Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

Third Year B. Tech.
(Computer Science and Engineering)
Sem - V to VI

AY 2020-21

ODD Semester

Professional Core (Theory) Courses

Title of the Course: Compiler Design **Course code:** 4CS301	L	T	P	Cr
	3	1	0	4

Desirable requirements: Formal Language and Automata Theory, Discrete Mathematics.

Textbooks:

1. D.M. Dhamdhere, "Systems Programming and Operating Systems", Tata McGraw- Hill Publishing Company limited, New Delhi, Second revised Edition, 2005.
2. A.V. Aho, R. Shethi and J.D. Ullman, "Compilers - Principles, Techniques and Tools", Pearson Education, Second Edition, 2007.

References:

1. K Cooper, L Torczon, "Engineering a Compiler", Morgan Kaufmann, Second Edition, 2011.
2. John J Donavan, "System Programming", Tata McGraw- Hill Publishing Company limited, New Delhi.
3. Sumitabha Das, "Unix Concepts and Administration", TMGH, 3rd Edition.
4. A.V. Aho, R. Shethiand J.D. Ullman, "Compilers - Principles, Techniques and Tools", Addison Wesley Publishing Company, 2007.

Course Objectives: This course will provide the in-depth knowledge of different concepts involved while designing a compiler.

- To introduce fundamentals of compiler design and various tools used to design a compiler
- To inculcate role of various phases involved during design of a compiler and impart in depth working of each phase.
- To exercise design of various phases of a compiler using compiler design tools and techniques.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Discuss** the need of compiler, fundamental concepts and various tools used to design a compiler.	2	Understanding
CO2	**Demonstrate** role and working of each phase involved during compilation.	3	Applying
CO3	**Analyze** the working of various phases of compiler.	4	Analyzing
CO4	**Assess** various phases of compiler using compiler design tools and techniques.	5	Evaluating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Fundamentals of Compiler **Overview**- Structure of a compiler, applications of compiler, one pass and two pass compiler. **Lexical analysis -** The role of a lexical analyzer, specification of tokens, recognition of tokens, LEX.	**6 Hrs.**
Module 2 Syntax Analysis Context-free grammar, writing grammars for context free environments, parse trees and ambiguity, role of parser, specification and recognition of tokens, top-down parsing, recursive descent and predictive parsers (LL), bottom-up parsing, operator precedence parsing, LR, SLR and LALR parsers.	**9 Hrs.**
Module 3 Syntax Directed Translation & Run time environments Syntax-directed definitions, evaluation orders for attributes of an SDD, S-attributed and L-attributed SDDs, construction of syntax tree, source language issues, storage organization and allocation strategies, parameter passing, symbol table organizations and generations, dynamic storage allocations.	**6 Hrs.**
Module 4 Intermediate Code Generation Intermediate languages, declarations, different intermediate representations –quadruples, triples, trees, flow graphs, SSA forms, and their uses; assignment statements and Boolean expressions, case statements, back patching, procedure calls.	**6 Hrs.**
Module 5 Code Optimization 1. Sources of optimization, basic blocks and flow graphs, optimization of basic blocks, loops in flow graphs, loop optimization, machine-independent optimization, machine-dependent optimization, dead-code Elimination, code improving transformations.	**6 Hrs.**
Module 6 Code Generation 2. Issues in the design of a code generator, run time storage management; simple code generator- register and address descriptors, code generation algorithm, design of the function *getReg*, DAG, peephole optimization, register allocation and assignment, selection of instruction, register allocation, parallel compilation, Just-in-Time compiler, study of compiler construction tools.	**7 Hrs.**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1: Fundamentals of Compiler

1. Discuss fundamental concepts of compiler design

2. Demonstrate working of lexical analysis.

Module 2: Syntax Analysis

1. Discuss the role of Syntax analyzer in the compilation process.
2. Demonstrate Top-Down and Bottom-up parsing techniques

Module 3: Syntax Directed Translation & Run time environments

1. Analyze the working of various three address code representation for intermediate code representation
2. Discuss the importance of syntax directed translation in compiler design

Module 4: Intermediate Code Generation

1. Demonstrate intermediate code generation phase in compiler design.

Module 5: Code Optimization

1. Demonstrate the code optimization during compiler construction

Module 6: Code Generation

1. Discuss various issues and algorithms involved in code generation phase of a compiler
2. Assess six phases of compiler using compiler design tools and techniques.

Title of the Course: Design and Analysis of Algorithm **Course code:** 4CS302	L	T	P	Cr
	3	-	-	3

Desirable requirements: Data structure

Textbooks:

1. Ellis Horowitz, Sartaj Sahni and Rajasekaran "Fundamentals of Computer Algorithms" , Galgotia Publications, 2nd Edition.
2. Aho, Hopfcraft and Ullman, Addison Wesley "Design and Analysis of Algorithms",

References:

1. Thomas Cormen, Leiserson, Rivest, and Stein "Introduction to Algorithms", PHI Publication. 3rd Edition, 2009
2. Goodman ,"Introduction to Design and Analysis of Algorithm", McGraw Hill.
3. R.C.T. Lee, S.S. Tseng, R.C. Chang, "Introduction to the Design and Analysis of Algorithm", Tata McGraw Hill.

Course Objectives :

1. To illustrate and apply the algorithm analysis techniques.
2. To discuss the efficient algorithm for various problem
3. To explain and demonstrate different algorithm techniques for real world problem
4. To compute and prove complexity class of various algorithm techniques

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	**Discuss** the fundamentals of algorithm design and analysis techniques.	2	Understanding
CO1	**Apply** knowledge of computing and mathematics to algorithm design	3	Applying
CO3	Critically **analyze** the various algorithm design techniques for a given problem.	4	Analyzing
CO4	**Classify** computational problems into P, NP, NP-Hard and NP-Complete.	5	Evaluating
CO5	**Design** efficient algorithms to improve complexity of existing algorithm.	6	Creating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction	**6 Hrs.**
Introduction to Algorithm Analysis Time and Space Complexity, Elementary operations and Computation of Time Complexity-Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms. Recurrence Equations: Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods. Master's theorem for complexity computation.	
Module 2: Divide and conquer	**7 Hrs.**
Binary Search, Merge sort , Quick sort , Heap Sort , Multiplication of Large Integers, Closest-Pair and Convex, Hull Problems, Strassen's Matrix Multiplication.	
Module 3: Greedy Technique	**6 Hrs.**
Greedy Technique – Container loading problem, Job sequencing with deadlines, Minimum cost spanning trees, Knapsack problem, Optimal Merge pattern, Huffman Trees.	
Module 4: Dynamic Programming	**7 Hrs.**
Principle of optimality – Coin changing problem, Computing a Binomial Coefficient – Floyd's algorithm – Multi stage graph – Optimal Binary Search Trees – 0/1 Knapsack problem and Memory functions.	
Module 5: Backtracking	**6 Hrs.**
Backtracking-General method, applications The 4, 8-queen problem, sum of subsets problem, graph coloring, Hamiltonian cycles.	
Module 6: Graph Traversal Techniques & Class of problem	**7 Hrs.**
Techniques for Graphs – Breadth First Search & Traversal, Depth First Search & Traversal, Topological sorting of DAGs AND/OR graphs, Connected components P, NP, NP- Complete and NP Hard Problems, Approximation Algorithms for NP-Hard Problems.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1: Define fundamental notation of algorithm representation and discuss complexity calculation

methods

Module 2: Apply divide and conquer approach to solve real world problem

Module 3: Provide solution to given problem by identifying optimal greedy algorithm

Module 4: Study Dynamic Programming method and identify the various problems which can be solved by using Dynamic programming

Module 5: Identifying various problem which are optimally solvable using backtracking approach

Module 6: Compare BFS and DFS graph traversal techniques by solution various problem. Discuss and classify complexity class analyzing complexity of different problem

Title of the Course: Computer Graphics **Course code:** 4CS303	L	T	P	Cr
	2	0	0	2

Pre-Requisite Courses: C/C++ Programming, Data Structures & Files, Java Programming

Textbooks:

1. "Mathematical Elements for Computer Graphics", David F. Rogers, J Alan, Adams, TMGH, 2nd Edition
2. "Procedural Elements for Computer Graphics", David F. Rogers, TMGH, 2nd Edition
3. "Interactive Comp. Graphics, A Top-Down Approach using OpenGL", Edward Angel, Pearson, 5th Edition

References:

1. Procedural Elements for Computer Graphics by David F.Rogers, TMH publication.
2. Mathematical Elements for Computer Graphics by David F. Rogers and J. A. Adams, TMH publication.
3. Computer Graphics, principles & practices by J.D. Foley, A. van Dam, S.K. Feiner and J.F. Huges, Addison Wesley.
4. Computer Graphics, C version, by D. Hearn and M.P. Baker, Pearson Education.
5. Computer Graphics, a programming approach, by S. Harrington, TMH publication.
6. Computer Graphics by A.N. Sinha and A.D. Udai, TMH publication
7.

Course Objectives:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
2. To learn the basic principles of 3- dimensional computer graphics.
3. Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
4. Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
5. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.
6. To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Perceive** the fundamental concepts of Computer Graphics.	2	Understanding
CO2	**Handle** different transformation algorithms.	3	Applying
CO3	**Execute** 2D Clipping Algorithms	3	Applying
CO4	**Appraise** acquired transformations with projection using modern tools.	4	Analyzing
CO5	**Rehash** technique of computer animation and its relationship with image and storage.	4	Analyzing

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE

Course Contents:

Module 1 Introduction to computer Graphics	**Hrs.**
Introduction to computer graphics: Definition, Input and output Devices, **Introduction to graphics primitives** such as points, lines, polygons, etc.; representation of pictures using primitives; storage & retrieval of pictures; . Rasterization techniques: **Line** – DDA; Bresenham's generalized integer version; Mid-point rasterization. **Circle** – Bresenham's algorithm; Mid-Point algorithm 1st order difference & 2nd order difference methods.	**4**
Module 2 2D and 3D introduction	**Hrs.**
2D Scan conversion & polygon filling: Active-Edge-List (y-bucket) scan conversion of lines & polygons; Edge –fill , simple Seed –fill & Scan –line seed –fill algorithms. **2D Geometric transformations:** Introduction to representation of 2D objects as matrices; transformation matrices for scaling, shear, rotation, reflection **3D Geometric transformations:** Introduction to representation of 3 D objects as matrices; transformation matrices for scaling, shear, rotation, reflection	**5**
Module 3 2D Clipping	**Hrs.**
Clipping against regular window – Explicit line clipping; Sutherland & Cohen line clipping, Mid-point subdivision line clipping; Sutherland & Hodgemann polygon clipping.	**4**
Module 4 Projection	**Hrs.**
Introducing the idea of projecting 3D object on to 2D plane; broad classification – parallel & perspective projection; different types of parallel projection & examples of each; formal definition of 3D to 2D projection and derivation of projection matrix; 1-point, 2-point & 3-point perspective projection; formal derivation of vanishing point(s) and physical implication of the same.	**4**

Module 5 Computer Animation	Hrs.
Introduction, Key frame animation, Construction of an animation sequence, Motion control methods, Procedural animation, Key-frame animation vs. Procedural animation, Introduction to Morphing, Wraping techniques, Three dimensional morphing.	5
Module 6 Image Manipulation and Storage	**Hrs.**
What is an Image? Digital image file formats, Image compression standard – JPEG, Image Processing - Digital image enhancement, contrast stretching, Histogram Equalization, smoothing and median Filtering.	4

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module wise Measurable Students Learning Outcomes:

After the completion of the course the student should be able to:

The student after completing the course will be able to:

Module 1

1. Differentiate Vector & Raster graphics.
2. Draw graphic entities with maximum correctness over screen alias.

Module 2

1. Represent the object in plane/space coordinate system.
2. Animate the object with linear and rotational move.

Module 3

1. Color objects with different filling algorithms and compare their time & space requirements.
2. Display images on discrete computer screens with minimum possible errors.

