in IT Management - Global IT Management, Cultural, Political and Geo-economic Challenges, Global Business/IT Strategies, Global Business/IT Applications, Global IT Platforms, Global Data Access Issues and Global Systems Development –Case studies

Text Book(s)

O'Brien JA, Marakas GM. Management information systems. McGraw-Hill Irwin; 2006.

O Brien,Marakas G M and Behi R , MIS,9th edition, Tata McGraw Hill Special Indian Edition;2010.

Reference(s)

Laudon K, Laudon JP. Management Information Systems;2010

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Professional Electives for Other Branches

19CSE471	PRINCIPLES OF OPERATING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- The course aims at teaching students understand the structure and implementation of modern operating systems, virtual machines and their applications.
- It summarizes techniques for achieving process synchronization and managing resources like memory and CPU in an operation system.
- It compares and contrasts the common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems (such a priority, performance comparison, and fair-share schemes).
- It gives a broad overview of memory hierarchy and the schemes used by the operating systems to manage storage requirements efficiently.

Course Outcomes

CO1: To understand the architecture and functionalities of modern Operating System.
CO2: To understand and apply the algorithms for scheduling.
CO3: To understand and apply the algorithms for resource management.
CO4: To apply semaphores and monitors for classical and real world synchronization scenarios.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1										2	2
CO2	2	2	3	2		2	2						2	2
CO3	2	2	3	2		2	2						2	2
CO4	2	2	2	2		2							2	2

Syllabus

Unit 1
Introduction to operating systems: Overview – hardware protection – operating systems services – system calls – system structure – virtual machines.

Unit 2
Process concepts – process scheduling – operations on process – inter-process communication – multi threading models – threading issues – thread types – CPU scheduling. Process synchronization: critical section problem – semaphores – classical problems of synchronization —Deadlocks – deadlock characterization – methods of handling deadlocks – deadlock prevention – avoidance – detection and recovery.

Unit 3
Storage management: memory management – swapping – contiguous memory allocation. Paging and segmentation – segmentation with paging – virtual memory – demand paging– page replacement

Text Book(s)

Silberschatz A, Gagne G, Galvin PB. Operating system concepts. Wiley; 2018.

Reference(s)

Deitel. Deitel, Choffnes. Operating System, Third Edition, Prentice Hall; 2003.
Tanenbaum AS, Bos H. Modern operating systems. Pearson; 2015.
Stevens WR, Rago SA. Advanced programming in the UNIX environment. Addison-Wesley; 2008.
Gary Nutt. Operating Systems, Third Edition, Addison Wesley; 2009.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE463	MOBILE APPLICATION DEVELOPMENT	L-T-P-C: 2-0-3-3

Course Objectives

- This is a hands-on elective course which introduces the fundamentals of native android application development using Android Studio.
- The students will learn to customize activities and intents, create rich user interface and manage data on databases such as SQLite.
- The course provides exposure to use various components such as services, async tasks, broadcast receivers and content providers.
- The students also learn to use various APIs such as Maps, Sensors and GPS enabling them to develop ready to use android applications for real-world use cases.

Course Outcomes

CO1: Understand the fundamental concepts of android operating system and android application development.
CO2: Understand the various building blocks of native android applications.
CO3: Design android specific user interface (UI).
CO4: Design and develop applications using android services and sensors.
CO5: Understand and apply data storage and sharing techniques for applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2				2								2	2
CO2	3	2	2	2	3							3	3	3
CO3	2	1	3		3			3	3	3		3	3	3
CO4	2	2	2	3	3			3	3	3		3	3	3
CO5	3	2	3	3	3			3	3	3		3	3	3

Syllabus

Unit 1

Introduction and User Interface
Basics of Android - Android OS architecture, Versions, SDK, API Levels. Set up of mobile app development environment - Understand the app idea and design user interface/wireframes of mobile application - Developing and debugging mobile app components - First application - understanding file structure - layout and resource files - deployment - emulators and devices.
Basic UI design - Button, EditText, TextView, basic event handlers. Activity - Lifecycle, Layouts - Selection components - Radio, checkbox, Date/Time Picker. ListView, Grid view, ScrollView, Image view, Image buttons, Spinner, Toggle, AutocompleteTextView.
Advanced UI design - Intents - Internal/External/Pending, Intent Filters, Android Manifest - Permissions - Fragment, Fragment Lifecycle, Fragment communication - Menu, Notifications, Material Design, Navigation Drawer, WebView.

