RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR FOUR YEAR BACHELOR OF TECHNOLOGY (B.TECH.) DEGREE COURSE
SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Compiler Design Subject Code: B TECH A I & D S - 7 0 1 T

Load Th	Credits Th	College Assessment Marks	University Evaluation	TotalMarks
3 Hours	3	30	70	100

Prerequisite: Artificial Intelligence

Course Objectives:

1.	To learn the process of translating a modern high-level language to executable code.
2.	To provide a student with an understanding of the fundamental principles in compiler design and to provide the skills needed for building compilers for various situations that one may encounter in a career in Computer Science
3.	To develop an awareness of the function and complexity of modern compilers
4.	To apply the code generation algorithms to get the machine code for the optimized code.
5.	To draw the flow graph for the intermediate codes and apply the optimization techniques to have a better code for code generation

Course Outcomes:

At the end of this course students are able to:

1.	Represent language tokens using regular expressions, context free grammar and finite automata and design lexical analyzer for a language.
2.	Compare top down with bottom up parsers, and develop appropriate parser to produce parse tree representation of the input.
3.	Generate intermediate code for statements in high level language
4.	Design syntax directed translation schemes for a given context free grammar.
5.	Apply optimization techniques to intermediate code and generate machine code for high level language program

Syllabus:

UNIT I: Introduction to Compilers Introduction: Phases of compilation and over view, Lexical Analysis (Scanner), Regular languages, finite automata, regular expression, relating regular expression and finite automata, scanner generator(lex, flex)	[06 Hours]
Unit II: Syntax Analysis Syntax Analysis (Parser): Context- free languages and grammers, push- down automata, LL(1)grammersandtop-down parsing,operator grammars ,LR(O),SLR(1),LR(1),LALR(1) grammars and bottom up parsing ,ambiguity and LR parsing, LALR(1) parser generator ,(yacc,bison)	[08 Hours]
Unit III: Intermediate Code Generation Semantic Analysis: Attribute Grammar, syntax directed definition, evaluation, and flow of attribute in a syntax tree, Symbol Table: Basic Structure, symbol table attributes and managements, Runtime Environment: Procedure activation, parameter passing, value return ,memory allocation	[07 Hours]
UNIT IV: Run-Time Environment and Code Generation Intermediate Code Generation: Translation of different language features,different types of intermediate forms, code improvement (optimization),control flow, data dependence etc, local optimization, global optimization, peep hole optimization etc.	[08 Hours]
UNIT V: Code Optimization Architecture dependent code improvement: instruction scheduling(for pipelining),loop optimization(for cache memory) etc, Register allocation and target code generation,Advance topics: Type Systems, data abstraction, compilation of object oriented features and non imperative programming languages.	[07 Hours]

Text books:

Below is the list of compiler design book recommended by the top university in India.

1. A.V. Aho, Monica, R.Sethi, J.D.Ullman, "Compilers, Principles, Techniques and Tools", Second Edition, Pearson Education/Addison Wesley, 2009.
2. Andrew W. Appel, "Modern Compiler Implementation in Java", Second Edition, 2009.
3. Aho A. Ravi Sethi and D Ullman. Compilers – Principles Techniques and Tools, Addison Wesley, 2006.
4. D. M.Dhamdhare, System Programming and Operating Systems,Tata McGraw Hill & Company, 1996.
5. J.P. Tremblay and P.G. Sorrenson, "The Theory and Practice of Compiler Writing", McGraw Hill, 1985.

Reference books:

1. Kenneth C. Louden, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.
2. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company,1984.

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SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Compiler Design (Lab) Subject Code : B TECH AI&DS-701P

Load	Credits	College Assessment Marks	UniversityEvaluation	Total Marks
2 hrs. /Week (Practical)	1	25	25	50

Course Objectives:

1	To implement Lexical Analyzer using Lex tool & Syntax Analyzer or parser using YACC Tool.
2	To implement NFA and DFA from a given regular expression.
3	To implement front end of the compiler by means of generating Intermediate codes.
4	To implement code optimization techniques.

Course Outcome:

At the end of this course students will be able to:

CO1	Understand the practical approaches of how a compiler works .
CO2	Understand and analyze the role of syntax and semantics of Programming languages in compiler construction .
CO3	Apply the techniques and algorithms used in Compiler Construction in compiler component design.
CO4	Generate machine code from the intermediate code forms
CO5	To use different tools in construction of the phases of a compiler for the mini language.

Recommended System / Software Requirements:
To execute the experiments, we should have the following hardware /softwares at minimum

1. Intel based desktop PC with minimum of 166MHz or faster processor with at least 64 MB RAM and 100 MB free disk space.
2. C, C ++ Compiler and JDK kit, Lex or Flex and YACC tools (Unix/Linux utilities)

Useful Text Books / Refereces / Websites:

1. Modern compiler implementation in C, Andrew w.Appel, Revised Edn, Cambridge University

Press
2. Principles of Compiler Design. – A.V Aho, J.D Ullman ; Pearson Education.
3. lex&yacc , -John R Levine, Tony Mason, Doug Brown; O'reilly.
4. Compiler Construction,- LOUDEN, Thomson.
5. Engineering a compiler – Cooper& Linda, Elsevier
6. Modern Compiler Design – Dick Grune,Henry E.Bal, Cariel TH Jacobs, Wiley Dreatech

Experiment List

To Write a C Program to Scan and Count the number of characters, words, and lines in a file.

To Write a C Program to implement NFAs that recognize identifiers, constants, and operators of the mini language.