Module 4

1. View objects in parallel, perspective mode; as well eliminate the invisible edges & surfaces.
2. Decide upon what to and where to display on the comp. screen.

Module 5

1. Draw axis/parameter dependent mathematical curve paths.
2. Understand their applications in the field of design, engineering, manufacturing, animation etc.

Module 6

1. Different image formats.
2. Have primary efforts towards lighting, shading, rendering, texturing the objects.

ODD Semester

Professional Core (Lab) Courses

Title of the Course: Design and Analysis of Algorithm Lab **Course code:** 4CS352	L	T	P	Cr
	-	-	2	1

Desirable requirements: Data structure

Textbooks:

1. Ellis Horowitz, Sartaj Sahni and Rajasekaran "Fundamentals of Computer Algorithms" , Galgotia Publications, 2nd Edition.
2. Aho, Hopfcraft and Ullman, Addison Wesley "Design and Analysis of Algorithms",

References:

1. Thomas Cormen, Leiserson, Rivest, and Stein "Introduction to Algorithms", PHI Publication. 3rd Edition, 2009
2. Goodman ,"Introduction to Design and Analysis of Algorithm", McGraw Hill.
3. R.C.T. Lee, S.S. Tseng, R.C. Chang, "Introduction to the Design and Analysis of Algorithm", Tata McGraw Hill.

Course Objectives :

1. Learn key techniques for designing and analyzing algorithms.
2. Study fundamental concepts and notations used in Algorithm design.
3. Study and apply different algorithm design methods namely, greedy method, divide and conquer, dynamic programming and backtracking.
4. Study the Parallel architectures for designing parallel algorithms.
5. Design and analyze the complexities of various algorithms following above methods.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Practice** different algorithm techniques for given problem.	3	Applying
CO2	**Identify** appropriate data structure to implement selected algorithmic approach	4	Analyzing
CO3	**Design** and **Implement** an algorithm for complex problem in polynomial time.	6	Creating
CO4	**Exhibit** technical and professional skill to demonstrate and convince accomplished algorithmic solution.	3	Applying

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Lab Assessment:
There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Laboratory Experiments:

Students will be given hands on experience to design and implement efficient and effective algorithms for various problems based on syllabus covered in the course Design and Analysis of Algorithm in the

Practical hours using any suitable programming language like C, C++,Java. The List of experiments may include 12 to 14 experiments from among the following-

1. To implement sorting algorithm using array as a data structure and analyse its time complexity for

different values of n. The large number of elements may be generated using Random Number

generator or may be stored in a file. (Quick Sort, Merge Sort)

2. To implement different search techniques using array and/or trees and analyze their time

complexity. (Linear, Binary, Binary recursive)

3. To implement Fractional Knapsack problem and activity selection problem using Greedy method.

4. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's& Prim’s algorithm

and compare.

5. To apply Greedy method to solve problems of

a) Job sequencing with deadlines

b) Optimal storage on tapes

6. Implement the following using Dynamic Programming

a) Matrix-chain multiplication

b) Longest common subsequence

c) Optimal binary search trees

7. To implement Strassen's matrix multiplication algorithm

8. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

9. Find a subset of a given set S = {s1,s2,.....,sn} of n positive integers whose sum is equal to a given positive integer d. For example, if S= {1, 2, 5, 6, 8} and d = 9 there are two solutions {1,2,6} and {1,8}. A suitable message is to be displayed if the given problem instance doesn't have a solution.

10. Implement any scheme to find the optimal solution for the Traveling Salesperson problem and then solve the same problem instance using any approximation algorithm and determine the error in the approximation.

11. Implement the following using Back Tracking

a) 8-Queen's problem

b) Hamiltonian cycle

c) Graph coloring Problem

12. Write a program to

a) Print all the nodes reachable from a given starting node in a digraph using BFS method.

b) Check whether a given graph is connected or not using DFS method.

13. Implement All-Pairs Shortest Paths Problem using Floyd's algorithm. Parallelize this algorithm by creating multiple threads and determine the speed-up achieved.

14. Compare and evaluate the performance of different Randomization and Approximation algorithms.

Title of the Course: Computer Graphics Lab **Course code: 4CS353**	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses: C/C++ Programming, Data Structures & Files, Java Programming

Textbooks:

1. "Mathematical Elements for Computer Graphics", David F. Rogers, J Alan, Adams, TMGH, 2nd Edition
2. "Procedural Elements for Computer Graphics", David F. Rogers, TMGH, 2nd Edition
3. "Interactive Comp. Graphics, A Top-Down Approach using OpenGL", Edward Angel, Pearson, 5th Edition

References:

1. Procedural Elements for Computer Graphics by David F.Rogers, TMH publication.
2. Mathematical Elements for Computer Graphics by David F. Rogers and J. A. Adams, TMH publication.
3. Computer Graphics, principles & practices by J.D. Foley, A. van Dam, S.K. Feiner and J.F. Huges, Addison Wesley.
4. Computer Graphics, C version, by D. Hearn and M.P. Baker, Pearson Education.
5. Computer Graphics, a programming approach, by S. Harrington, TMH publication.
6. Computer Graphics by A.N. Sinha and A.D. Udai, TMH publication

Course Objectives:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
2. To learn the basic principles of 3- dimensional computer graphics.
3. Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
4. Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
5. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.
6. To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Outline** the fundamental concepts of Computer Graphics.	2	Understanding
CO2	**Illustrate** the fundamental concepts of computer graphics with its different transformations using algorithms.	3	Applying
CO3	**Solve** different algorithms on 2D clipping	3	Applying
CO4	**Investigate** acquired transformations with projection.	4	Analyzing
CO5	**Scrutinize** technique of computer animation and figure out relation with image and storage.	4	Analyzing

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Practicals:

Minimum 8 experiments will be performed to understand functioning of Computer graphics & its visualization. The list contains;

1. Practical based on C/C++ graphics library.
2. Introductory OpenGL programming.
3. Visualization of Data Sets.
4. 2D Transformations.
5. 3D Transformations and animation.
6. Line/Circle generation algorithm.
7. Polygon filling algorithms.
8. Hidden line/surface elimination algorithms (Z Buffer)
9. Curve Generation (Cubic spline, Bezier).
10. Study of Multimedia-file formats. (BMP-JPG/WAV-MP3/DAT-MPG etc).
11. Visualization applications / Case tools/ animation using Multimedia concepts

Title of the Course: Mini Project 1 **Course code:** 4CS341	L	T	P	Cr
	-	-	2	1

Desirable requirements: Nil

Textbooks: Nil

References:

Course Objectives :

1. To use latest design and development tools.

2. To undergo project management techniques and project design principles.

3. To implement the project with appropriate programming languages and testing tools.

4. To develop analytical vision and skills to analyse, compare the outcome with other techniques.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	recognise present technological trends through seminar and presentation	1	Remembering
CO2	articulate the appropriate selection of software tool for project implementation.	2	Understanding
CO3	engage in teams and produce group activities of software development	3	Applying
CO4	develop a software product and demonstrate its significance	4,5	Analyzing,Evaluating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments:

Lab Assessment:
There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
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Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Course Contents:

1. Students should maintain a project log book containing weekly progress of the project

2. At the end of the semester project group should achieve all the proposed objectives of the problem statement.

3. The work should be completed in all aspects of design, implementation and testing.

4. Project report should be prepared and submitted in soft and hard form along with all the code and datasets.

5. Group should demonstrate the work with various test cases and results obtained and explain future scope.

6. The group should participate in technical symposiums, paper presentations to demonstrate their work and findings in technical community.

Title of the Course: Programming Lab 3	L	T	P	Cr
Course code: 4CS354	**0**	**0**	**4**	**2**

Desirable Requirement: Basics of Object-Oriented Programming

Textbooks:

1. Jennifer Niederst Robbins, "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", O'Reilly Media, 5th Edition, 2018, ISBN-13: 978-1491960202.
2. Robin Nixon, "Learning PHP, MySQL & JavaScript with j Query, CSS & HTML5", O'Reilly Media, 5th Edition, 2018, ISBN-13: 978-9352130153

References:

1. Robert W. Sebesta, "Programming the World Wide Web", Pearson, 8th Edition, 2015, ISBN-13: 9780133776058
2. Terry Ann Felke-Morris, "Basics of Web Design: HTML5 & CSS", Pearson, 5th Edition, 2019, ISBN-13: 9780133970746
3. Elliotte Harold, W. Means, "XML in a Nutshell, A Desktop Quick Reference", O'Reilly Media 3rd Edition, 2004, ISBN-13: 9780596007645.

Online References:

1. https://www.w3schools.com/
2. https://www.javatpoint.com/
3. https://developer.mozilla.org/en-US/docs/Web

Course Objectives:

Summary:

World Wide Web (WWW) is an information storing, retrieval and sharing system/service where web resources such as documents, audios, videos, images, etc. are identified by Uniform Resource Locator (URL), which may be interlinked by hypertext and are accessible over the Internet.

Many web programming languages are required to create web pages that may be published on the WWW. This course introduces some of them, such as Hyper Text Markup Language (HTML), Cascading Style Sheet (CSS), Client-side scripting language – JavaScript and library of JavaScript, server-side scripting language – PHP or Node.js or any other state-of-the-art, Data Interchange Formats - XML and JSON, and AJAX. The course also introduces the basics of web security. Students will learn these technologies and tools and will be able to develop websites for individual learning and for socio-economic cause.

