BHARATHIAR UNIVERSITY : : COIMBATORE 641 046

**M. Sc. Computer Science Curriculum (University Department)**

*(For the students admitted during the academic year 2024-2025 onwards)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Code** | **Title of the Course** | **Credits** |  **Hours** | **Maximum Marks** |
| **Theory** | **Practical** | **CIA** | **ESE** | **Total** |
| **FIRST SEMESTER** |
| 24CS1C1 | Advanced Operating System | 4 | 4 | - | 25 | 75 | 100 |
| 24CS1C2 | Data Structures and Algorithms | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS1C3 | Advanced Java Programming | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS1C4 | Python Programming | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS1C5 | Mathematical Foundations of Computer Science | 4 | 4 | - | 25 | 75 | 100 |
| 24CS1EX | Elective – I | 4 | 4 | - | 25 | 75 | 100 |
| PDC | Industry Literacy | 1 |  |  | 25 |  | 25 |
| 1GS | General Supportive - I | 2 |  |  | 12 | 38 | 50 |
|  24CS1JOC1 | Job-Oriented Course | 2 |  |  |  |  | 50 |
| **Total** | **29** |  |  |  |  | **725** |
| **SECOND SEMESTER** |
| 24CS2C1 | Linux Programming | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS2C2 | Compiler Design | 4 | 4 | - | 25 | 75 | 100 |
| 24CS2C3 | Internet of Things | 4 | 4 | - | 25 | 75 | 100 |
| 24CS2C4 | Data Mining Techniques and Tools | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS2C5 | Database Administration and Management | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS2EX | Elective - II | 4 | 4 | - | 25 | 75 | 100 |
| 24CS2MP | Mini Project - I | 2 |  |  | 50 |  | 50 |
| 2GS | General Supportive - II | 2 |  |  | 12 | 38 | 50 |
| 24CS2VAC1 | Value Added Course | 2 |  |  |  |  | 50 |
|  24CS2JOC1 | Job-Oriented Course | 2 |  |  |  |  | 50 |
| **Total** | **32** |  |  |  |  | **800** |
| **THIRD SEMESTER** |
| **24CS3C1** | **C# and .NET Technology** | 4 | 2 | 4 | 25 | 75 | 100 |
| **24CS3C2** | **Software Project Management** | 4 | 4 | - | 25 | 75 | 100 |
| **24CS3C3** | **Cloud Computing** | 4 | 2 | 4 | 25 | 75 | 100 |
| **24CS3C4** | **Big Data Analytics** | 4 | 2 | 4 | 25 | 75 | 100 |
| 24CS3C5 | Wireless Networks | 4 | 4 | - | 25 | 75 | 100 |
| 24CS3EX | Elective - III | 4 | 4 | - | 25 | 75 | 100 |
| **PDC** | **Research Review Analysis** | 1 |  |  | 25 |  | 25 |
| 3GS | General Supportive - III | 2 | 2 | - | 12 | 38 | 50 |
|  24CS2VAC2 | Value Added Course  | 2 |  |  |  |  | 50 |
| **Total** | **29** |  |  |  |  | **725** |
| **FOURTH SEMESTER** |
|  24CS4PW | Project Work | 9 |  |  | 135 | 90 | 225 |
| **Total** | 9 |  |  |  |  | **225** |
| **Grand Total** | **99** |  |  |  |  | **2475** |

**Note: Students must mandatorily publish or present their Research Review Analysis work in an international journal/conference before attending the viva-voce**

**Online Course**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | SWAYAM – MOOC Course\* | 2 |  |  |  |  |   |

\*Swayam – The Mooc online course shall be for at least 4 weeks with at least 2 credits.

 The course shall be mandatory and shall be completed within the third semester (i.e., before the beginning of the fourth semester)

**Elective Papers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sem** | **Elective** | **Suggested Code** | **Title of the Paper** | **No. of Credits** |
| I | Elective – I | 24CS1E1 | Information Security | 4 |
| 24CS1E2 | Artificial Intelligence | 4 |
| 24CS1E3 | Business Intelligence | 4 |
| II | Elective – II | 24CS2E1 | Data Privacy and Security | 4 |
| 24CS2E2 | Machine Learning Techniques | 4 |
| 24CS2E3 | Health Care Analytics | 4 |
| III | Elective – III | 24CS3E1 | Cyber Security | 4 |
| 24CS3E2 | Deep Learning Techniques | 4 |
| 24CS3E3 | Social Media Analytics | 4 |