Write a C Program to implement DFAs that recognize identifiers, constants, and operators of the mini language.

Write a C/C++ program to implement the design of a Lexical analyzer to recognize the tokens defined by the given grammar.

Write a C program to identify whether a given line is a comment or not.

Write a C program to recognize strings under 'a', 'a*b+', 'abb'.

Write a C program to test whether a given identifier is valid or not.

Write a C program to simulate lexical analyzer for validating operators

Implement the lexical analyzer using JLex, flex or other lexical analyzer generating tools.

i) *Write a C program for constructing of LL (1) parsing.

ii) *Write a C program for constructing recursive descent parsing.

Write a C program to implement LALR parsing.

Write a C program to generate machine code from abstract syntax tree generated by the parser. The instruction set specified in Note 2 may be considered as the target code.

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SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Digital Signal & Image Processing Subject Code: B TECH AI&DS-702T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3 Hrs(Theory)	3	30	70	100

Prerequisite(s): Digital Signal & Image Processing Course Objectives:

1	To understand the fundamental concepts of digital signal processing and Image processing.
2	To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
3	To apply processing techniques on 1-D and Image signals.
4	To apply digital image processing techniques for edge detection.

Course Outcomes:
At the end of this course students are able to:

CO1	Apply the concept of DT Signal and DT Systems.
CO2	Classify and analyze discrete time signals and systems
CO3	Use the enhancement techniques for digital Image Processing
CO4	Differentiate between the advantages and disadvantages of different edge detection techniques
CO5	Develop small projects of 1-D and 2-D Digital Signal Processing.

Syllabus:

UNIT I: Discrete-Time Signal and Discrete-Time System Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication). Classification of Discrete-Time Signals, Classification of Discrete-Systems, LTI system, Concept of Impulse Response and Step Response, Output of DT system using Time Domain Linear Convolution.	[08 Hours]
UNIT II: Discrete Fourier Transform Introduction to DTFT, DFT, Relation between DFT and DTFT,IDFT Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. Transfer function of DT System in frequency domain using DFT.Linear and Circular Convolution using DFT, Convolution of long sequences, Introduction to 2-D DFT	[07 Hours]
UNIT III: Fast Fourier Transform Need of FFT, Radix-2 DIT-FFT algorithm, DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm. Spectral Analysis using FFT, Image File Formats: BMP, TIFF and JPEG.	[08 Hours]
UNIT IV: Digital Image Fundamentals Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization, Representation of Digital Image, Connectivity	[07 Hours]
UNIT V: Image Enhancement in Spatial domain Gray Level Transformations, Zero Memory Point Operations, Histogram Processing, Histogram equalization. NeighborhoodProcessing, Spatial Filtering, Smoothing and Sharpening Filters, Median Filter.	[06 Hours]

Text Books:

1. John G. Proakis, Dimitris and G.Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications' 4th Edition 2007, Pearson Education.
2. A. Anand Kumar, Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.
3. Rafel C. Gonzalez and Richard E. Woods, Digital Image Processing', Pearson Education Asia, 3rd Edition, 2009,
4. S. Sridhar, Digital Image Processing', Oxford University Press, Second Edition, 2012.

Reference Books:

1. Sanjit Mitra, Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.
2. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, Digital Signal Processing' Tata McGraw Hill Publication 1st Edition (2010).
3. S. Jayaraman, E. Esakkirajan and T. Veerkumar, Digital Image Processing' TataMcGraw Hill Education Private Ltd, 2009.
4. Anil K. Jain, Fundamentals and Digital Image Processing', Prentice Hall of India Private Ltd, 3rd Edition.

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SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Digital Signal and Image Processing (Lab) Subject Code : B TECH AI&DS- 702P

Load	Credits	College Assessment Marks	University Evaluation	Total Marks
2 hrs/Week (Practical)	1	25	25	50

Course Objectives:

1	The objective of the Digital Signal and Image Processing Lab is to provide hands-on experience and practical understanding of digital signal processing techniques and image processing algorithms.
2	Through a series of experiments, students will learn how to process and analyze digital signals and images using various methods and tools.

Course Outcome:

At the end of this course students will be able to:

CO1	Understand the fundamental concepts and techniques of digital signal processing.
CO2	Apply different digital signal processing algorithms for signal enhancement, filtering, and feature extraction.
CO3	Acquire practical skills in implementing digital signal processing algorithms using software tools and programming languages.
CO4	Comprehend the basics of image processing and different image enhancement techniques.
CO5	Develop the ability to implement image processing algorithms for image filtering, segmentation, and feature extraction.

Experiment List

Digital Signal and Image Processing Lab Syllabus - 10 Experiments

Experiment 1: Introduction to MATLAB
- Introduction to MATLAB software and its features
- Basic MATLAB commands for signal and image processing
- Loading, displaying, and manipulating signals and images

Experiment 2: Digital Image Enhancement
- Image enhancement techniques: Histogram equalization, contrast stretching
- Implementation and analysis of image enhancement algorithms
- Assessing the quality of enhanced images using metrics

Experiment 3: Image Filtering
- Basics of image filtering: Spatial domain filtering, frequency domain filtering
- Implementing image filters: Low-pass, high-pass, and band-pass filters
- Comparing different filter types and their effects on images

Experiment 4: Image Compression
- Image compression methods: Lossless and lossy compression
- Implementing compression algorithms: Huffman coding, discrete cosine transform (DCT)
- Assessing the compression ratio and image quality after compression