Following are the objectives of this course:

1. to inculcate understanding of World Wide Web, Internet, the concepts of web applications development and web programming languages.
2. to introduce selection of appropriate concepts of internet and web programming such as HTML, CSS, JavaScript, and other server-side scripting languages.
3. to infuse skills of combining different components and technologies to design a web application for real world problem.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**summarize** the different concepts and components of WWW, web development technologies and web security.	2	Understanding
CO2	**illustrate** the concepts of different web development technologies using different web development tools.	3	Applying
CO3	**test** the components of WWW, HTML tags, CSS properties, client-side and server-side programming concepts, web data representation formats and AJAX components using different web development tools.	4	Analyzing
CO4	**classify** the components of WWW, HTML tags, CSS properties, client-side and server-side programming concepts, web data representation formats, AJAX components and web security threats and measures.	5	Evaluating
CO5	**build** a web application, individually or in a team by combining different web development technologies and web security measures for real world problems using different web development tools.	6	Creating

CO-PO Mapping: (Use 1,2,3 as correlation strengths)

PO and PSO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	**2**	**1**				**1**								
CO2	**3**	**2**	**2**	**3**	**3**									**1**
CO3		**3**		**2**	**2**									
CO4		**2**		**2**	**3**	**1**								
CO5			**3**	**2**	**3**	**1**			**3**					**2**

1: Low, 2: Medium, 3: High

Assessments:

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Course Contents:

Module 1: Introduction to World Wide Web	**Hrs.**
Client, Server, Communication, Protocols, Ports, Client-Server Architectures, Internet, World Wide Web, HTTP, HTTP Status Codes, Web Clients/Browsers, and Web Servers. **Experiments:** 1. Describe client, server, communication, ports, protocols, HTTP, browsers and web servers. 2. Distinguish between client and server, Internet, WWW, and client-server architectures. 3. Get header information of a web page using browser's developer mode. 4. Installation of web server.	**4**
Module 2: Markup Languages and Building Web Pages	**Hrs.**
Introduction to Markup Languages, Introduction to HTML and HTML5, Fundamental HTML Elements, HTML Forms, HTML Media, HTML Graphics, HTML APIs, HTML Web Components. **Experiments:** 1. Design and develop web pages using fundamental HTML elements, such as head, title, body, header, comment, etc. 2. Design and develop web pages using HTML Formatting elements, such as abbr, address, etc. 3. Design and develop HTML Forms using HTML Form and Input elements, such as form, input, textarea, etc. 4. Design and develop web pages that embed images and client-side maps. 5. Design and develop web pages that embed audio and video. 6. Design and develop web pages that embed links. 7. Design and develop web pages that embed lists and tables. 8. Design and develop web pages with styles, semantics and layouts, such as header, footer, section, data, div, etc. 9. Design and develop web pages to embed YouTube videos. 10. Design and develop web pages that embed graphics using canvas and SVG. 11. Design and develop web pages using HTML APIs. 12. Design and develop web pages using web components.	**10**
Module 3: Style sheet Languages and Presentation of Web Pages	**Hrs.**
Introduction to style sheet languages, Introduction to Cascading Style Sheet (CSS), Text Formatting, Colors and Backgrounds, Borders and Margins, Floating and Positioning, Page Layout, Navigation Bars and Dropdowns, CSS Selectors. **Experiments:** 1. Design and develop web pages by applying CSS text formatting properties, such as Text Alignment, Text Decoration, Text Transformation, Text Spacing, Text Shadow, Font Family, Font Style, Font Size, etc. 2. Design and develop web pages by applying CSS colors and backgrounds properties, such as color, RGB, HEX, HSL values, background image, background color, etc. 3. Design and develop web pages by applying CSS borders and margin properties, such as Border Width, Border Color, Margins, etc.	**8**

4. Design and develop web pages by applying CSS floating, overflow and positioning properties, such as float, overflow, position, etc. 5. Design and develop web pages by applying CSS page layout properties, such as display, padding, height, width, max-width, align, etc. 6. Design and develop web pages by applying CSS properties to links, lists and tables. 7. Design and develop web pages by using CSS navigation bars and dropdowns. 8. Design and develop web pages by using CSS Selectors. 9. Design and develop web pages by using inline CSS, internal CSS and external CSS.	
Module 4: Client-side Programming	**Hrs.**
JavaScript: Introduction to JavaScript, Basic Syntax, Variables, Data Types, Statements, Operators, Conditions, Loops, Functions, Arrays, Objects, Form Validation, DOM, JavaScript Objects, JavaScript Functions, Asynchronous JavaScript and any one of the state-of-the-art JavaScript libraries. **Experiments:** 1. Implement a script using JavaScript that changes HTML content, HTML attributes hides and show HTML elements, HTML output and window alert box for web pages. 2. Implement a script using JavaScript that shows use of JavaScript variables, data types and statements for web pages. 3. Implement a script using JavaScript that shows use of JavaScript Arithmetic, Assignment and String Concatenation operations for web pages. 4. Implement a script using JavaScript that shows use of JavaScript conditionals and loops for web pages. 5. Implement a script using JavaScript that shows use of JavaScript Functions, Arrays, and Objects for web pages. 6. Implement a script using JavaScript that shows use of Asynchronous JavaScript. 7. Design and develop web pages and insert JavaScript in head tag, body tag, external file, external URL and external folder. 8. Implement a script using JavaScript library.	**10**
Module 5: Server-side Programming	**Hrs.**
Introduction to Server-side Programming, Installation of Web and database Server, Process user input, Efficient storage and delivery of information to and from databases, File handling and controlled access to the content, store session/state information, cookies, notifications and communication. **Note:** 1. One of the following server-side scripting languages can be used for the implementation: PHP, Node.js, or other state-of-art scripting languages. 2. One of the following databases can be used for data storage and retrieval: MySQL, MongoDB, Firebase or other state-of-art databases. **Experiments:** 1. Installation and configuration of web server and database server. 2. Implement basic functionalities of server-side scripting language, such as data types, operators, conditionals, and loops. 3. Implement basic functionalities of server-side scripting language, such as objects, arrays, and functions. 4. Implement web page form validations using server-side scripting language.	

5. Implement file handling using server-side scripting language. 6. Implement cookies using server-side scripting language. 7. Implement sessions using server-side scripting language. 8. Implement CRUD operations on database using server-side scripting language.	
Module 6: Representation of Web Data, AJAX and Web Security	**Hrs.**
XML: Introduction to XML, Basics of XML, DTD, Namespaces, XHTML, XPath, XLinks, XQuery and XSLT. **JSON:** Introduction to JSON, JSON vs XML, Syntax, Data Types, Parse, Stringify, Objects and Arrays, JSON in HTML. **AJAX:** Introduction to AJAX, XMLHttpRequest, AJAX XML, AJAX PHP, and AJAX Database. **Web Security:** Introduction, types of web threats, and prevention measures. Experiments: 1. Create a XML file and display in the browser. 2. Create a XML file with the help of namespaces and display in the browser. 3. Create a DTD file and display in the browser. 4. Create and display XSLT file using XML and display in the browser. 5. Create XSLT file using XPath and XPointer and display in the browser. 6. Create a hyperlink using XLinks and display in the browser. 7. Create and display JSON files in HTML. 8. Create a JSON file using basic concepts and use it in HTML. 9. Extract and display the information using XQuery. 10. Implement an AJAX Request-Response with server. 11. Implement an AJAX Request-Response using PHP. 12. Implement an AJAX Request-Response with database. 13. Implementing basic security measures in web development.	**10**

ODD Semester

Professional Elective (Theory) Courses

Title of the Course: Machine Learning **Course code: 4CS311**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Basic Programming, Probability theory and linear algebra

Textbooks:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

References:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill
2. http://nptel.ac.in

Course Objectives :

1. To introduce some of the basic concepts of machine learning from a mathematically well motivated perspective
2. To cover the different machine learning paradigms and some of the popular algorithms and architectures used in each of these paradigms

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	explain fundamental issues and challenges and algorithms of machine learning	2	Understanding
CO2	demonstrate and use various algorithms and models with the mathematical justifications	3	Applying
CO3	measure strengths and weaknesses of various machine learning approaches and use appropriate machine learning algorithms for real-world applications.	5	Evaluating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction	**7 Hrs.**
Introduction to Machine Learning, Concepts of Supervised and Unsupervised Learning, Statistical Decision Theory : Linear and Multivariate Regression, Dimensionality Reduction	
Module 2 : Linear Classification and SVM	**6 Hrs.**
Linear Classification, Linear Discriminant Analysis, Support Vector Machine	
Module 3 : Bayesian Learning and Decision Trees	**7 Hrs.**
Maximum Likelihood estimate, Priors and MAP estimate, Decision Trees	
Module 4 : Evaluation Measures and Hypothesis Testing	**6 Hrs.**
Evaluation Measures, Bootstrapping and cross validation, ROC curve Hypothesis Testing : Basics, Sampling Distributions and Z test, t-test	
Module 5 : Graphical and Gaussian Mixture Models	**7 Hrs.**
Graphical Models : Bayesian Networks, Hidden Markov Models Learning Theory and Expectation Maximization: Gaussian Mixture Model, Expectation Maximization	
Module 6 : Reinforcement Learning	**6 Hrs.**
Introduction to Reinforcement Learning, RL framework and TD learning, Applications	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1: Explain fundamentals of machine learning and decision theory

Module 2: Demonstrate the knowledge of Linea classification, support vector machines

Module 3: Demonstrate and use the concepts of Bayesian Learning and decision trees

Module 4: Explain and apply evaluation measures an hypothesis testing for problem solving

Module 5: Explain and use Graphical and Gaussian mixturee models of machine learning

Module 6: Explain reinforcement learning, its framework and practical applications

Title of the Course: Digital Image Processing **Course code:** 4CS312	L	T	P	Cr
	3	-	-	3

Desirable requirements:

Textbooks:

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, 4th Edition. 2018, PHI
2. A. K. Jain, Fundamentals of Digital Image Processing, PHI

References:

1. Milan Sonka, Vaclav Hlavac, Boyle, Digital Image Processing and Computer Vision, Cengage Learning
2. S. Jayaraman, S. Esakkirajan, T. Veerkumar, Digital Image Processing, Tata McGrawHill
3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing Using MATLAB, 2nd ed.