Unit 2
Components
Data storage - SQLite, Shared Preferences, Internal/External Storage, Room Persistence Library. Background Processing - Services - Started, Bound, Foreground, Intent Service - AsyncTasks. Broadcast receivers, Content Providers, Content resolvers.

Unit 3
Sensors and Location API
Sensors - Motion sensors, Environmental, Position sensors. Touch sensors and Gesture detector. Location Based Services - GPS and Google Maps.Apps with Connectivity to External APIs.

Text Book(s)
Burd B. Android application development all-in-one for dummies. John Wiley & Sons; 2015.

Reference(s)
AndroidDeveloperFundamentalsVersion2,2018.Accessibleonline:
https://developer.android.com/courses/fundamentals-training/overview-v2
Darcey L, Conder S. Sams Teach Yourself Android Application Development in 24 Hours: Sams Teac Your Andr Appl D_2. Pearson Education; 2011.
Hardy B, Phillips B. Android Programming: The Big Nerd Ranch Guide. Addison-Wesley Professional; 2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE464	FUNDAMENTALS OF SOFTWARE ENGINEERING	L-T-P-C: 2-0-3-3

Course Objectives

- To introduce basic software engineering concepts
- To introduce the Agile Software development process.
- Hands one training (experiential learning) to digest the concepts learned in the class.
- This is a reading and discussion subject on issues in the engineering of software systems and software development project design.
- It includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why.

Course Outcomes

CO1: Understand the principles of software engineering
CO2: Understand various software process models
CO3: Apply the appropriate design methodology for a real world application
CO4: Evaluate a system developed for real-world applications in Agile Mode

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1											2	3	2
CO2	2	3	2									2	3	2
CO3	2	1	3			2				1		2	3	2
CO4	2	2	2			3				3		2	3	2

Syllabus

Unit 1
Process Models – overview, Introduction to Agile, Agile Manifesto, principles of agile manifesto, Agile Requirements - User personas, story mapping, user stories, estimating and prioritizing stories, INVEST, acceptance criteria, Definition of Done, Release planning. Key aspects of Scrum: roles - Product Owner, Scrum Master, Team and product backlog Scrum process flow: product backlog, sprints backlog, scrum meetings, demos. How sprint works: Sprint Planning, Daily scrum meeting, updating sprint backlog, Burn down chart, sprint review, sprint retrospective. Scrum Metrics- velocity, burn down, defects carried over.

Unit 2
Traditional process Models: Waterfall, incremental. Requirements Engineering: Tasks Initiation-Elicitation-Developing Use Cases-Building the analysis Model-Negotiation- Validation. Requirements Modelling - building the analysis model, Scenario based methods, UML Models.

Unit 3
Design engineering Design concepts, Design models, software architecture, architectural styles and patterns. Performing user interface Design-Golden Rules-User Interface Analysis and Design- Interface Analysis-Interface design steps.Testing strategies and tactics: Unit testing, integration testing, validation and system testing.

Text Book(s)
Pressman R S, Bruce R.Maxim. Software engineering - A Practitioner's Approach, Eighth Edition, Tata McGraw-Hill, 2014.