Experiment 5: Image Segmentation
- Image segmentation techniques: Thresholding, region-based segmentation
- Implementing segmentation algorithms
- Evaluating the accuracy of segmentation using metrics like precision, recall, and F1 score

Experiment 6: Image Restoration
- Image restoration methods: Noise removal, image deblurring
- Implementing restoration techniques: Spatial and frequency domain methods
- Analyzing the effectiveness of restoration algorithms

Experiment 7: Image Registration
- Image registration concepts: Aligning and matching images
- Implementing image registration algorithms: Feature-based, intensity-based methods
- Evaluating the accuracy of registration using metrics

Experiment 8: Image Recognition
- Introduction to image recognition and classification techniques
- Implementing image recognition algorithms: Template matching, machine learning-based methods
- Assessing the performance of recognition algorithms using metrics like accuracy and precision

Experiment 9: Digital Signal Processing
- Basics of digital signal processing: Sampling, quantization, Fourier analysis
- Implementing signal processing techniques: Filtering, spectral analysis
- Analyzing the effects of different signal processing operations

Experiment 10: Image Compression Using Wavelets
- Introduction to wavelet transforms and their applications in image compression
- Implementing wavelet-based image compression algorithms
- Comparing wavelet-based compression with other methods and evaluating the results

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SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Human-Computer Interaction (Elective III) Subject Code: B TECH AI&DS-703.1T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3	3.00	30	70	100

Prerequisite(s): None

Course Objectives:

1	To learn the foundations of Human Computer Interaction.
2	To become familiar with the design technologies for individuals and persons with disabilities.
3	To be aware of mobile HCI.
4	To learn the guidelines for user interface.

Course Outcomes:

At the end of this course, students are able to:

CO1	Ability to apply HCI and principles to interaction design.
CO2	Design effective dialog for HCI
CO3	Design effective HCI for individuals and persons with disabilities.
CO4	Assess the importance of user feedback.
CO5	Develop meaningful user interface.

Syllabus:

UNIT I: Introduction to the HCI: What is HCI, Its history, Problems and challenges, Differences between humans and computers, Philosophy of mind: Brains vs. Circuit Boards, Human sensation, perception, and cognition, Problem solving and reasoning, Relation of memory to HCI	[08 Hours]

Unit II: Human memory: Three forms of human memory: sensory buffers, short-term memory (working memory), and long-term memory (LTM), How information gets to LTM: Rehearsal, unconscious consolidation, meaningful associations, Two types of LTM: Declarative and implicit memory, Methods for improving recall: Association, categorization, and visualization, Types of interaction (or dialog styles) Commandline, menus, form-filling and GUIS Good and bad examples of interaction styles	[07Hours]
Unit III: Design rules: Authority vs. generality , Principles, standards, and guidelines Golden rules and heuristics Three categories of primary usability principles: Learnability, flexibility, and robustness, Why physical design is easier than HCI design: Human error and mistakes	[07Hours]
UNIT IV: Design evaluation: Two forms of design evaluation: Expert analysis and user participation, Approaches to expert analysis: Cognitive walkthroughs, heuristic evaluation, model-based evaluation, and evaluation based on existing research, Types of user-based evaluation: Observational methods, query techniques, physiological and direct recording, and experimental methods	[07Hours]
UNIT V: Experimental Evaluation and Empirical Methods: Hypothesis testing, Choosing participants and sample size Variables: independent and dependent measures, Types of experimental designs and when you use them ,Data analysis, Approaches to Universal Design (UD) implementation: Shared purpose, built-in redundancy, augmenting existing information, compatibility with third party assistive technology (AT)	[07Hours]
TEXTBOOKS: 1. The essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech. Units 1, 2, 3 2. Human–Computer Interaction. Alan Dix, Janet Finlay, Gre Goryd, Abowd, Russell Beale, Pearson Education Units 4,5 REFERENCE BOOKS: 1. Designing the user interface. 3rd Edition Ben Shneidermann, Pearson Education Asia. 2. Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech. 3. User Interface Design, Soren Lauesen, Pearson Education. 4. Human–Computer Interaction, D. R. Olsen, Cengage Learning. 5. Human–Computer Interaction, Smith - Atakan, Cengage Learning	

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SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject -Medical Image Analysis Subject Code: B TECH _AI&DS-703T

Load	Credits	College Assessment Marks	University Evaluation	Total Marks
03 Hrs(Theory)	03	30	70	100

Course Objective

1	The aim is to teach students advanced technology in processing and analysis of medical images.
2	Design and develop new techniques for improving clinical workflow with incorporation of medical image analysis in regular clinical usage.

Course Outcome:

Upon successful completion of this course, the student will be able to:

CO1	Explain and discuss the scientific principles of medial image formation, tissue energy interaction as basis for different imaging modalities
CO2	Demonstrate the ability of analyzing medical images using their foundations of linear algebra, graph based and machine learning based approaches
CO3	Demonstrate the ability to retrieve, analyse, visualize, archive high-dimensional and large volume medical imaging data for quantitative high-throughput medical diagnosis.
CO4	Design and develop new techniques for improving clinical workflow with incorporation of medical image analysis in regular clinical usage.