Course Objectives :

1. To learn fundamental of digital image processing.
2. To learn the concepts of image enhancement, image segmentation, compression etc and apply the algorithms to build applications.
3. To compare various algorithms and select the appropriate for a particular application.
4. To create initial background of the area of Image Processing to excel in this stream for further research.
5. To develop engineering skills and intuitive understanding of the tools used in Image Processing.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Discuss** general terminology of digital image processing.	2	Understanding
CO2	**Apply** and **demonstrate** image processing algorithms in practical applications	4	Applying
CO3	**Illustrate** and **critique** different techniques employed for the enhancement, segmentation, morphology and compression of images	5	Evaluating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Digital Image Fundamentals	**6 Hrs.**
Introduction and applications, Fundamental Steps and Components of Image Processing System Digital Image Fundamentals: Image Acquisition, A simple image model, Sampling and Quantization, Imaging Geometry, Different types of digital images	
Module 2: Image Transforms	**6 Hrs.**
2D systems and Necessary Mathematical preliminaries, 2D Orthogonal and Unitary Transforms, DFT, KL-Transforms, Cosine, Hadamard Transforms, Introduction to Wavelet Transforms	
Module 3: Image Enhancement	**6 Hrs.**
Point Processing, Basic Gray Level Transformations, Histogram Processing, Spatial domain Filtering, Frequency domain filtering	
Module 4: Image Segmentation and Analysis	**8 Hrs.**
Edge Detection – using first and second order derivatives, LoG, Canny edge detector, Boundary Extraction – Connectivity, Heuristic Graph Search, Hough Transform, Active Contour, Watershed Transform, Region-based Segmentation – region growing, region splitting and merging, Feature Extraction	
Module 5: Morphological Image Processing	**7 Hrs.**
Mathematical Morphology, Erosion and Dilation, Opening and Closing, Hit-or-Miss transformation, Basic morphological algorithm: Boundary extraction, Hole filling, Extracting of connected components. Thinning, Thickening	
Module 6: Image Compression	**6 Hrs.**
Fundamentals, Compression model, Lossless Vs Lossy Compression, Fundamentals of Information Theory, Run-length coding, Huffman coding, Dictionary-based compression, Predictive coding, Transform-based coding, Image Compression Standards	

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

Module 1
Describe the fundamental concepts of Image Processing and its applications.
Module 2
Explain Image Processing Transforms which play significant role in image enhancement, filtering, analysis and compression**.**
Module 3
Implement various techniques to improve the quality of an image.
Module 4
Explain segmentation which is one of the most important steps leading to image analysis, learning and implementing various methods to divide an image into parts or groups of pixels which are homogeneous with respect to some criterion**.**
Module 5
Describe fundamentals of Morphological Image Processing and its operations
Module 6
Explain the need of image compression i.e. the technique of reducing the amount of data required to represent a digital image.

Title of the Course: Internet(Web) of Things **Course code: 4CS313**	L	T	P	Cr
	3	-	-	3

Desirable Requirements:

Textbooks:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, “Internet of Things”, Wiley, 2019.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.

References:

1. Stefan Poslad, *“*Ubiquitous Computing: Smart Devices, Environments and Interactions”, Wiley, 2009.
2. Arshdeep Bahga and Vijay Madisetti "Internet of Things: A Hands-on Approach", Universities Press.

Course Objectives :

1. Enrich students with the new revolutionary pervasive ubiquitous computing knowledge.
2. Unleash the prerequisites and concepts enabling Internet of Things.
3. Explore protocols, architectures, communication technologies & devices of Internet of Things.
4. Acquaint learners with the successful case studies of potential applications of Internet of Things.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom’s Cognitive	
		level	Descriptor
CO1	cognize with the concepts of Internet of Things.	2	Understanding
CO2	explore the architecture, various protocols used in enabling Internet of Things frameworks.	4	Analyzing
CO3	articulate and appraise hands on experiments in Internet of Things.	5	Evaluating
CO4	prepare aptitude to implement concepts of Internet of Things technologies in real life applications.	6	Creating

CO-PO Mapping :

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2			1	1										
CO3					2									
CO4				3		1	1						1	

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Introduction to IoT: Concepts- Things in IoT, Principles, Characteristics , Benefits, IoT Stack Layers, Enabling Technologies, Challenges, IoT Levels	**5**
Module 2	**Hrs.**
Sensors, Protocols & Wireless communication for IoT: Sensor types, Protocol Standardization for IoT, MQTT, CoAP, IPv6, URI, M2M and WSN Protocols – SCADA and RFID Protocols. Machine-to-Machine Communications Wireless Communications: IEEE802.11 Standards, BLE, Zigbee, Context aware sensor networks. Issues with IoT Standardization – Unified Data Standards	**6**
Module 3	**Hrs.**
Development & Embedded Technologies Interoperability in IoT: Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino IDE, Raspberry Pi Architecture, Configuration and programming, Python support.	**7**
Module 4	**Hrs.**
IoT Cloud Platforms: Introduction, Types, Various application development platforms viz AWS, Azure, Adafruit, ThinkSpeak, Ubidots etc , Architecture , IoT with Cloud Challenges, Selection of Cloud service provider for IoT applications overview, Fog Computing, Online	**6**

databases viz Firebase	
Module 5	**Hrs.**
IoT Architectures & Governance: Standard Architectures, Resource Management in the IoT, IoT Privacy, Security and Governance challenges. Profile user identification techniques viz RFID, Image processing.	**5**
Module 6	**Hrs.**
Internet of Things Application Scenarios: Smart Transportation, infrastructure, Health care systems, Smart City automation, Home automation, Tracking, Over-The-Air passive surveillance, Control application examples, Heating ventilation and Air conditioning applications.	**5**

Module wise Measurable Students Learning Outcomes :

Module wise Outcomes

At end of each module students will be able to,

Module 1: cognize with the fundamental concepts of IoT, such as principles, characteristics , benefits, IoT stack layers, enabling technologies, challenges and Levels.

Module 2: Explore and be able to analyse knowledge of Sensors,Protocols & Wireless communication used in IoT technology. Also realizes the Issues with IoT Standardization.

Module 3: experiment development using embedded technologies such as Arduino and Raspberry Pi in detail with Python support.

Module 4: exposed to IoT Cloud Platforms, with exploration on types, Various application development platforms , architecture , challenges, how to select cloud service provider application wise. Also students will grab brief knowledge about latest Fog Computing and online databases.

Module 5: aware about standardization , resource Management , privacy, security and Governance challenges. Also brief know-how on profile user identification techniques.

Module 6: taught to potential application Scenario as case studies so as to realize how to apply IoT learning to meet suitable cross domain societal challenges.

ODD Semester

Open Electives Courses

Title of the Course: Software Engineering and Database Essential **Course code:** 4OE371	**L**	P	T	CR
	3	0	0	3

Pre-Requisite Courses:-NIL

Textbooks:

1. Pankaj Jalote, *"An integrated approach to S/W engineering",*Narosa Publishers, 2nd Edition.
2. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, *Database System Concepts*, Mc-Graw Hill, 4th Edition 2002 / 6th Edition 2011
3. Pankaj Jalote, "Software Project Management in practice", Pearson education

References:

1. Roger S. Pressman, *"Software Engineering: Practitioner's Approach"*. McGraw Hill
2. Raghu Ramakrishnan and Johannes Gehrke, *Database Management Systems*, 3rd Edition. 2002

Course Objectives :

1. Understand importance of engineering approach to software development and comprehend the knowledge of software processes & models practiced at IT industries.
2. Be acquainted with the SDLC phases in detail and appreciate the importance of software quality by virtue of software testing methods.
3. To use conceptual designs to prepare database schemas.
4. To understand the relational model and the theoretical issues associated with relational database Design.
5. To learn SQL and Database Architectures.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	explain proficiency to undertake software projects based on software engineering practices.	2	Understanding
CO2	summarizing the spirit of team-working in SDLC phases & project planning benefits.	2	Understanding
CO3	describe the conceptual designs of Database, identifies the need, analyze the problem and Design ER diagram as well as prepare the relational database schema.	1,4	Remembering, Analyzing
CO4	apply SQL to extract required information from the database. Compare, analyses various ways of writing the queries for a given problem and Differentiating database Architecture.	4	Analyzing.

CO-PO Mapping : *1: Low, 2: Medium, 3: High*

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**
CO1	3					2	1						3
CO2			3						3		1		
CO3			3	1									
CO4		2		2								1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction Software Engineering Basics: Software Crisis, Need of software engineering approach. **Software Processes:** Software Processes: project management process, software development process models, Configuration management process, process management process.	**7 Hrs.**
Module 2: Software Quality & Project Planning **Notion of Software Quality:** Quality objectives, Need for improvement, Software quality factors, Quality standards, **Project Planning Basics:** Project management plan, Cost estimation, Project scheduling, Staffing and personnel Planning, Risk management.	**6 Hrs.**
Module 3: Software Development Phases Software Requirement Process, Design principles, Structured design methodology, Coding Standards, levels of Testing.	**6 Hrs.**
Module 4:Introduction and Database Modeling using ER Model ***Introduction*:** General introduction to database systems, its advantages and applications, Database System Architecture, Database users and Administrator, Data models, Database management system, Database languages, View of Database, Data Models. **ER *Model*:** Entity set, Entity types, attributes, Notations, Relationship sets, Relationship types, Keys- super key, candidate key, primary key, Extended Features of ER Model-Generalization, Specialization and aggregation	**6 Hrs.**

Module 5: Relational Model and SQL **Relational *Model*:** Structure of Relational Database, Reduction of ER model into Relational schemas, Schema-instance distinction, Key , Relational algebra, Tuple relation calculus, Domain relational calculus, Example queries, ***SQL*:** Introduction to SQL, Data definition statements with constraints, Insert, Update and Delete, Set Operations, Aggregate functions group by and having clauses, Nested Queries, Views, Joins.	**8 Hrs.**
Module 6:Database Architectures Centralized &Client-Server architectures, server system architecture, Architectures for parallel databases, Distributed database concepts, Homogeneous & Heterogeneous databases, distributed data storage, data fragmentation, and replication and allocation techniques for distributed database.	**6 Hrs.**

Module wise Measurable Students Learning Outcomes :

The student after completing the course will be able to:

Module 1: Introduction Software Engineering

- Awareness of Software processes & Models used at IT.

Module 2: Software Quality & Project Planning

- Understand quality parameters and standards.
- Know project planning phases and responsibilities.

Module 3: Software Development Phases

- As per SDLC phase understand requirement process and need of SRS artifact.
- Understand functional & non-functional requirements as well. Realize the importance of design aspects, concepts & methodology. Practices to learn how to draw DFD on requirements.
- Know testing concepts, levels of testing

Module 4: Introduction and Database Modeling using ER Model

- Understanding the concept of database system and its applications.
- Studying database system architecture and various database models.
- Understanding the problem statement and preparing the conceptual model using ER diagram.

Module 5: Relational Model and SQL

- Studying relational data model using any RDBMS.
- Extracting information from the database using SQL

Module 6: Parallel and Distributed Databases and C/S architectures

- Awareness of Database Architectures and its operation.