**Supportive Papers**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Suggested Code | Sem | Title of the paper | Hrs | Credits | Marks |
| 24CSS01 | I/II/III | Windows and MS Word | 2 | 2 | 50 |
| 24CSS02 | Internet and HTML Programming | 2 | 2 | 50 |
| 24CSS03 | Relational Database Management System | 2 | 2 | 50 |
| 24CSS04 | Object Oriented Programming | 2 | 2 | 50 |
| 24CSS05 | Software Engineering | 2 | 2 | 50 |
| 24CSS06 | Multimedia Systems | 2 | 2 | 50 |

**List of Job-Oriented Courses**

1. Data Analysis using Excel

2. Power BI for Data Analytics

3. Mobile Application Development

4. Smart Applications with the Internet of Things

**List of Value-Added Courses**

1. Software Testing Tools

2. Cyber Security and Digital Forensics

3. Remote Sensing and GIS

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| **Course code**  | **24CS3C1** | **C# and .NET TECHNOLOGY** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **CORE** | **2** | **0** | **4** | **4** |
| **Pre-requisite** | Basics of VB language and ASP | **Syllabus Version** | **2024-25** |
| **Course Objectives:** |
| The main objectives of this course are to: 1. Provide in-depth knowledge on VB.NET and ASP.NET to students and help them to develop dynamic web applications, websites using VB and C# object-oriented way of programming an elegant way using window controls and web controls.
2. Train the students to enrich their knowledge in ASP.NET user controls, custom controls, and data management with ADO.NET.
3. Provide knowledge in developing LINQ-related applications and also in developing AJAX application and ASP.NET web services.
 |
| **Expected Course Outcomes:** |
| On the successful completion of the course, students will be able to: |
| 1 | Understand about .NET framework, .NET features, common language runtime, .NET framework libraries, and the Visual Studio Integrated Development Environment and Programming in C# | K1/K2 |
| 2 | Write a console application using classes and objects, constructors, overloading, inheritance, polymorphism, interfaces, arrays, exceptions, delegates, and events in C# and VB Scripts. Create window applications using window controls, Menus and graphics in VB and C#. | K2/K3/K6 |
| 3 | Understand the ASP.NET features, including ASP.NET page directives, to build an application using Web server Controls, Validation Server Controls, rich web controls, Custom Controls, Collections, and Lists. | K1/K2 |
| 4 | Understand ADO.NET and develop the application using ADO.NET with VB.NET and ASP.NET, and also LINQ queries. | K2/K3/K4/K6 |
| 5 | Building ASP.NET 3.5 Enterprise Applications using ASP.NET Ajax applications and ASP.NET web services. | K2/K3/K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
|  |
| **Unit:1** | **Introduction to .NET and C#** | **10 hours** |
| The .NET Framework – Benefits of .NET - Common Language Runtime – Features of CLR - Compilation and MSIL – The .NET Framework libraries – The Visual Studio Integrated Development Environment – Introduction to C#: Basics of C# - Data types - variable declarations – Implicit & Explicit type casting – Branching and Looping.  |
|  |
| **Unit:2** | **Introduction to VB.NET and Object Oriented Concepts in C#.NET & VB.NET** | **13 hours** |
| Introduction to VB.NET – VB.NET fundamentals – Branching and Looping Statements - Object Oriented Programming in C#.NET and VB.NET: Objects and Functions – Encapsulation – Inheritance - Constructors – Overloading - Inheritance and Polymorphism – Exception - Delegates and Events Arrays – Strings – Exceptions. |
|  |
| **Unit:3** | **Building Windows Applications and Deployments** | **10 hours** |
| Building Windows Applications – Creating a Windows Applications using window controls - Windows Forms, Text Boxes, Rich Text boxes, Labels, and link labels – Buttons, Check boxes, Radio buttons, Panels and Group Boxes, List Boxes, Checked List boxes, Combo boxes and Picture boxes, Scroll bars – Calendar control, Timer control – Handling Menus – Dialog boxes – Deploying an Application – Graphics.  |
|  |
| **Unit:4** | **Basics of ASP.NET, Types of Controls and Collections** | **12 hours** |
| ASP.NET Basics: Features of ASP.NET – ASP.NET page directives - Building Forms with Web server Controls – Validation Server Controls - Rich Web Controls - Custom Controls – Collections and Lists. |
|  |
| **Unit:5** | **ADO.NET and Web Services** | **13-- hours** |
| Data Management with ADO.NET - Introducing ADO.NET - ADO.NET features - Using SQL Server with VB.NET – Using SQL Server with ASP.NET – LINQ queries – Building ASP.NET 3.5 Enterprise Applications: Developing ASP.NET Ajax applications – ASP.NET web services. |
|  |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
|  |
|  | **Total Lecture hours** | **60 hours** |
| **Text Book(s)** |
| 1 | Bill Evjen, Scott Hanselman, Devin Rader, Professional ASP.NET 4 in C# and VB I Edition, 2010, Wiley Publishing, Inc. |
| 2 | Steven Holzner, Visual Basic.NET Programming Black Book, 2005 Edition, Paraglyph press USA&Dreamtech Press, India.  |
| 3 | KoGENT Solutions Inc., ASP.NET 3.5 (Covers C# and VB 2008 codes) Black Book, Platinum Edition, Dreamtech press, 2010 |
| 4 | Jesse Liberty, Programming C#, Fourth Edition, Building .NET Applications with C#, O'Reilly Media publication, 2005 |
|  |
| **Reference Books** |
| 1 | Jonas Fagerberg, ASP.NET Core 1.1 Web API For Beginners: How To Build a Web API, The Tactical Guide Book, CSharpSchool.com, 2017. |
| 2 | Jesse Liberty, Programming Visual Basic.NET 2003, Second Edition, O Reilly, Shroff Publishers and Distributors Pvt. Ltd. . |
| 3 | Andrew Troelsen, „C# and the .NET Platform‟, A Press, 2001. |
| 4 | Bill Evjen, JasonBeres, et al. Visual Basic.NET Programming Bible, 2002 Edition, IDG books India (p) Ltd.  |
| 5 | Mridula Parihar et al., ASP.NET Bible, 2002 Edition, Hungry Minds Inc, New York, USA. |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | <https://www.w3schools.com/asp/> |
| 2 | <https://www.tutorialspoint.com/vb.net> |
| 3 | https://www.tutorialspoint.com/ASP.net |
| **Course Designed By: Dr. R. Porkodi** |