Reference(s)

Crowder JA, Friess S. Agile project management: managing for success. Cham: Springer International Publishing; 2015.
Stellman A, Greene J. Learning agile: Understanding scrum, XP, lean, and kanban. " O'Reilly Media, Inc."; 2014.
Gregory J, Crispin L. More agile testing: learning journeys for the whole team. Addison-Wesley Professional; 2014.
Rubin KS. Essential Scrum: a practical guide to the most popular agile process. Addison-Wesley; 2012.
Cohn M. User stories applied: For agile software development. Addison-Wesley Professional; 2004.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE465	INTRODUCTION TO BIG DATA ANALYTICS	L-T-P-C: 2-0-3-3

Pre-Requisite(s): 19CSE204 Object Oriented Paradigm**,** 19CSE303 Embedded Systems, 19MAT115 Discrete Mathematics

Course Objectives

- The aim of this course is to provide an introduction to big data technologies and tools used for big data.
- Basics of relational databases and its implementation strategy using SQL are discussed in the first phase.
- The second phase discusses on concepts big data and its architecture, storage and processing of data in parallel and distributed system.
- In the last phase retrieval and analysis of unstructured data are done using NOSQL databases.

Course Outcomes

CO1: Understand fundamental concepts of Databases and SQL.
CO2: Apply SQL for data storage and retrieval.
CO3: Understand fundamental concepts of Big Data and its technologies.
CO4: Apply Map reduce programming for big data.
CO5: Analyze appropriate NoSQL database techniques for storing and processing large volumes of structured and unstructured data.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										3	2
CO2	1	3	2										3	2
CO3		2	2	1	3								3	2
CO4		3	2	2	3								3	2
CO5				2	3								3	2

Syllabus
Unit 1
Introduction: Overview of DBMS, File vs DBMS, elements of DBMS, Relational Data Model: Introduction to relational model, Structure of relational mode, domain, keys, tuples to relational models. SQL – table creation, relationships, basic queries DML and DDL, Joins, Grouping.

Unit 2
Introduction to Big Data: Types of Digital Data - Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data-3Vs of Big Data -Terminologies in Big Data - CAP Theorem - BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vs NewSQL. Introduction to Hadoop: Features – Advantages – Versions - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs. Hadoop - Hadoop Components – Architecture – HDFS - Map Reduce: Mapper – Reducer - - Map Reduce: Mapper – Reducer – Combiner – Partitioner. Hadoop 2 (YARN): Architecture - Interacting with Hadoop Eco systems.

Unit 3

No SQL databases: Cassandra: Introduction – Features - Data types – CQLSH - Key spaces - CRUD operations – Collections – Counter – TTL - Alter commands - Import and Export - Querying System tables.

Text Book(s)

Seema Acharya, Subhashini Chellappan. Big Data and Analytics, Wiley Publication; 2015.

Reference(s)

Hurwitz JS, Nugent A, Halper F, Kaufman M. Big data for dummies. John Wiley & Sons; 2013.
White T. Hadoop: The definitive guide. " O'Reilly Media, Inc."; 2012.
Bradberry R, Lubow E. Practical Cassandra: a developer's approach. Addison-Wesley; 2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

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19CSE466	FOUNDATION OF INFORMATION TECHNOLOGY	L-T-P-C: 2-0-3-3

Course Objectives

- This course covers the basic concepts in computer science and engineering but not limited to object-oriented programming, database design and software engineering that aids the students of non-CSE to develop applications to solve real world problems.

Course Outcomes

CO1: Understand and Apply the fundamental concepts of Computer System and Computer Programming.
CO2: Apply Object Oriented Paradigm.
CO3: Design Relational Database Management system for a scenario.
CO4: Understand and Apply Software Engineering Principles.
CO5: Apply OOAD principles, Design UML and understand Testing Tools

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2											3	2
CO2	2	2											3	2
CO3	2	2		2									3	2
CO4	2	1											3	2
CO5	2	1											3	2

Syllabus
Unit 1
An Overview of the Computer System-The Parts of a Computer System, Operating System, Input, Output and storage devices, Basics of Networking - Types of Networks and Topology,Introduction to Programming using Scratch and Flowgorithm, Introduction to Object Oriented Paradigm: Abstraction, Encapsulation and Data Hiding, Classes and Objects, Methods, Inheritance and Polymorphism, Introduction to Python programming: Python data variables and operators, Control Structures, Strings, Functions – Built-in functions, User-defined functions and Recursion. Data Structures – List.