ODD Semester

Minor Specialization Courses

Title of the Course: Database Engineering **Course code:** 1CSM03	L	T	P	Cr
	3	0	0	3

Desired requirements: Data structure

Textbooks:

Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", Mc-Graw Hill, 4th Edition 2002 / 6th Edition 2011/ 7th Edition

References:

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, 3rd Edition. 2002
2. Ramez Elmasri and Shamkant Navathe, Benjamin Cummings, Fundamentals of Database Systems, 3rd Edition, 1999 / later

Course Objectives :

1. To enable the students to understand various functional components of database system and basic concepts of conceptual database design.
2. To use conceptual designs to prepare database schemas.
3. To make the students understand the relational model and the theoretical issues associated with relational database design.
4. To make the students learn and use SQL, understanding of essential DBMS concepts such as: database security, indexing, transaction processing, and concurrency.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** the fundamental database management system	2	Understanding
CO2	**Apply** ER model and relational model for database design of given problem	3	Applying
CO3	**Demonstrate** SQL query using open source or commercialize database.	3	Applying
CO4	**Illustrate** the fundamentals for database storage, indexing, transaction and concurrency control	2	Understanding

CO-PO Mapping :

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	**1**												**1**	
CO2		**2**												
CO3					3								**1**	
CO4	**1**	**2**												

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction	**Hrs. 5**
General introduction to database systems, its advantages and applications, Database System Architecture, Database users and Administrator, Data models, Database management system, Database languages, View of Database, Data Models.	
Module 2 Database Modelling using ER Model	**Hrs. 7**
Entity set, Entity types, attributes, Notations, Relationship sets, Relationship types, Keys- super key, candidate key, primary key, Extended Features of ER Model-Generalization, Specialization and aggregation	
Module 3 Relational Model & SQL	**Hrs. 8**
Structure of Relational Database, Reduction of ER model into Relational schemas, Schema-instance distinction, Referential integrity and foreign keys. Introduction to SQL, Data definition statements with constraints, Insert, Update and Delete, Set Operations, Aggregate functions group by and having clauses	
Module 4 Relational Database Design	**Hrs. 7**
Importance of a good schema design, Motivation for normal forms, Atomic domains and 1NF, Dependency theory - functional dependencies, Closure of a set of FD's, Definitions of 2NF, 3NF	
Module 5 Data Storage and Indexing	**Hrs. 5**
File organization, Organization of records in files, Data Dictionary, Database Buffer, and **Indexing**: Concept, Ordered Indices-Primary, Secondary	
Module 6 Transaction, Concurrency Control and Database security	**Hrs. 7**
Transaction processing: Concept, ACID properties, Transaction states , Serializability **Concurrency control**: Lock-based protocols, Timestamp - based Protocols, **Database security**: Authentication, Authorization and access control, Discretionary Access Control (DAC), Mandatory Access Contro (MAC)	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1

- explain the concept of database system and its applications.
- demonstrate database system architecture and various database models.

Module 2

- understand the problem statement and preparing the conceptual model using ER diagram..

Module 3

- describe and implement relational data model using any RDBMS..
- extract information from the database using SQL, compare various SQL constructs

Module 4

- demonstrate and use the concept of functional dependency and various normal forms for “good” database design

Module 5

- explain file organization concepts and various indexing techniques

Module 6

- explain the concept of transaction and implement transactions.
- describe and compare various concurrency control mechanisms and apply the concepts for hands-on experimentation.
- Illustrate different aspect of database security

EVEN Semester

EVEN Semester

Professional Core (Theory) Courses

Title of the Course: Cloud Computing **Course code:** 4CS321	L	T	P	Cr
	3	-	-	3

Desirable Requirements: Operating system, Computer Networks

Textbooks:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski ,"Cloud Computing: Principles and Paradigms", Wiley, 1 Edition 2013
2. Gautam Shroff, "Enterprise Cloud Computing - Technology, Architecture, Applications", Cambridge University Press, 2010
3. Ronald L. Krutz, Russell Dean Vines ,"Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley- India,2010

References:

1. Barrie Sosinsky,"Cloud Computing Bible", Wiley-India, 2010

Course Objectives :

1 An understanding of fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges.
2 Providing basic ideas and principles in cloud management techniques, virtualization techniques and cloud software deployment considerations.
3 Exploring cloud computing driven open source and commercial systems and applications.

Course Learning Outcomes:

CO	**After the completion of the course the student should be**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Distinguish concepts of distributed paradigm from other computing paradigm and the mechanism of inter process communication in distributed systems.	2	Understanding
CO2	Describe main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing.	2	Understanding
CO3	Illustrate different cloud infrastructure models, cloud computing architecture and various deployment models.	3	Applying
CO4	Classify different hypervisors and virtualization techniques based on their characteristics.	4	Analyzing
CO5	Identify core issues of cloud computing such as security, privacy, and interoperability.	4	Analyzing
CO6	Examine the components of Open and commercial cloud platform	4	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1													
CO2		2											2	
CO3		2											1	
CO4		2											1	
CO5		2											1	
CO6		2	2											

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Principles of distributed computing Eras of computing, Elements of distributed computing – General concepts and definitions, components of a distributed system, architectural styles for distributed computing, models for inter-process communication, Technologies for distributed computing – Remote procedure call, distributed object frameworks, service oriented computing.	**Hrs. 7**
Module 2:Introduction to Cloud Computing Cloud Computing (NIST Model)Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers Properties, Characteristics & Disadvantages,Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing, Role of Open Standards.	**Hrs. 5**
Module 3: Cloud Computing Architecture Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models (XaaS), Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud.	**Hrs. 7**
Module 4: Virtualization Introduction, characteristics of virtualized environments, Taxonomy of virtualization Techniques, Virtualization and cloud computing, Pros and Cons of virtualization, technology Examples.	**Hrs. 6**
Module 5 : Cloud Security Type of attack, Security stack of IaaS, PaaS, SaaS, Gartner's seven cloud computing security Risks, Other cloud security issues: Virtualization, Access Control and identity Management, Application security, Data life cycle management	**Hrs. 6**
Module 6: Case Study on Open Source & Commercial Clouds Eucalyptus ,Microsoft Azure ,Amazon EC2,Google App Engine, Open Stack, Open Nebula	**Hrs. 8**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:
Module 1:Describe elements of distributed computing along with concepts inter process communication paradigm
Module 2: Describe advantage of cloud computing over grid computing
Module 3: Demonstrate models of cloud deployment and services offered by cloud model
Module 4: Distinguish among available virtualization techniques
Module 5. Discuss and Identify security and privacy issues in cloud computing.
Module 6. Deploy and analyse applications over commercial cloud computing infrastructures such as Amazon Web Services, Windows Azure, and Google AppEngine. Also demonstrate open source cloud building software

Title of the Course: Advanced Database Systems **Course code:** 4CS322	L	T	P	Cr
	3	0	0	3

Desirable requirements : Database Engineering

Textbooks:

1. Silberschatz, Korth, Sudarshan "Database system concepts" MGH 6th Edition.
2. Raghu Ramkrishnan "Database Management System" MGH

References:

1 Thomas Connolly & Carolyn Begg "Database Systems : A practical approach to design, implementation &Management" Pearson 3rd Edition
2. RamezElmasri and ShamkantNavathe, "Fundamentals of Database Systems" Benjamin Cummings, 2nd Ed, 1994.
3. Open source databases official websites

Course Objectives:

1. An understanding of the fundamentals in object based databases and explore the database centric design issues involved in application development, the advances in database system.
2. Providing the methodology to implement the complex and real world database applications.
3. Evaluation and analysis of the different types of advanced databases.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Exploit** the fundamental concepts involved in advanced databases and **apply** it in complex data handling.	3	Applying
CO2	**Analyze** the architectures and performance of different databases using **modern tools** for domain specific applications.	4	Analyzing
CO3	**Recommend** the optimal database based solution to solve real world problem.	5	Evaluating
CO4	**Apply** the acquired knowledge in databases to **design** and **build** the different business applications.	6	Creating

CO-PO Mapping :

PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												2	
CO2					2								2	2
CO3			2										2	
CO4			3										1	3

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE

Course Contents:

Module 1 Object-Based Databases	**Hrs.**
Overview, Complex Data Types, Structure Types and Inheritance in SQL, Table Inheritance, Arrays and Multiset Types in SQL, Object-Identity and Reference Types in SQL, Implementing O-R Features, Object-Relational Mapping	**5**
Module 2 Application development & Administration	**Hrs.**
Application Programs and User Interfaces, Application Architectures, Standardization , Rapid Application Development, Application Performance, Application Security. Performance Tuning, Performance Benchmarks, Other issues in Application Development	**7**
Module 3 Parallel and Distributed databases	**Hrs.**
Parallel databases : I/O parallelism, inter-query parallelism, intra-query Parallelism, intra-operation parallelism, inter-operation parallelism, Query Optimization.	**4**
Distributed databases : Homogeneous & heterogeneous databases, distributed data storage, distributed transactions, concurrency control in distributed databases, distributed query processing, Heterogeneous distributed databases.	**4**
Module 4 Cloud Databases – I	**Hrs.**
Introduction, Architecture of a cloud data storage system, Data Models, Transactions and replication, Deployment models, Comparison of Relational databases and Cloud databases, Challenges to develop Cloud Databases.	**5**
Module 5 Cloud Databases – II	**Hrs.**
Case study of following NoSQL databases : Voldmort , MongoDB , Cassandra , Neo4J , Cloud Native , Data Lake	**8**
Module 6 Spatial, Temporal Data and Mobility	**Hrs.**
Motivation, Time in Databases, Spatial and Geographic Data, Multimedia Databases, Mobility and Personal Databases.	**6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1

1. **Describe** the fundamental concepts involved in object databases
2. **Apply** the concept in complex data handling.