**List of Programs**

**C#.NET**

1. Create a window-based application to manipulate string operations using the String class.
2. Create a window-based application to perform various array operations using the Array class.
3. Create a window-based application to implement a sorted list collection with the necessary functions.
4. Create a window-based application to illustrate how LINQ operations are done in data objects.

**VB.NET & ADO.NET**

1. Create a window-based application to illustrate how to send mail through any Windows application.
2. Create a Window form with all necessary controls for obtaining students' details, including 3 subject marks. The total and average of obtained marks should be calculated by calling class library functions totcal( ) and averagecal( ).
3. Develop a data-centric VB.NET application using the SQLClient namespace and perform the following operations.
4. Create the file
5. Insert file records
6. Display the file
7. Delete the records from the file
8. Update the records in the file
9. Searching for records in the file
10. Develop a data-centric VB.NET application and navigate the records using ADO.NET.

**ASP.NET & ADO.NET**

1. Create a web application to prepare the monthly scheduler for an organization using calendar control in ASP.NET.
2. Develop a web application to create and display flash news and banner advertisements that may scroll on any web page using Rich Web Controls.
3. Develop data centric VB.Net application using the OLEDB namespace and perform the following operations.
4. Create the file
5. Insert file records
6. Display the file
7. Delete the records from the file
8. Update the records in the file
9. Searching of records in the file
10. Develop a data-centric VB.NET application and navigate the records using the OLEDB namespace in ADO.Net.

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **M** | **M** | **L** | **M** | **S** | **S** | **L** | **L** | **L** |
| **CO2** | **S** | **S** | **S** | **L** | **S** | **S** | **S** | **M** | **L** | **M** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **S** | **S** | **M** | **M** | **L** |
| **CO4** | **S** | **S** | **S** | **L** | **M** | **S** | **S** | **L** | **M** |  **M** |
| **CO5** | **S** | **S** | **S** | **M** |  **S** | **S** | **S** | **S** | **M** | **M** |