Syllabus:

Unit-1: Introductory Concepts , Basic concepts of human anatomy, Modalities for Macro-scale / whole body, Mesoscopic and Microscopic range imaging, PACS, DICOM images, 3D visualization, time-lapse and GPU computing	(7 lectures)
Unit-2: Analytical Foundations for Medical Image Analysis,Shape modelling, Region growing, watersheds, clustering, Texture, image statistics,Graph cuts, image denoising, Supervised and unsupervised learning	(7 lectures)

Unit-3: Analysis of X-ray, Magnetic Resonance and Computerized Tomography Images Image formation in X-ray, Digital Angiography, Digital Mammography, magnetic resonance, Computerized Tomographic Reconstruction, PET, SPECT hybrid imaging, Image and volume registration.	(8 lectures)
Unit-4: Analysis of Speckle Images Image formation in ultrasound (US), A-/B-/M- mode imaging, doppler and tissue harmonic, Speckle reduction, beam steering, image compounding and filtering, Optical coherence tomography, frequency domain sensing, Cardiovascular and Ophthalmic imaging.	(7 lectures)
Unit-5: Analysis in Optical Microscopic Imaging Image formation in a bright field, phase contrast and dark field, fluorescence and nonlinear microscopy, Digital pathology and 3D microscopy 6. Visualization, VirtualAnatomy, Computational Imaging,PACS (5 lectures	(7 lectures)

Books

1. J. D. Bronzino, Biomedical Engineering Handbook, CRC Press, Springer and IEEE Press, 2000.
2. A. C. Kak and M. Slaney, Principles of Computerized Tomography, Society of Industrial and Applied Mathematics, 2001.
3. B. Saleh, Introduction to Subsurface Imaging, Cambridge, 2011. 4 I. Bankman, Handbook of Medical Imaging, Springer, 2000.
4. I. Bankman, Handbook of Medical Image Processing and Analysis,

Springer, 2/e, 2008

5. G. R. Sinha and B. C. Patel, Medical Image Processing Concepts and Applications, PHI, 2014.
6. . R. E. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2/e, 2001.
7. G. Dougherty, Digital Image Processing for Medical Applications, Cambridge, 2009.
8. . C. M. Rumack, S. R. Wilson, J. W. Charboneau and D. Levine, Diagnostic Ultrasound (Vol. 1 and 2), Elsevier, 4/e, 2011.
9. . W. Dahnert, Radiology Review Manual, Lippincott Williams & Wilkins, 7/e, 2011.
10.. J. Mertz, Introduction to Optical Microscopy, Roberts & Company Publishers, 2009.

. P. Milanfar, Super-resolution Imaging, CRC Press, 2011.

12 R. M. Rangayyan, Biomedical Image Analysis, CRC Press, 2005.

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SEMESTER: VII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject : Python Programming (Open Elective- II) Subject Code B TECH AI&DS-704T

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03 Hrs (Theory)	03	100	30	70	100

Prerequisite(s): C Language

Course Objective/Learning Objective:

1	To understand the fundamentals of Python programming language.
2	To develop problem-solving and programming skills using Python.
3	To use Python in different applications such as web development, data analysis, and artificial intelligence.

Course Outcome:

At the end of this course, Student are able to:

CO1	Develop programming skills in Python programming language.
CO2	Implement object-oriented programming concepts using Python.
CO3	Utilize Python libraries for data analysis and visualization.
CO4	Develop web applications using Flask framework.
CO5	Apply machine learning concepts using Scikit-Learn.

UNIT I: (08 Hrs)

Introduction to Python Programming: Overview of Python programming language, Variables, data types, and operators, Conditional statements and loops, Functions, and modules

UNIT II: (07 Hrs)

Object-Oriented Programming in Python: Object-oriented programming concepts, Classes, objects, and methods, Inheritance, and polymorphism

UNIT III: (07 Hrs) Python Libraries for Data Analysis: Introduction to NumPy and Pandas, Data manipulation with NumPy and Pandas, Data visualization with Matplotlib and Seaborn.
UNIT IV: (07 Hrs) Web Development with Flask: Introduction to Flask framework, creating web applications using Flask, Flask extensions for database integration
UNIT V: (07 Hrs) Introduction to Machine Learning with Python: Introduction to Scikit-Learn, Supervised and unsupervised learning, Classification, and regression algorithms
Textbooks: • "Python for Everybody: Exploring Data in Python 3" by Charles Severance. • "Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming" by Eric Matthes.
References: • "Learning Python, 5th Edition" by Mark Lutz. "Python Data Science Handbook: Essential Tools for Working with Data" by Jake VanderPlas.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR FOUR YEAR BACHELOR OF TECHNOLOGY (B.TECH.) DEGREE COURSE
SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Cloud Computing Subject Code: B TECH AI&DS-801.1T

Course Objectives:

1	Understand cloud computing fundamentals:
2	Learn cloud service providers and technologies:
3	Understand security and compliance in the cloud:
4	Explore cloud migration and management:
5	Gain awareness of emerging trends:

Course Outcomes:

CO 1	Explain need, types and tools of Virtualization for cloud.
CO 2	Describe architecture and underlying principles of cloud computing.
CO 3	Describe Services Oriented Architecture and various types of cloud services.
CO 4	Explain Inter cloud resources management cloud storage services and their providers Assess security services and standards for cloud computing.
CO 5	Analyze advanced cloud technologies.

Syllabus

Sr.No.	Detailed Content	Hours
I	Introduction To Cloud Computing: Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning.	08
II	Cloud Enabling Technologies Service Oriented Architecture: REST and Systems of Systems – Web Services – Publish, Subscribe Model – Basics of Virtualization – Types of Virtualization –Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices –Virtualization Support and Disaster Recovery.	08
III	Cloud Architecture, Services And Storage: Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – IaaS – PaaS – SaaS – Architectural Design Challenges	08

	– Cloud Storage – Storage-as-a-Service – Advantages of CloudStorage – Cloud Storage Providers – S3.	
IV	Resource Management And Security In Cloud: Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security,Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.	08
V	Cloud Technologies And Advancements Hadoop: MapReduce 08 – Virtual Box — Google App Engine – Programming Environment for Google App Engine — Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation.	08

Text books:

1.Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.

2. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017.

3. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, —Mastering Cloud Computing, Tata Mcgraw Hill, 2013.

4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.

5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009.

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RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR FOUR YEAR BACHELOR OF TECHNOLOGY (B.TECH.) DEGREE COURSE
SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject- Augumented Reality and Virtual Reality Subject Code: B TECH AI&DS-801T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3 Hrs(Theory)	3	30	70	100

Course Objectives:

1	To make students know the basic concept and framework of virtual reality.
2	To introduce students the technology for multimodal user interaction and perception in VR, in particular the visual, audial and haptic interface and behavior.
3	To aware students the technology for managing large scale VR environment in real time.
4	To provide students with an introduction to the VR system framework and development tools.
5	To expose learners to the basic of AR/VR technology and devices.

Course Outcomes:
At the end of this course students are able to:

CO1	1. To understand the basic concept and framework of virtual reality
CO2	To understand the technology for multimodal user interaction and perception in VR
CO3	Decide & Apply algorithmic strategies to solve a given problem
CO4	To apply VR Tools in real time environment.
CO5	To understand augmented reality

Syllabus:

Unit 1 Introduction – VR and AR Fundamentals, Differences between AR/VR Selection of technology AR or VR AR/VR characteristics Hardware and Software for AR/VR introduction. Requirements for VR/AR. Benefits and Applications of AR/VR. AR and VR case study.	[07 Hours]
Unit 2 Visual Computation in Virtual Reality-Fundamentals of Computer Graphics; Real time rendering technology; Principles of Stereoscopic Display; Software and Hardware Technology on Stereoscopic Display.	[07 Hours]
Unit 3 Software technologies - Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback	[08 Hours]
Unit 4 VR toolkits, Available software in the market (Unity and Vuforia based) - Case Studies in AR, VR - Industrial applications, medial AR/VR, education and AR/VR. Environment Modeling in Virtual Reality - Geometric Modeling; Behavior Simulation; Physically Based Simulation	[07 Hours]
Unit 5 Haptic & Force Interaction in Virtual Reality Concept of haptic interaction-Principles of touch feedback and force feedback; Typical structure andprinciples of touch/force feedback facilities in applicationsVR Development Tools-Frameworks of Software	[06 Hours]
Text Books: 1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006. 2. Alan B Craig, William R Sherman and Jeffrey D Will. Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, 2009. 3. Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.	

Reference Books:

1. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley, USA, 2005.
2. Oliver Bimber and Ramesh Raskar, Spatial Augmented Reality: Meging Real and Virtual Worlds, 2005.
3. Burdea, Grigore C and Philippe Coiffet, Virtual Reality Technology, Wiley Interscience, India

4. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley, USA, 2005.
5. Oliver Bimber and Ramesh Raskar, Spatial Augmented Reality: Meging Real and Virtual Worlds, 2005.
6. Burdea, Grigore C and Philippe Coiffet, Virtual Reality Technology, Wiley Interscience, India

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SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Biometric Technology and Applications Subject Code: B TECH AI&DS-801T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3 Hrs(Theory)	3	30	70	100

Aim: To understand the concepts of Biometrics, to enable design of biometric system Prerequisite(s): Basic Mathematics

Course Objectives:

1	To understand the basic principles and methods used for biometric identification.
2	To understand scientific foundations needed to design, implement, and evaluate biometric identification systems

Course Outcomes:
At the end of this course students are able to:

CO1	To gain the basic working of biometric machine
CO2	To understand fundamentals of Fingerprint Identification Technology
CO3	To analyze the notion of Face Recognition
CO4	To understand the Iris Biometric Technology
CO5	To understand the Voice Biometric Technology

Syllabus:

Unit I: Introduction: History and Overview of Biometrics, Biometric applications, Benefits of biometrics, Verification and identification: Basic working of biometric matching, Accuracy, False match rate, False non-match rate, Failure to enroll rate, Active and passive biometric, Parameters of a good biometrics	[08 Hours]
Unit II: Fingerprint Identification Technology: Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges -Fingerprint Image Processing General description of fingerprints, Micro and Macro Features , Types of algorithms used for interpretation, Components and Operations: Strength and weakness.	[07 Hours]

Unit III: Face Recognition: Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Types of algorithms used for interpretation, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition.	[08 Hours]
Unit IV: Iris Biometric Technology: General description, Feature, Types of algorithms used for interpretation, Components and Operations, Strength and weakness	[06 Hours]
Unit V: Voice Biometric Technology: General description, Feature, Types of algorithms used for interpretation, Components and Operations, Strength and weakness.Fusion in Biometrics: Introduction to Multibiometric – Information Fusion in Biometrics – Issues in Designing a Multibiometric System – Sources of Multiple Evidence	[07 Hours]

Text Books:

James Wayman, Anil Jain, Davide Maltoni, Dario Maio, Biometric Systems, Technology Design and Performance Evaluation, Springer, 2005. • David D. Zhang, Automated Biometrics: Technologies and Systems, Kluwer Academic Publishers, New Delhi, 2000. • Arun A. Ross , Karthik Nandakumar, A.K.Jain, Handbook of Multibiometrics, Springer, New Delhi, 2006.