Module 2

1. **Make** use of acquired knowledge to build and demonstrate the different business applications.
2. **Devise** the performance of the enterprise application

Module 3

1. **Evaluate** parallel and distributed databases
2. **Analyze** their performance for enterprise application

Module 4

1. **Explain** cloud database architecture and data models
2. **Compare** it with relational database

Module 5

1. **Illustrate** different open source cloud database
2. **Design** and build the applications using cloud database

Module 6

1. **Explain** the advances in databases beyond the traditional models
2. **Discuss** and evaluate the temporal , spatial and multimedia databases

EVEN Semester

Professional Core (Lab) Courses

Title of the Course: Advanced Database System Laboratory **Course code:** 4CS372	L	T	P	Cr
	0	0	2	1

Desirable requirements : Database Engineering

Textbooks:

1. Silberschatz, Korth, Sudarshan "Database system concepts" MGH 4th Edition
2. Raghu Ramkrishnan "Database Management System" MGH

References:

1. Thomas Connolly & Carolyn Begg "Database Systems : A practical approach to design, implementation & Management" Pearson 3rd Edition
2. RamezElmasri and ShamkantNavathe, "Fundamentals of Database Systems" Benjamin Cummings 2nd Ed, 1994
3. Official websites of open source databases

Course Objectives:

1. Practicing the concepts/techniques studied in theory course.
2. Providing hands-on with different database servers / platforms / tools.
3. Designing and implementation of the database based applications.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Scrutinize** different database servers, application architectures / models, frameworks and **identify** optimal one, suitable for particular application.	4	Analyzing
CO2	**Select** the advanced/modern databases and **recommend** for prediction and modeling of complex real world data.	5	Evaluating
CO3	**Design** and **build** the different enterprise applications using modern tools.	6	Creating

CO-PO Mapping :

PO And PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1				**2**									**2**	
CO2					**2**								**2**	
CO3					**3**						**1**		**2**	**3**

1: Low, 2: Medium, 3: High

Assessments :

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Course Contents

1. Minimum 12 assignments or 6 mini-projects should be practice/perform based on the understanding of concepts covered in theory course.
2. The detail list of assignments/mini-projects will be display by subject teacher.
3. Explore to all the state of the art technology related to each module in theory course.
4. Use industry standard development tools for above laboratory work.
5. All assignments/laboratory work should follow software engineering standards.

Title of the Course: Mini Project 2 **Course code:** 4CS342	L	T	P	Cr
	-	-	2	1

Desirable requirements: Nil

Textbooks:

Nil

References:

Course Objectives :

1. To use latest design and development tools
2. To undergo project management techniques and project design principles.
3. To implement the project with appropriate programming languages and testing tools
4. To develop analytical vision and skills to analyse, compare the outcome with other techniques

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	recognise present technological trends through seminar and presentation.	1	Remembering
CO2	articulate the appropriate selection of software tool for project implementation.	2	Understanding
CO3	engage in teams and produce group activities of software development.	3	Applying
CO4	develop a software product and demonstrate its significance	4, 5	Analysing, Evaluating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Lab Assessment:
There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Course Contents:

1. Students should maintain a project log book containing weekly progress of the project

2. At the end of the semester project group should achieve all the proposed objectives of the problem statement.

3. The work should be completed in all aspects of design, implementation and testing.

4. Project report should be prepared and submitted in soft and hard form along with all the code and datasets.

5. Group should demonstrate the work with various test cases and results obtained and explain future scope.

6. The group should participate in technical symposiums, paper presentations to demonstrate their work and findings in technical community.

EVEN Semester

Professional Elective (Theory) Courses

Title of the Course: Soft Computing **Course code:** 4CS331	L	T	P	Cr
	3	0	0	3

Desirable requirements:

Textbooks:

S. Rajasekaran, G.A.VijayalakshmiPai *"Neural Networks, Fuzzy Logic and Genetic Algorithms",* , PHI

(ECE).

References:

1. MIT-OCW

2. Hertz, Krogh, Palmer*"Introduction to the Theory of Neural Computation"*

3. B. Yegnanarayana, PHI, *"Artificial Neural Networks"*,

4. David E. Goldberg, Addison Wesley**,** *"Genetic Algorithms"*

Course Objectives :

1. Understand comparative performance of soft and hard computing approaches.

2. Provide to students a sound foundation of mathematical, scientific and engineering principles to formulate, solve and analyze learning problems using soft computing.

3. Imbibe capability for innovation in soft computing.

4. Understand hybrid applications of ANN, Fuzzy and GA

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	interpret soft computing schemes using knowledge of discrete mathematics, data structures, theory of computer science and computer architectures.	2	Understanding
CO2	demonstrate machine learning processes.	3	Applying
CO3	compare and analyze soft computing schemes.	4	Analyzing
CO4	design schemes using soft computing	6	Creating
CO5	evaluate various schemes of soft computing	5	Evaluating

CO-PO Mapping :

PO and PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2			3										**2**	
CO3		**3**		2										
CO4			3										**2**	
CO5				3										

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally the last three modules) covered after MSE.

Course Contents:

Module 1: Module 1 Fundamentals of Neural Networks	**5 Hrs.**
Basics:Human Brain, Model of Artificial Neuron, Neural Network Architectures, Characteristics of Neural Networks, Learning Methods; McCulloch-Pitts Model; Optimization Problems.	
Module 2: Back propagation Networks (BPN)	**9 Hrs.**
BPN Architecture, Back propagation learning, applications: Parity Problem, Encoder Decoder, NETtalk and DEC-talk, Character Recognition, Learning Time Sequences, Cognitron; CNN, RCNN, Softmax and one application of each.	

Module 3: Unsupervised Learning	**4 Hrs.**
Introductions, ARTI Architecture, ART1 Algorithm, Kohonen's Algorithm, Applications of ART1	
Module 4: Fuzzy Systems	**6 Hrs.**
Crisp logic; Predicate Logic; Fuzzy logic: Fuzzy Quantifiers, Fuzzy Inference; Fuzzy Rule Based System; Defuzzification Methods, Application	
Module 5: Genetic Algorithm	**9 Hrs.**
Fundamentals: Biological background, Creation of Offsprings, Working Principle, Encoding, Reproduction ; Mathematical Foundations; Data Structure: Mutation, Crossover, Selection; Applications	
Module 6: Hybrid Systems	**6 Hrs.**
Integration of neural networks, fuzzy logic and genetic algorithms: Hybrid Systems; Neuro-Fuzzy hybrids, Neuro-Evolutionary Hybrids, Fuzzy-Evolutionary Hybrids, GA-based BPN, Simplified Fuzzy ARTMAP	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1: Understand fundamentals of neural networks / models..

Module 2: Use back propagation network for pattern recognition.

Module 3: Use unsupervised network for pattern clustering.

Module 4: Apply fuzzy logic for control and decision making applications.

Module 5: Use Genetic algorithms for soft computing.

Module 6: Understand and Compare hybrid systems for efficient soft computing applications.

Title of the Course: Computer Vision **Course code:** 4CS332	L	T	P	Cr
	3	0	0	3

Desirable requirements : Digital Image Processing

Textbooks:

1. Richard Szeliski ,Computer Vision: Algorithms and Applications, Springer , September 3, 2010.
2. D. A. Forsyth, J. Ponce ,Computer Vision: A Modern Approach, Pearson Education, 2003.
3. Sonka, Hlavac, Boyle, Digital Image Processing and Computer Vision, Cengage Learning (2008)

References:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga ; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Course Objectives :

1. To illustrate fundamentals of Computer Vision.
2. To write and apply computer vision concepts.
3. To study and compare various algorithms of computer vision.
4. To design scheme of computer vision.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Illustrate fundamentals of computer vision.	3	Applying
CO2	Compare a different algorithms of computer Vision.	4	Analyzing
CO3	Measure performance of different computer vision algorithm.	5	Evaluate
CO4	Design a scheme of computer vision to solve real life problem.	6	Creating

CO-PO Mapping :

PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												3	
CO2		3											3	
CO3		2											3	
CO4			3										3	

1: Low, 2: Medium, 3: High

Assessments :

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weight age for course content (normally last three modules) covered after MSE.

Teacher Assessment:
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Course Contents:

Module 1 Introduction	**Hrs.**
What is computer vision? A brief history, Structure from motion, Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion, Dense motion estimation.	**8**
Module 2 Image stitching	
Motion models, Global alignment, Compositing.	**6**
Module 3 Computational photography	
Photometric calibration, High dynamic range imaging, Super-resolution and blur removal Image matting and compositing, Texture analysis and synthesis.	**7**
Module 4 Stereo correspondence	
Epipolar geometry, Sparse correspondence ,Dense correspondence, Local methods, Global optimization, Multi-view stereo, 3D reconstruction.	**6**
Module 5 Image-based rendering	
View interpolation, Layered depth images, Light fields and Lumigraphs, Environment mattes, Video-based rendering.	**7**
Module 6 Recognition	
Object detection, Face recognition, Instance recognition, Category recognition, Context and scene understanding, Recognition databases and test sets	**5**

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

Module 1:
Describe the fundamental concepts of computer vision and its applications.
Module 2:
Explain Image stitching.
Module 3:
Understand texture analysis and synthesis.
Module 4:
Explain 3D reconstruction of images.
Module 5:
Describe different Image based rendering algorithm.
Module 6:
Implementation of different Recognition algorithm.

Title of the Course: Advanced Computer Network **Course code**: 4CS333	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Computer Network and Data Communication

Textbooks:

"Mobile Computing" Asoke K Telukder, Roopa R Yavagal, TMH 2

References:

1. *"Mobile Communications"* Jochen Schiller, Pearson.
2. *"Wireless Communications and Networks 3G and beyond"* ITI Saha Misra, TMH**.**
3. *"Principle of wireless Networks"* by Kaveh Pahlavan and Prashant Krishnamurthy, Pearson 2002.

Course Objectives :

To study the evolving wireless technologies and standards
To understand the architectures of various access technologies such as 3G, 4G, WiFi etc.
To understand various protocols and services provided by next generation networks.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	interpret the voice and data communication through various networks	2	Understanding
CO2	Apply knowledge of TCP/IP extensions for mobile and wireless networking.	3	Apply
CO3	Analyze security, mobility, scalability, and their unique characteristics in wireless networks.	4	Analyzing

CO-PO Mapping :

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		**1**												
CO2		**2**										**1**	**2**	
CO3						2								

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Basic history of Mobile Computing	**Hrs.**
Architecture for mobile computing, Three tier architecture, design considerations for mobile computing, mobile computing through internet, Wireless network architecture, Applications, Security, Concerns and Standards, Benefits, Future. Evolution of mobile computing.	**6**
Module 2: Overview of Wireless n/w. and Technologies-I	**Hrs.**
Introduction, Different generations. Introduction to 1G, 2G, 3G and 4G, Bluetooth, Radio frequency identification(Rfid),Wireless Broadband, Mobile IP: Introduction, Advertisement, Registration, TCP connections, two level addressing, abstract mobility management model, performance issue, routing in mobile host, Adhoc networks, Mobile transport layer: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, transaction oriented TCP.	**7**
Module 3 Overview of Wireless n/w. and Technologies-II	**Hrs.**
Wireless network topologies, Cell fundamentals and topologies, Global system for mobile communication, Global system for mobile communication (GSM), Short message services, Security in wireless networks.	**7**
Module 4: General packet radio service (GPRS)	**Hrs.**
GPRS and packet data network, GPRS network architecture, GPRS network operation, data services in GPRS, Applications of GPRS, Billing and charging in GPRS.	**6**
Module 5: Infrastructure and ad-hoc network	**Hrs.**
System Architecture, Protocol Architecture, Medium Access Control layer, MAC Management, Wireless LAN advantages, IEEE 802.11a, 802.11b standards ,Wireless LAN architecture, Mobility in Wireless LAN, Deploying Wireless LAN, Mobile ad hoc networks and sensor networks, wireless LAN security.	**6**
Module 6: Wireless Application Protocol (WAP)	**Hrs.**
WAP, MMS, GPRS application CDMA and 3G Spread-spectrum Technology, FHSS, DSSS, CDMA versus GSM, Wireless data, third generation networks, applications in 3G Wireless LAN, WiFi v/s 3G Voice over Internet protocol and convergence, Voice over IP,H.323 framework for voice over IP, SIP, Real time protocols, voice over IP applications, IMS, Mobile VoIP, Security issues in mobile Information security, security techniques and algorithms, security framework for mobile environment.	**8**

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

Module 1 :

- understand the concepts of Mobile Computing

Module 2 :

- discuss the architectures of various access technologies such as 3G, 4G, WiFi etc.