 \*S-Strong; M-Medium; L-Low

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| --- | --- | --- | --- | --- | --- | --- |
| **Course code** | **24CS3C2** | **SOFTWARE PROJECT MANAGEMENT** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **CORE** | **4** | **0** | **0**  | **4** |
| **Pre-requisite** | Fundamentals of Software Project Management | **Syllabus Version** | **2024-25** |
| **Course Objectives:** |
| The main objectives of this course are: 1. To provide in-depth knowledge about the basic concepts of software project management, project planning, and a step-wise framework in project planning
2. To discuss the Project planning, cost-benefit
3. To inculcate continual training and learning to improve group work
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|  |
| **Expected Course Outcomes:** |
| On the successful completion of the course, students will be able to: |
| 1 | Understand the fundamentals of Software Project Management | K2/ K4 |
| 2 | Identify the Project Evaluation Methods and different Process Models  | K2/ K4 |
| 3 | Explore the fundamentals of Software Effort Estimation  | K2/ K4 |
| 4 | Analyze the need for Risk Management and the related concepts. | K2/ K4 |
| 5 | Know the various types of contracts and agile management | K2/ K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
|  |
| **Unit:1** | **Introduction** | **10 hours** |
| Software Project Management -Software Project Versus Other Project –Requirement Specification – Information and Control in Organization –Introduction to step wise Project Planning –Select –Identify Scope and Objectives -Identify Project Infrastructure –Analyse -Project Characteristics –Products and Activities –Estimate Effort for each Activity –Identify Activity Risks –Allocate Resources -Review / Publicize Plan –Execute Plan and Lower Levels of Planning. |
|  |
| **Unit:2** | **Project Evaluation** | **12 hours** |
| Introduction –Strategic Assessment –Technical Assessment –Cost Benefit Analysis –Cash Flow Forecasting –Cost Benefit Evaluation Techniques –Risk Evaluation –Selection of an Appropriate Project App roach –Choosing Technologies –Choice of Process Models –Structured Methods –Rap id Application Development –Waterfall Model –V-Process Model –Spiral Model –Software Prototyping –Ways of Categorizing Prototypes –Tools –Incremental Delivery –Selection Process Model |
|  |
| **Unit:3** | **Software Effort Estimation** | **15 hours** |
| Introduction –Problems with Over and Under Estimates –Basis for Software Estimating –Software Effort Estimation Technique –Albrecht Function Point Analysis –Function Points –Object Points –Procedural Code Oriented Approach –COCOMO –Activity Planning –Project Schedules -Projects and activities –Sequencing and Scheduling Activities –Network Planning Models –Formulating a Network Planning –Adding Time Dimension –Forward Pass –Backward Pass –Identifying the Critical Path –Activity Float -Shortening Project Duration –Identifying Critical Activities –Precedence Networks. |
|  |
| **Unit:4** | **Risk Management** | **10 hours** |
| Introduction –Nature of Risk Man aging Identification –Analysis –Reducing –Evaluating –Z values –Resource Allocation –Nature of Resources –Requirements –Scheduling –Critical Paths –Counting the Cost –Resource Schedule –Cost Schedule –Scheduling Sequence –Monitoring and Control –Creating the Frame Work -Collecting the Data –Visualizing the Progress –Cost Monitoring –Prioritizing Monitoring –Change Control |
|  |
| **Unit:5** | **Managing Contracts and Agile Project Management**  | **11 hours** |
| Introduction –Types of Contract –Stages in Contract Placement –Terms of Contract –Contract Management –Acceptance –Managing People and Organizing Teams –Organizational Behavior Background –Selecting the Right Person for the Job –Instruction in the Best Methods –Motivation –Decision Making –Leadership – Organizational Structures. **Introduction to Agile:** Agile principles, benefits over traditional models – Scrum roles, events, and artifacts – Crystal and DSDM frameworks – Sprint planning, estimation techniques – Tools (JIRA, Trello, Azure DevOps, Rally) – Agile culture, collaboration and case studies from industry. |
|  |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
|  |
|  | **Total Lecture hours** | **60 hours** |
| **Text Books** |
| 1 | Bob Hughes (Author), Mike Cotterell (Author), Rajib Mall (Author)- 2 October 2017 |
| 2 | Software Engineering Project Management, Richard Thayers 2nd Edition 2014 |
| 3 | Effective Software Project Management, Robert K. Wysocki - 2010 |
| **Reference Books** |
| 1 | Walker Royce, “Software Project Management, Addition Wesley. |
| 2 | DerrelInce, H. Sharp, and M. Woodman, “Introduction to Software Project Management and Quality Assurance, Tata McGraw-Hill, 1995 |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | <https://nptel.ac.in/courses/106/105/106105218/> |
| 2 | <https://swayam.gov.in/nd1_noc19_cs70/preview> |
| 3 | <https://freevideolectures.com/course/4071/nptel-software-project-management> |
| 4 | <https://www.nptelvideos.com/video.php?id=918> |
| 5 | <https://www.classcentral.com/course/swayam-software-project-management-14294> |
| 6 | <https://www.w3schools.in/sdlc-tutorial/software-development-life-cycle-sdlc/> |
| Course Designed By: **Dr. D. NAPOLEON** |