Unit 2
Database fundamentals: Data and Need for DBMS, Relational Model and Keys: Data representation and keys in RDBMS, Logical database Design: ER Modeling and notations, Physical Database Design: Converting ER model to Relational Schema. Normalization- Introduction – 1NF, 2NF, 3NF.Implementation with SQL – Introduction, Data types and operators in SQL, SQL statements, Built-in Functions, Group-By and CSE clause, Joins and sub queries. Transaction Management: ACID properties.

Unit 3
Introduction to Software Engineering, UML Diagrams: Object Oriented Analysis and Design, Role of UML in Object Oriented Analysis and Design, UML Building blocks: Structural Things, Behavioral, Grouping and Annotational.Relationships – Dependency, Association, generalization and Realization, UML- Class diagrams, Testing strategies

Text Book(s)

1. Electronic Resources at http://campusconnect.infosys.com/
2. Phillips D. Python 3 Object Oriented Programming. Packt Publishing Ltd; 2010.
3. Swaroop C H. A Byte of Python, ebshelf Inc; 2013.
4. Silberschatz A, Korth HF, Sudarshan S. System Concepts; 2010.
5. Pressman RS. Software engineering: a practitioner's approach. Palgrave Macmillan; 2014.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE467	PRINCIPLES OF DATABASE MANAGEMENT SYSTEMS	L-T-P-C: 2-0-3-3

Course Objectives

- This course presents the concepts of database, database design, normalization, database-system implementation and maintenance.

Course Outcomes

CO1: Understanding the purpose and architecture of DBMS.
CO2: Design of relational databases and writing SQL and PL/SQL statements to query relational databases.
CO3: Design and build ER models for sample databases.
CO4: Design and build a normalized database management system for real world databases.
CO5: Understand the principles of transaction processing and concurrency control.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	2	2	1	2	1	2	1	1	3	2
CO2	3	2	1	3	3	3	1	3	1	3	2	2	3	2
CO3	3	3	3	3	3	3	2	3	3	3	3	2	3	2
CO4	3	3	2	3	3	3	2	3	3	3	3	2	3	2
CO5	2	1	1	2	2	2	2	2	1	2	2	1	3	2

Syllabus

Unit 1
Introduction:History of database systems - Purpose of Database systems – File Systems Vs Database systems – Database architecture – Different Data models of Database.Relational Data Model: Structure of relational databases – Database schema – Formal Relational Query Languages. Database Design: Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas.

Unit 2
Relational Database Design: Different Normal forms: 1NF, 2NF, 3NF, BCNF and Higher Normal Forms, Decomposition using Functional Dependencies - Functional Dependency Theory - Multi-valued dependency - SQL: Introduction to SQL – Intermediate SQL.

Unit 3
Transactions: Transaction concept – A simple transaction model - Transaction atomicity and durability - Serializability – Recoverable schedules, Casecadeless schedules. Concurrency control: Lock-based protocols – Locks, granting of locks, The two-phase locking protocol, Graph-based protocols. Deadlock handling: Deadlock prevention, Deadlock detection and recovery.

Text Book(s)
Silberschatz A, Korth H F, SudharshanS. Database System Concepts, Sixth Edition, TMH publishing company limited; 2011.

Reference(s)

1. Đorđević-Kajan S. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom: Database system: The complete book. Facta universitatis-series: Electronics and Energetics; 2003.
2. Elmasri R, Navathe SB. Fundamentals of Database systems; 2006.
3. Ramakrishnan R, Gehrke J. Database management systems. McGraw Hill; 2000.