Module 3 :

- understand the wireless network technologies and security issues

Module 4 :

- understand the basic principles and architecture of GPRS

Module 5 :

- discuss the system architecture and mobility in wireless networks.

Module6 :

- getting familiar with Wireless Application Protocols

Title of the Course: Remote Sensing & Geographic Information System **Course code:** 4CS334	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Fundamentals of Image processing

Textbooks:

1. Chandra, A.M. and Ghosh, S.K., "Remote Sensing and GIS", Narosa Publishing House. 2008
2. Lo, C.P. and Young, A.K.W., "Concepts and Techniques of Geographical Information System", Prentice Hall India. 20012

References:

1. Lillesand, T.M. and Kieffer, "Remote Sensing and Image Interpretation", - 6th Edition, John Wiley and Sons. 2012

2. Chang, K, "Introduction to Geographical Systems", 4th Edition, Tata McGraw-Hill. 2010

Course Objectives :

1. To introduce the fundamentals of Remote Sensing (RS) and geographical information systems (GIS)
2. To explore various Remote Sensing satellites, their characteristics and data products.
3. To inculcate advantages, limitations and interdisciplinary applications of RS and GIS.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Explain fundamental concepts of RS and GIS	2	Understanding
CO2	Interpret and Apply various satellite sensor data and data products	3	Applying
CO3	Demonstrate GIS data and GIS database management system	3	Applying
CO4	Compare and Analyze RS and GIS data using modern tools and techniques	4	Analyzing
CO5	Select and Verify suitable RS and GIS data and data products to design solution for various interdisciplinary problems using RS and GIS tools and techniques.	5	Evaluating

CO-PO Mapping :

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**2**													
CO2	**3**												**2**	
CO3	**3**												**2**	
CO4		**2**			3								**3**	**3**
CO5			2		2								**3**	**2**

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last

three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Concepts and Foundation of Remote Sensing Introduction, Remote Sensing System, Electromagnetic Energy, Electromagnetic Spectrum and its Characteristics, Energy Interaction in the Atmosphere and with the Earth's Surface, Resolution in Remote Sensing, Applications of Remote Sensing.	**7**
Module 2	**Hrs.**
Sensors, Platforms and Satellite Data Products Broad Classifications of Sensors and Platform, Earth Observation Satellite and Sensors, Data Reception, Transmission and Processing, Remote Sensing Data and Data Products	**6**
Module 3	**Hrs.**
Satellite Image Interpretation and Processing Interpretation Procedure and Elements, Interpretation strategies and keys, Digital Image processing and Image Analysis steps, Image Rectification and Restoration, Image Enhancement, Image Transformation, Image Classification and Analysis.	**7**
Module 4	**Hrs.**
GIS – An Overview Introduction, Geographical concepts and Terminology, Difference between Image Processing system and GIS, Various GIS packages and their salient features, Essentials components of GIS, Utility of GIS, Applications of GIS	**5**
Module 5	**Hrs.**
GIS Data Introduction, GIS Data types and Data Representation, Data Acquisition, Georeferencing of GIS Data, Raster and Vector data, Raster to Vector conversion, Remote Sensing Data in GIS, GIS Database and Database Management System	**8**
Module 6	**Hrs.**
Spatial Data Analysis Measurements in GIS-Lengths, Perimeters, and Areas, Queries, Reclassification, Buffering and Neighborhood Functions, Map Overlay, Spatial Interpolation, Analysis of Surfaces, Network Analysis.	**6**

Module wise Measurable Students Learning Outcomes :
After the completion of the course the student should be able to:

Module 1: Understand Fundamentals of RS.
Module 2: Classify various Earth Observation Satellites and Examine their characteristics.
Module 3: Analyze satellite images through Digital Image Processing
Module 4: Understand Fundamentals of GIS.
Module 5: Understand GIS data types and analyze GIS data.
Module 6: Relate different measures of GIS and Design solutions to various problems.

Title of the Course: Deep Learning **Course Code:** 4CS335	L	T	P	Cr
	3	-	-	3

Desirable requirements: Working knowledge of Linear Algebra, Statistics and Probability Theory

Textbooks:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville Deep Learning, MIT Press, 2016
2. Aurelien Geron, " Hands-On Machine Learning with Scikit-Learn & TensorFlow", O'REILLY, Dec 2017

References:

1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007
3. Prof. Mitesh M. Khapra, "Deep Learning", course on NPTEL, July 2018
4. Andrew Ng, "Deep Learning Specialization", Coursera online course

Course Objectives :

1. To explain the fundamentals of neural networks, recurrent neural networks (RNN), long short term memory cells and convolutional neural networks (CNN).
2. To demonstrate various learning models for practical application.
3. To discuss CNN, RNN and Generative model according to accuracy and speed evaluation parameter's

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Illustrate** fundamentals of deep learning using foundation of mathematics terminology	2	Understanding
CO2	**Compare** various deep learning models by hyper tuning various parameters	4	Analyzing
CO3	**Demonstrate** various case studies of deep learning.	3	Applying
CO4	**Design** and deploy deep learning models on various frameworks and platform.	6	Creating

CO-PO Mapping :

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

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three

modules) covered after MSE.

Course Contents:

Module 1: Introduction to Deep Learning	**7 Hrs.**
Neural network fundamentals: General Introduction to Deep Learning, Perceptron algorithm, Back propagation and Multi-layer Networks. **Image fundamentals**: Pixels, Image coordinate, scaling and aspect ratios	
Module 2: Parameterized Learning and Optimization Methods	**6 Hrs.**
Parameterized Learning: Introduction to linear classification, Four components of parameterized learning, role of loss function. **Optimization Methods**: Optimization Methods: Gradient descent, stochastic gradient descent (SGD) and extensions to SGD, regularization	
Module 3: Convolutional Neural Networks (CNN)	**7 Hrs.**
Understanding Convolutions: Convolutions versus Cross-correlation, The "Big Matrix" and "Tiny Matrix" Analogy, Kernels, A Hand Computation Example of Convolution The Role of Convolutions in Deep Learning. **CNN Building blocks**: Layer Types, Convolutional Layers, Activation Layers , Pooling Layers , Fully-connected Layers , Batch Normalization , Dropout, ShallowNEt, LeNet, MiniVGGNET	
Module 4: Deep learning based object detection	**6 Hrs.**
Fundamentals of Object detection, Family of R-CNN, Single shot detectors (SSD), You only look once (YOLO)	
Module 5: Sequence Models	**7 Hrs.**
Recurrent Neural Networks, Vanishing gradients, Gated Recurrent Units (GRU), Long-short-term-memories (LSTMs)	
Module 6: Generative Models	**6 Hrs.**
Autoencoders, Variational Autoencoders, Generative Adversarial Networks	

Module wise Measurable Students Learning Outcomes :

Students will be able

Module 1: To understand fundamentals of deep learning

Module 2: Identify various methods of Fine tuning of optimization parameter

Module 3: Design CNN model for different application

Module 4: Understand object detection using CNN model and to analyze performance.

Module 5: Compare various sequence model architectures.

Module 6: Demonstrate generative model on a simple Dataset

EVEN Semester

Professional Elective (Lab) Courses

Title of the Course: Advanced Web and Mobile Application Development Laboratory **Course code:** 4CS381	L	T	P	Cr
	0	**0**	**4**	**2**

Desirable Requirement: Programming Lab 3

Textbooks:

1. Vasan Subramanian, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node", Apress, 2nd Edition, 2019, ISBN-13: 978-1484243909
2. Azat Mardan, "Full Stack JavaScript: Learn Backbone.js, Node.js, and MongoDB", Apress, 2nd Edition, 2018, ISBN-13: 978-1484237175
3. Neil Smyth, "Android Studio 3.6 Development Essentials - Java Edition: Developing Android 10 (Q) Apps Using Android Studio 3.6, Java and Android Jetpack", Payload Media, 2020, ISBN-13: 978-1951442156

References:

1. Dawn Griffiths, David Griffiths, "Head First Android Development", O'Reilly Media, 2nd Edition, 2017, ISBN: 9781491974056
2. Rick Boyer, "Android 9 Development Cookbook: Over 100 recipes and solutions to solve the most common problems faced by Android developers", Packt Publishing Limited, 3rd Edition, 2018, ISBN-13: 978-1788991216
3. Felipe Coury, Ari Lerner, Carlos Taborda, "ng-book: The Complete Guide to Angular", Createspace Independent Publishing Platform, 5th Edition, 2018, ISBN-13: 978-1985170285

Online References:

1. www.w3schools.com
2. https://developer.android.com/docs
3. Official framework websites for Documentation/Help

Course Objectives:

Summary:

Since its invention, World Wide Web (WWW) has impacted every area of human life. It is continuously evolving and new technologies are being added every few months to make it better in terms of ease of development, User Interface (UI) and User Experience (UX), ease of use, and many more to count on. Also, with the development of smartphone technology, people are relying more on the smartphones because of its portable nature, equal amount of processing power as compared to the computers, ease of use, support from third party apps, etc.

This course introduces students to the state-of-the-art front-end, back-end web and mobile app development frameworks/libraries and tools. Students will learn these technologies and tools, debug and test their projects done with these technologies and tools and can deploy/publish their projects/app over the internet.