Mapping with programme outcomes:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| CO1 | **S** | **L** | **M** | **M** | **M** | **L** | **L** | **S** | **S** | **L** |
| CO2 | **S** | **M** | **M** | **S** | **S** | **L** | **M** | **S** | **M** | **S** |
| CO3 | **S** | **L** | **L** | **S** | **L** | **M** | **S** | **M** | **M** | **S** |
| CO4 | **S** | **M** | **L** | **L** | **M** | **M** | **S** | **M** | **L** | **M** |
| CO5 | **S** | **L** | **L** | **S** | **M** | **M** | **M** | **S** | **L** | **M** |

**S- Strong; M-Medium; L-Low**

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| --- | --- | --- | --- | --- | --- | --- |
| **Course code** | **24CS3C3** |  **CLOUD COMPUTING** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **CORE** | **2** | **0** | **4** | **4** |
| **Pre-requisite** | Basic knowledge of software systems, specifically of the operating system |  **Syllabus Version** | **2024-25** |
| **Course Objectives:** |
| The main objectives of this course are to:1. Understand the different concepts of cloud computing and its services2. Store and retrieve the data from the cloud and provide security to the data in the cloud |
|  |
| **Expected Course Outcomes:** |
| On the successful completion of the course, students will be able to: |
| 1 | Articulate the main concepts, key technologies of cloud computing in terms of strengths, limitations, and applications. | K1 |
| 2 | Categorize the architecture and infrastructure of cloud computing, such as IaaS and SaaS | K1/K3 |
| 3 | Explain the concept of virtual machines and virtualization | K3/K4 |
| 4 | Apply suitable storage algorithms in cloud computing | K3 |
| 5 | Be exposed to broad approaches to migrating to a cloud and mobile cloud computing | K2/K3/K4 |
| 6 | Describe the data security concepts in cloud computing | K2/K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create |
|  |
| **Unit:1** | **Introduction** | **12 hours** |
| Introduction: Cloud Computing Basics: Cloud Computing Overview - Applications of cloud computing - Intranets and the cloud – First movers in the cloud - Benefits - limitations of cloud computing – Security Concerns – Cloud Computing Services – Salesforce.com |
|  |
| **Unit:2** | **Cloud Computing Technology** | **12 hours** |
| Hardware and Infrastructure – Clients – Security – Network – Services - Cloud Storage – Standards – Cloud Computing at work: Software as a Service – Software Plus Services – Developing Applications |
|  |
| **Unit:3** | **Virtual Machines and Virtualization** |  **12 hours** |
| Introduction - Understanding Virtualization - History of Virtualization – Leveraging Blade Servers – Server Virtualization – Desktop Virtualization – Virtual Networks – Data Storage Virtualization. Data Storage in Cloud: Evolution of Network Storage – Cloud-based data Storage – Advantages and disadvantages of Cloud-based data storage- Cloud-based Backup systems - File Systems – Cloud-based Block Storage |
|  |
| **Unit:4** | **Migrating to the Cloud** | **12 hours** |
| Introduction – Broad approaches of migrating into the cloud – The Seven-Step Models of Migrating into the Cloud. Mobile Cloud Computing: Evolution of Mobile Computing – Mobile Cloud EcoSystem – Mobile Players |
|  |
| **Unit:5** | **Data Security in the Cloud** | **10 hours** |
| Introduction – Current state of data security – Homo sapiens and Digital Information – Cloud Computing and Data security Risk – Cloud Computing and Identity – The Cloud, Digital Identity and Data Security- Content Level Security- Pros and Cons |
|  |
| **Unit:6** | **Introduction to Industry 5.0** | **02 hours** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops  |
|  |
|  | **Total Lecture hours** | **60 hours** |
|  **Text Books** |
| 1 |  Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, “ Cloud Computing: A Practical Approach”, McGraw Hill |
| 2 |  Kris Jamsa, “ Cloud Computing,” Jones and Bartlett Student Edition, 2014 |
|  **Reference Books** |
|  1 |  Rajkumar Byya, James Broberg, Andrzej Goscinski, “ Cloud Computing Principles and Paradigms”, Wiley & Sons  |
|  2  |  E-Resources |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 |  <https://swayam.gov.in/nd1_noc20_cs55/> |
| 2 |  <https://nptel.ac.in/courses/106/105/106105223/>  |
|  |
| **Course Designed By: Dr.E.Chandra**  |