REFERENCES:

Reference Books: • Paul Reid, Biometrics for Network Security, Pearson Education, 2004. • Nalini K Ratha, Ruud Bolle, Automatic fingerprint Recognition System, Springer, 2003 • L C Jain, I Hayashi, S B Lee, U Halici, Intelligent Biometric Techniques in Fingerprint and Face Recognition CRC Press, 1999. • John Chirillo, Scott Blaul, Implementing Biometric Security, John Wiley, 2003. • Woodward, J.D. and Orlans, Nicholos M., Biometrics, McGraw Hill (2002). • Reid, P., Biometrics for Network Security, Dorling Kingsley (2007).

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR FOUR YEAR BACHELOR OF TECHNOLOGY (B.TECH.) DEGREE COURSE
SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Software Architecture

Subject Code: B TECH AI&DS-801T

Load Th	Credits Th	Assessment College Marks	University Evaluation	Total Marks
3 Hrs(Theory)	3	30	70	100

Aim: Software architecture main goal is to tightly integrate the set of tools for managing every aspect of software projects which will help to streamline workflow.

Course Objectives:

1	To understand the differences between Conventional design and Software architecture design.
2	To understand a basis for re-use of elements and decisions
3	To understand risk management and also helps to reduce risks and chance of application failure
4	To apply different quality attribute achievement tactics for software development process to reduce development cost.

Course Outcomes: At the end of this course Student are able to:

CO1	Understand the concept of softwar design cycle.
CO2	Understand various software quality attributes.
CO3	Understand different architectural style concept
CO4	To understand and apply software architecture to debug the specific domain problem for betterment of application enhancement
CO5	Develop, design and implement simple software application

1	Introduction: Software process and the role of modeling and analysis, software architecture and software design, architectural styles, working of architecture business cycle, architectural patterns, analysis of architectures, formal descriptions of software architectures, architectural description languages and tools, web application architectures	[08 Hours]
2	Architectural styles: Conventional Architectural styles, Applied Architectures and Styles: Distributed and Networked, Architectures for Network Based Applications Architectures, Decentralized Architectures, Service-Oriented Architectures and Web Services.	
3	Quality Attributes: Introduction to Quality Attributes, Need of quality attributes, Understanding quality attributes and tactics, architecture and quality attributes, achieving quality attributes. Quality attributes in software architecture templates. Deriving duality attributes for software architectures	
4	Introduction to Middleware: Middleware components, programming models, implementation, systems qualities Moving from qualities to architecture and views, Components and COTS, Economics- Driven Architecture.	
5	Design patterns: Patterns and Software architecture.; Design Patterns: history, types, Uses of design pattern, Study of representative patterns like Singleton, Factory, Adaptor, Facade, Proxy, Observer, Composite,Designing and Documenting Software Architecture: Evolutionary delivery life cycle, attribute driven design, uses of architecture documentation,	
	Text Books: • Software Architecture: Foundations, Theory, and Practice, Richard N. Taylor, Nenad Medvidovic and Eric Dashofy, Wiley, 2008. • Software Architecture - Perspectives on an Emerging Discipline, M. Shaw, Prentice Hall, 1996. • Software Architecture in Practice, Len Bass, Paul Clements and Rick Kazman, Pearson Education, 3rd Edition, 2012	
	Beginning J2EE 1.4: From Novice to Professional, James L. Weaver, Kevin Mukhar, A press, 2004. • Design and Use of Software Architectures, Jan Bosch, Addison-Wesley, 2000. • Software Architecture: Organizational Principles and Pattern, Dikel D. M, et Al, Pearson, 2001.	

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SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Mobile Communication & Web Analytics Subject Code: B TECH AI&DS-802T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3 Hrs (Theory)	3	30	70	100

Prerequisite(s): Mobile Communication & Web Analytics Course Objectives:

1	To explain the evolution of mobile devices and networks.
2	To explain key concepts in web analytics.
3	To describe different mobile devices and their features.
4	To explain different methods for collecting data from mobile devices.
5	To analyze factors that impact mobile user experience and techniques for optimizing mobile user engagement and retention.

Course Outcomes:
At the end of this course students are able to:

CO1	Understand the basic concepts and principles of mobile communication and web analytics, and their interplay in today's digital landscape.
CO2	Learn about mobile devices and networks, their capabilities, and their impact on web analytics.
CO3	Learn about different methods for collecting and analyzing data from mobile websites and applications.
CO4	Understand the factors that impact mobile user experience, and how to optimize mobile user engagement and retention.
CO5	Learn best practices for designing and optimizing mobile websites and applications to improve user experience and engagement.

Syllabus:

UNIT I: Introduction to Mobile Communication and Web Analytics Overview of mobile communication and its impact on web analytics, History and evolution of mobile devices and networks, Key concepts in web analytics, including data collection, analysis, and interpretation	[08 Hours]
UNIT II: Mobile Devices and Networks Mobile devicesand their features and capabilities, Mobile network technologies and their impact on web analytics, Mobile device usage patterns and trends	[07 Hours]
UNIT III: Mobile Data Collection and Analysis Methods for collecting data from mobile websites and applications, Best practices for analyzing mobile data using artificial intelligence, Common mobile analytics tools and their features and benefits	[08 Hours]
UNIT IV: Mobile User Behavior and Engagement Understanding user behaviour and engagement on mobile devices using AI, Factors that impact mobile user experience, such as page load times, responsiveness, and navigation, Techniques for optimizing mobile user engagement and retention using AI	[07 Hours]
UNIT V: Mobile Website and Application Optimization with AI Best practices for designing and optimizing mobile websites and applications with AI, Techniques for improving mobile website and application performance and usability using AI, Strategies for using AI to optimize the mobile user experience	[06 Hours]
Textbooks: . 1. Jochen H. Schiller, "Mobile Communications", 2nd Edition, 2003, Addison-Wesley publications. . 2. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity", 1st Edition, 2009, Sybex publications. . 3. Johan Johansson, "Mobile Web Analytics: A Guide for Mobile Marketers, Web Analysts, and Website Owners", 1st Edition, 2012, SAS Institute.	
Reference books: 1. Jerry D. Gibson, "Mobile Communications Handbook", 3rd Edition, 2012, CRC Press. 2. Avinash Kaushik, "Web Analytics: An Hour a Day", 1st Edition, 2007, Sybex publications. 3. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More", 2nd Edition, 2019, O'Reilly Media. 4. Feras Alhlou, Shiraz Asif, and Eric Fettman, "Google Analytics Breakthrough: From Zero to Business Impact", 1st Edition, 2016, Wiley publications.	

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SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: High Performance Computing Subject Code: B TECH AI&DS-802T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3 Hrs(Theory)	3	30	70	100

Aim: To introduce the concepts of Modern Processors

Prerequisite(s): Computer Architecture and Organization

Course Objectives:

1	To understand Parallel Computing Paradigms.
2	To gain knowledge on Optimization techniques for serial code.

Course Outcomes: At the end of this course Student are able to:

1	Understand the concepts used in Modern Processors for increasing the performance
2	Understand Optimization techniques for serial code.
3	Understand the taxonomy of parallel computing
4	To Implement Parallel Computing Paradigms.
5	To design and implement distributed memory parallel programming with MPI

Unit I: Modern Processors : Stored Program Computer Architecture General purpose cache- based microprocessor-Performance based metrics and benchmarks- Moore's Law- Pipelining- Super scalarity SIMD- Memory Hierarchies Cache- mapping- prefetch- Multicore processorsMutithreaded processors- Vector Processors- Design Principles- Maximum performance estimatesProgramming for vector architecture	[06 Hours]

Unit II: Basic optimization techniques for serial code : Scalar profiling function and line based runtime profiling- hardware performance counters- common sense optimizations- simple measures, large impact- elimination of common subexpressions- avoiding branches using simd instruction sets- the role of compilers - general optimization options- inlining - aliasing- computational accuracy register optimizations- using compiler logs- c++ optimizations - temporaries- dynamic memory management- loop kernels and iterators data access optimization.	[10 Hours]
Unit III: Parallel Computers : Taxonomy of parallel computing paradigms Shared memory computers- Cache coherence- Hierarchical systems- Networks Basic performance characteristics- Buses- Switched and fat- tree networks- Mesh networks- Hybrids - Basics of parallelization - Why parallelize - Data Parallelism - Function Parallelism- Parallel Scalability- Factors that limit parallel execution	[08 Hours]
Unit IV: Distributed memory parallel programming with MPI: Message passing - introduction to MPI – example - messages and point-topoint communication - collective communication – nonblocking point-to-point communication- virtual topologies - MPI parallelization of Jacobi solver- MPI implementation - performance properties	[06 Hours]
Unit V: Shared memory parallel programming with OpenMp :Introduction to OpenMp - parallel execution - data scoping- OpenMp work sharing for loops- synchronization - reductions - loop scheduling - tasking - case study: OpenMp- parallel jacobi algorithm- advanced OpenMp wavefront parallelization- Efficient OpenMP programming: Profiling OpenMP programs - Performance pitfalls	[06 Hours]
Textbooks: Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011.	
Reference books: Charles Severance, Kevin Dowd, High Performance Computing, O'Reilly Media, 2nd Edition, 1998. • KaiHwang, Faye Alaye Briggs, Computer Architecture and Parallel Processing, McGraw Hill, 1984.	

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR FOUR YEAR BACHELOR OF TECHNOLOGY (B.TECH.) DEGREE COURSE
SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Cyber Crimes & Digital Forensics Subject Code: BTECH_AIDS-802T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3 Hrs.(Theory)	3	30	70	100

Course Objectives

1.	Describe cyber Crime and Digital Forensic concepts
2.	Determine various digital forensic Operandi and motive behind cyber attacks
3.	Demonstrate various forensic tools to investigate the cybercrime and to identify the digital pieces of evidence
4.	To correctly define and cite appropriate instances for the application of computer forensics Correctly collect and analyze computer forensic evidence
5.	Identify the essential and up-to-date concepts, algorithms, protocols, tools, and methodology of Computer Forensics

Course Outcomes:
At the end of this course students are able to:

1.	Describe Forensic science and Digital Forensic concepts
2.	Determine various digital forensic Operandi and motive behind cyber attacks
3.	Interpret the cyber pieces of evidence, Digital forensic process model and their legal perspective.
4.	Demonstrate various forensic tools to investigate the cybercrime and to identify the digital pieces of evidence.
5.	Analyze the digital evidence used to commit cyber offences

Syllabus:

UNIT I: Cyber Crime and computer crime Introduction to Digital Forensics, Definition and types of cybercrimes, Use of Computer Forensics in Law Enforecement,Computer Forensics Services,Benefits of professional Forensics Methodology,Steps taken by Computer Forensics Specialists, Types of Business Computer Forensic Technology.Types of Law Enforcement- Computer Forensic Technology..	[06 Hours]