1) to inculcate understanding of state-of-the-art front-end and back-end development frameworks of web programming and mobile app development tools.
2) to introduce selection of appropriate concepts from different state-of-the-art frameworks/libraries and tools for developing a web and mobile app.
3) to infuse skills of combining different components from state-of-the-art technologies to design a web and mobile app to solve real world problems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**summarize** the concepts of various state-of-the-art front-end, back-end web and mobile app development technologies & frameworks.	2	Understanding
CO2	**illustrate** the concepts of various state-of-the-art front-end, back-end web and mobile app development technologies & frameworks using different web development tools.	3	Applying
CO3	**test** the concepts and components of various state-of-the-art front-end, back-end web and mobile app development technologies & frameworks using web development tools.	4	Analyzing
CO4	**select** appropriate front-end, back-end web and mobile app development technologies, frameworks, tools and their components to solve real-world problems.	5	Evaluating
CO5	**build** a web app and/or mobile app, individually or in a team by combining various state-of-the-art front-end, back-end and/or mobile app development technologies & frameworks for real-world problems.	6	Creating

CO-PO Mapping:

PO and PSO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	**2**	**1**												**1**
CO2	**3**	**2**	**2**	**3**	**3**									**2**
CO3		**3**		**2**	**2**									**1**
CO4		**2**		**2**	**3**									**1**
CO5			**3**	**2**	**3**				**3**					**2**

1: Low, 2: Medium, 3: High

Assessments:

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25

Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Module 1: Web Application Framework/Library – Part 1	**Hrs.**
State-of-the-art Front-End Framework library: One of the following technologies will be considered: Angular, React.js or other state-of-the-art front-end development framework/library. **Experiments:** 1. Installing framework and configuring Integrated Development Environment (IDE), and its dependencies. 2. Creating workspace, project and setting up the necessary environment. 3. Implementing the fundamental syntaxes and components of the framework. 4. Building and testing the application. 5. Deploying the application.	**10**
Module 2: Web Application Framework/Library – Part 2	**Hrs.**
State-of-the-art Front-End Framework library: One of the following technologies will be considered: Meteor.js, Vue.js or other state-of-the-art front-end development framework/library. **Experiments:** 1. Installing framework and configuring Integrated Development Environment (IDE), and its dependencies. 2. Creating workspace, project and setting up the necessary environment. 3. Implementing the fundamental syntaxes and components of the framework. 4. Building and testing the application. 5. Deploying the application.	**10**
Module 3: Server-side Development Framework/Library – Part 1	**Hrs.**
State-of-the-art server-side Technology: Ruby on Rails, Flask or other state-of-the-art back-end development framework/library. **Experiments:** 1. Installing framework and configuring Integrated Development Environment (IDE), and its dependencies. 2. Creating workspace, project and setting up the necessary environment. 3. Implementing the fundamental syntaxes and components of the framework. 4. Implementing server-side validations and authentication for web application. 5. Implementing CRUD operations for web application. 6. Building and testing the application. 7. Deploying the application.	**10**
Module 4: Server-side Development Framework/Library – Part 2	**Hrs.**
State-of-the-art server-side Technology: Django or another state-of-the-art framework/library. **Experiments:** 1. Installing framework and configuring Integrated Development Environment (IDE), and its dependencies. 2. Creating workspace, project and setting up the necessary environment. 3. Implementing the fundamental syntaxes and components of the framework.	**8**

4. Implementing server-side validations and authentication for web application. 5. Implementing CRUD operations for web application. 6. Building and testing the application. 7. Deploying the application.	
Module 5: Mobile App Development	**Hrs.**
Introduction to App Development, Introduction to Android App Development, Installation and configuration of IDE, Activities, Intents and Intent Filters, UI and Navigation, Camera, Connectivity to database, Web-based content, debugging and testing the app, and publishing the app. **Experiments:** 1. Installing and configuring Integrated Development Environment (IDE). 2. Managing the project. 3. Writing the app. 4. Connecting the app to the database. 5. Building and running the app on an emulator and on a hardware device. 6. Configuring, debugging, testing, and profiling the app. 7. Publishing the app on the marketplace.	**10**
Module 6: Hosting Web Applications	**Hrs.**
Building web application and Hosting web application. **Experiments:** 1. Choosing a hosting server and selecting a plan for web hosting. 2. Choosing and configuring DNS address. 3. Uploading, configuring and running the website over the internet.	**4**

Title of the Course: Software Engineering Tools Laboratory **Course Code:** 4CS382	L	T	P	Cr
	0	0	4	2

Desirable Requirements: Software Engineering SDLC, Project Management, Agile Methodology

Textbooks:

1. Dr.K.V.K.K.Prasad, *"Software Testing Tools* "
2. Desikan, Ramesh, "*Software Testing: principles and Practices*", Pearson Education, ISBN

References:

1. Nina Godbole, "Software Quality Assurance: Principles And Practice", Alpha Science International, Ltd (August 1, 2004)

Course Objectives :

1. To Understand the Software Development dearth and Tools practiced in IT industry.
2. To Comprehend the hands on exploration of various Software frameworks and CASE tools used on SDLC.
3. To cognize with the Testing tools to ensure quality assurance.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	be familiar with open source software development tools currently used in the industry.	2	Understanding
CO2	utilize open source software for developing a variety of software applications, particularly Web applications	3	Applying
CO3	get acquainted with use of software tools to achieve quality and industry readiness	6	Creating

CO-PO Mapping :

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2											1	
CO2					2									
CO3				2		2								2

1: Low, 2: Medium, 3: High

Assessments :

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Module 1	**Hrs.**
Introduction: FOSS, Open source software tools, Benefits, Software quality assurance.	
Module 2	**Hrs.**
Software Development Frameworks: Eclipse and Android SDK, Node.Js, DotNet, Ruby on Rails	
Module 3	**Hrs.**
Project Management Tools: Github- Issues, Labels, Mile stones, Wiki pages, Project board.	
Module 4	**Hrs.**
Configuration Management Tools: Documentation tools, Version control VSS, , Access control, Distributed source code control (CVS, SVN)	
Module 5	**Hrs.**
Software Testing tools: Need for Automated Testing tools, the V model for testing, Functional, Regression, Performance, Test Management, Source Code Testing and How to select testing tools.	
Module 6	**Hrs.**
Study of testing tools: Win Runner, Load Runner, Selenium, Test director ,QTP, Rational Robot, Clearcase etc.	

EVEN Semester

Open Electives Courses

Title of the Course: Artificial Intelligence and Machine Learning	L	T	P	Cr
Course Code: 4OE378	3	-	-	3

Desirable requirement: Introductory Programming knowledge, Probability and statistcs

Textbooks:

1. Elaine Rich and Kelvin Knight ,Nair , "Artificial Intelligence," McGraw Hill Publication
2. Janakiraman et al., "Foundations of Artificial Intelligence and Expert Systems", Macmilan India
3. Tom M. Mitchell, Machine Learning, McGraw-Hill

References:

1. NPTEL course on Introduction to AI
2. NPTEL course on Introduction to ML

Course Objectives :

1. Introduce and apply Principles of Artificial Intelligence
2. Introduce and apply Principles of Machine Learning

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	**Illustrate** AI and ML Problems and its simple solutions	2	Applying
CO2	**Compare** simple solutions for AI and ML problems	3	Analyzing
CO3	**Classify** various AI and ML problem solving schemes	4	Evaluating

CO-PO/PSO Mapping :

PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												**1**	
CO2		**3**											**1**	
CO3		**3**											**1**	

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction to AI and Problem Solving	**Hrs.**
Introduction, History, Application, Approaches, Problem solving by searching, Constraint satisfaction problems.	**06**
Module 2 Knowledge Representation, Logic and Reasoning	**Hrs.**

Propositional Logic, Inference rules, First Order Logic, Rule based systems, Reasoning with uncertainty, Fuzzy reasoning, Bayes networks	**07**
Module 3 Expert Systems	**Hrs.**
ES Characteristics, Architecture, Rule based ES, Rule Induction, Introduction to Natural Language Processing.	**06**
Module 4 Introduction to Machine Learning	**Hrs.**
Introduction to Machine Learning, Concepts of Supervised and Unsupervised Learning, Linear and Multivariate Regression, Dimensionality Reduction	**07**
Module 5 Bayesian Learning and Decision Trees	**Hrs.**
Equations, Description, Maximum Likelihood estimate, Decision Trees, examples	**06**
Module 6 Module 4 : Evaluation Measures and Hypothesis Testing 6 Hrs.	**Hrs.**
Evaluation Measures, ROC curve, Case Study	**06**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1: Understand and describe AI problems and its solutions in simple form

Module 2: Describe rule based systems

Module 3: Describe a scheme in ES

Module 2: Describe rule based systems

Module 3: Describe a scheme in ES

Module 4: Understand and describe Machine learning

Module 5: Describe and apply Bayesian and decision tree

Module 6: Compare various ML schemes using performance measures

EVEN Semester

Minor Specialization Courses

Title of the Course: Computer Networks **Course code:** 1CSM04	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw-Hill, 4th/5th Edition, 2017.

References:

1. William Stallings, "Data and Computer Communications", Prentice Hall(PHI) , 8th /9th Edition, 2010/2011

2. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education,5th /7th edition, 2012/2016

Course Objectives : The objective of the course is to provide a foundation and clear understanding of various concepts of networking which will give students insight about how the computer networks actually work in real time. Objectives are further divided as:

1. Elaborate various terminologies related to computer networking
2. Give information about networking components
3. Make students aware about various concepts and networking model behind day to day networking
4. Explain protocols used in real time applications

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Describe** fundamentals related to Computer networking	2	Understanding
CO2	**Interpret** various techniques behind networking	3	Apply
CO3	**Distinguish** among networking concepts and protocols	4	Analyze

CO-PO Mapping :

PO and PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**1**													
CO2		**2**												
CO3		**2**												**1**

1: Low, 2: Medium, 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 : Introduction	**5 Hrs.**
A Basic Model of Communication, Networks, Networking Concepts and Terminology: Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity, Data and Signals.	
Module 2: Transmission Media and Networking Devices	**6 Hrs.**
Guided Transmission Media, Wireless Transmission, Types of electronics communication, Electromagnetic spectrum, Networking Devices	
Module 3 : Networking Basics	**6 Hrs.**
Evolution of network, Introduction to Computer Networks, Physical & Logical Topology, Introduction to types of network, internetworking, Intranet,Internet	
Module 4 : Network Models and Routing	**6 Hrs.**
The OSI Model, Layers of OSI Model, TCP/IP Protocol Suit, Routing in Internet, Switching.	
Module 5 :Addressing	**8 Hrs.**
Physical Addressing, Logical Addressing: IPv4 addresses , IPv6 addresses, internetworking, Address Mapping Protocols	
Module 6 : Application Layer Protocols	**8 Hrs.**
The application Layer, Working of EMAIL, File Transfer Protocol (FTP), WWW, HTTP, Domain Name Space (DNS), SNMP	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1:

- Understand basic networking terminologies

Module 2:

- Differentiate types of transmission and networking devices

Module 3:

- Understand Idea behind computer networking and different types of network

Module 4:

- Articulate the knowledge of networking models and routing in Internet

Module 5:

- Apprehend the concept of addressing and address mapping protocol

Module 6:

- Learn application layer protocols used in real time application

This is Last Page