Evaluation Pattern

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment Theory(CAT)	10	
Continuous Assessment Lab(CAL)	40	
End Semester		30

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19CSE477	PRINCIPLES OF COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Course Objectives

- This course introduces the foundational principles of computer networks and the layered architecture
- This course focuses on network layer and transport layer in detail

Course Outcomes

CO1: To understand the basic concepts of networks, and signals.
CO2: To understand the transmission media and data link layer functionalities.
CO3: To analyze routing protocol and internetworking concepts.
CO4: To configure DNS and HTTP servers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	2		2								2	3	2
CO3	3	3	3	3	2							2	3	2
CO4	3	2	3	2	2							2	3	2

Syllabus

Unit 1
Introduction:-Data communications- Networks- The Internet - Protocols and standards. Network Models:- layered tasks , TCP/IP protocol suite, Addressing. Data and signals:- Analog and digital ,data rate limits, performance. Digital transmission: - digital –to digital conversion, Analog-to-digital conversion, transmission modes.

Unit 2
Transmission media: - guided media – unguided media (wireless). Switching: - Circuit switched networks, datagram networks, virtual circuit networks, structure of a switch. Data link layer - Error detection and corrections: - Introduction, block coding, linear block codes, cyclic codes, checksum. Data link control:- Framing, flow and error control, protocols, noiseless channels, noisy channel. Multiple Access: - Random access, Controlled access, Channelization. Wired LANs – Ethernet: - IEEE standards, Standard Ethernet, changes in the standard, Fast Ethernet, Gigabit Ethernet.

Unit 3
Network layer : IPv4 Addresses, IPv6 Addresses. Internet Protocols: - Internetworking, IPv4, IPv6, transition from IPv4 to IPv6. Transport Layer: process- to – process delivery, user datagram protocol, TCP. Overview of DNS and overview of HTTP.

Text Book(s)
Forouzan AB. Data communications & networking (sie). Tata McGraw-Hill Education; 2007.

Reference(s)
Stallings W. Data and computer communications. Pearson Education India; 2007.
Douglas E. Comer. Internet working with TCP/IP Volume -1, Sixth Edition, Addison-Wesley Professional; 2013.

Evaluation Pattern

Assessment	*Internal*	*External*
Mid term	20	
*Continuous Assessment	30	
End Semester		50

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19CSE282	PYTHON PROGRAMMING	L-T-P-C:0-0-3 1

Course Objective

This course provides the foundations of programming using Python programming language

Course Outcomes

CO1: Understand the given programming language constructs and solve and implement known problems using the same
CO2: Understand and apply advanced libraries in this programming language for real-time applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1				2								3		1
CO2	1	1	1	1	3								3		

Syllabus:

Introduction to Python: motivation for learning Python in scenarios like rapid prototyping.

Installing Python: basic syntax, interactive shell, editing, saving, and running a script.

The concept of data types: variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages;

Conditions, boolean logic, logical operators: ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation

Working with text files: manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated).

Lists, tuples, and dictionaries: basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values;
traversing dictionaries.

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Recursive functions.

Use of popular Python packages for scientific computing: Exercises to understand usage of libraries like *Numpy, SciPy, Pandas, Scikit-learn* in interpreted and script modes.

Use of libraries like *gpiozero, mraa, paho-mqtt, and requests* for IoT applications and hands-on exercises.

Text Book(s)

Guttag, John. *Introduction to Computation and Programming Using Python: With Application to Understanding Data Second Edition*. MIT Press, 2016. ISBN: 9780262529624.

William McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython,* Second edition (27 October 2017), Shroff/O'Reilly, ISBN-10: 9789352136414, ISBN-13: 978-9352136414

Hans Fangohr, Faculty of Engineering and the Environment, University of Southampton, *Introduction to Python for Computational Science and Engineering (A beginner's guide),* September 7, 2015. Online version available at: *https://www.southampton.ac.uk/~fangohr/training/python/pdfs/Python-for-Computational-Science-and-Engineering.pdf*

Reference(s)

Al Sweigart, Automate the Boring Stuff with Python, April 2015, ISBN-13: 978-1-59327-599-0, also available for free at https://automatetheboringstuff.com

gpiozero – A simple interface to GPIO devices with Raspberry Pi https://gpiozero.readthedocs.io

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignments, Projects, and Reports