Unit II: Computer Forensics Evidence and capture: Data Recovery Defined-Data Back-up and Recovery-The Role of Back -up in Data Recovery-The Data -Recovery Solution. Evidence Collection and Data Seizure: Why Collect Evidence? Collection Options-Obstacles-Types of Evidence-The Rules of Evidence-Volatile Evidence-General Procedure-Collection and Archiving-Methods of Collections-Art facts-Collection Steps -Controlling Contamination: Thechain of custody.	[07 Hours]
Unit III: Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene-Computer Evidence processing steps-Legal Aspects of collecting and Preserving Computer forensic Evidence. Computer image Verification and Authentication: Special needs of Evidential Authentication - Practical Consideration-Practical Implementation.	[08 Hours]
UNIT IV Computer forensic analysis and validation: Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, performing remote acquisitions Network Forensics: Network forensic overview, performing live acquisitions, developing standard procedures for network forensics, using network tools, examining the honeynet project. Processing crime at incident scenes: Identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case.	[08 Hours]
UNIT V Working with windows and dos systems: understanding file systems, exploring Microsoft file structures examining NTFS disks, understanding whole disk encryption, windows registry, Microsoft startup tasks, MS Dos startup tasks, virtual machines.	[07 Hours]

Text books:

1. Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi.
2. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning.
3. The basics of digital Forensics (Latest Edition) – The primer for getting started in digital forensics by John Sammons – Elsevier Syngress Imprint
4. Cybersecurity – Understanding of cybercrimes, computer forensics and Legal perspectives by Nina Godbole and Sunit Belapure – Wiley India Publication
5. Practical Digital Forensics – Richard Boddington [PACKT] Publication, Open source community

Reference books:

1. Real Digital Forensics by Keith j.Jones, Richard Bejitlich,Curtis W.Rose ,Addison-Wesley Pearson Education
2. Forensic Compiling,A Tractitioneris Guide by Tony Sammes and Brain Jenkinson,Springer International edition .
3. Homeland Security ,Techniques& Technologies by Jesus Mena,Firewall Media.
4. Software Forensics Collecting Evidence from the Scene of a Digital Crime by Robert M.Slade ,TMH 2005
5. Windows Forensics by chad Steel,Wiley India Edition.

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SEMESTER: VIII (C.B.C.S.)
BRANCH: ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Subject: Data Visualization (Elective V) Subject Code: B TECH_AI&DS-802.4T

Load Th	Credits Th	College Assessment Marks	University Evaluation	Total Marks
3	3.00	30	70	100

Prerequisite(s): DBMS & Data Mining
Course Objectives:

1	To understand the concepts related to knowledge extraction and data preparation
2	to introduce data visualization as an analytical tool
3	To learn best practices in data visualization, sharpen analytical skills
4	to design dashboards for use by stakeholders.

Course Outcomes:
At the end of this course, students are able to:

CO1	Use the data preprocessing techniques to prepare data for knowledge extraction
CO2	Explore various data visualization techniques in order to provide new insight
CO3	Apply appropriate data visualization techniques to provide trends/insights for the given dataset.
CO4	Apply visualization tools / techniques for various data analysis tasks
CO5	Given the application context for given data set, Design the information Dashboard for access information based on user criteria.

Sr. No	List of Open-Source Software/learning website:
1	HTML5 (Canvas and SVG tags)
2	D3.js (https://d3js.org/), Canvas.js
3	Google API

Syllabus:

UNIT I: Introduction to data visualization (DV): Acquiring and Visualizing Data, Simultaneous acquisition and visualization, Applications of Data Visualization, Keys factors of Data Visualization, Exploring the Visual Data Spectrum: charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Exploring advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts, Infographics), Making use of HTML5 CANVAS.	[08 Hours]
Unit II: Basics of Data Visualization – Tables: Reading Data from Standard text files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data (Building a table, Using Semantic Table, Configuring the columns), Assuring Maximum readability (Styling your table, Increasing readability, Adding dynamic Highlighting), Including computations, Using data tables library, relating data table to a char	[07Hours]
Unit III: Visualizing data Programmatically: Creating HTML5 CANVAS Charts (HTML5 Canvas basics, Linear interpolations, A Simple Column Chart, Animations), Starting with Google charts (Google Charts API Basics, A Basic bar chart, A basic Pie chart, Working with Chart Animations)	[07Hours]
UNIT IV: Introduction to D3.js: Getting setup with D3, Making selections, changing selection's attribute, Loading and filtering External data : Building a graphic that uses all of the population distribution data, Data formats you can use with D3, Creating a server to upload your data, D3's function for loading data, Dealing with Asynchronous requests, Loading and formatting Large Data Sets	[07Hours]
UNIT V: Advanced-Data Visualization: Making charts interactive and Animated: Data joins, updates and exits, interactive buttons, Updating charts, Adding transactions, using keys Adding a Play Button:	[07Hours]

Textbooks:

Reference Books:

1. Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery, "JavaScript and jQuery for Data Analysis and Visualization", WROX
2. Ritchie S. King, Visual story telling with D3" Pearson
3. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
4. A Julie Steele and Noah Iliinsky, Designing Data Visualizations: Representing Informational Relationships, O'Relly
5. Andy Kirk, Data Visualization: A Successful Design Process, PAKT
6. Scott Murray, Interactive Data Visualization for Web, O'Relly
7. Nathan Yau, "Data Points: Visualization that means something", Wiley, 2013.
8. Tamara Munzner, Visualization Analysis and Design, AK Peters Visualization Series, CRC Press, Nov. 2014