**Mapping with Programme Outcomes**

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **S** | **M** | **L** | **L** | **M** | **L** | **L** | **S** | **S** |
| **CO2** | **M** | **M** | **M** | **M** | **M** | **M** | **L** | **S** | **S** | **S** |
| **CO3** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **M** | **L** |
| **CO4** | **S** | **S** | **S** | **S** | **L** | **S** | **M** | **S** | **M** | **M** |
| **CO5** | **S** | **S** | **M** | **S** | **L** | **S** | **M** | **M** | **S** | **S** |
| **CO6** | **S** | **S** | **L** | **S** | **S** | **S** | **S** | **M** | **S** | **M** |

S- Strong; M-Medium; L-Low

**List of programs for practical Lab:**

1. To simulate a basic cloud environment with one datacenter, one VM, and one cloudlet.
2. To simulate a cloud environment with multiple VMs and multiple cloudlets.
3. To implement and observe time-shared VM scheduling policy.
4. Implement and observe space-shared VM scheduling policy.
5. To simulate and analyze the cost of creating VMs in a cloud environment.
6. To evaluate how task length affects cloudlet execution time.
7. To simulate energy-aware resource allocation in CloudSim.
8. To simulate cloud infrastructure with multiple datacenters.
9. To simulate cloudlet failure and handling strategies.
10. To simulate VM migration in response to load balancing.
11. To simulate cloudlet execution based on priority.
12. To simulate VMs with varying processing powers (MIPS).
13. To statically bind specific cloudlets to selected VMs.
14. To simulate network latencies using CloudSim.
15. To compare different broker policies (e.g., BestFit, RoundRobin).

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| **Course code** | **24CS3C4** | **BIG DATA ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **CORE** | **2** | **0**  |  **4** | **4** |
| **Pre-requisite** | Fundamentals of Database Management and Data Mining | **Syllabus Version** | **2024-25** |
| **Course Objectives:** |
| The main objectives of this course are: 1. To provide in-depth knowledge about the basic concepts of Big Data, characteristics, and industry examples.
2. To discuss the Hadoop framework, HDFS, and MapReduce.
3. To inculcate HBase, Cassandra, HiveQL, Pig, and Neo4j data models.
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|  |
| **Expected Course Outcomes:** |
| On the successful completion of the course, students will be able to: |
| 1 | Understand about basics of Big Data, Technologies, and Applications in various domains.  | K2 |
| 2 | Understand the foundations of Hadoop and Hadoop Distributed File System. Design of HDFS and file-based data structures. | K2/K3/K4 |
| 3 | Analyze the working of MapReduce and YARN for job scheduling.  | K2/K3/K4 |
| 4 | Evaluate the need and fundamentals of HBase. Apply the Cassandra data model for different applications. Understand the basic commands in HiveQL, Pig, and Pig Latin. | K2/K3/K4 |
| 5 | Analyze the basic concepts and need for Graph databases, create databases, and retrieve records using Neo4j. Understand the data visualization and its need.  | K2/K3/K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
|  |
| **Unit:1** | **Introduction to Big Data** | **10 hours** |
| Introduction: What is big data – why big data – convergence of key trends - unstructured data – industry examples of big data – Web analytics - big data and marketing – fraud and big data - risk and big data – credit risk management – big data and algorithmic trading - big data and healthcare – big data in medicine – advertising and big data – big data technologies - cloud and big data– mobile business intelligence – crowd sourcing analytics. |
|  |
| **Unit:2** | **Hadoop** | **12 hours** |
| History of Hadoop - The Hadoop Distributed File System – components of Hadoop - Analyzing the Data with Hadoop - Design of HDFS – HDFS concepts - Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures. |
| **Unit:3** | **MapReduce** | **15 hours** |
| MapReduce: MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution –MapReduce types – input formats – output formats. |
| **Unit:4** | **Hadoop Eco System** | **10 hours** |
| HBase – data model and implementations – HBase clients – HBase examples. Cassandra – Cassandra data model –Cassandra examples – Cassandra clients –Hadoop integration. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation –HiveQL queries-case study. |
| **Unit:5** | **Graph Databases** | **11 hours** |
| Introduction - Neo4J - Key concept and characteristics -Modeling data for neo4j - Importing data into neo4j - visualizations - neo4j - Cypher Query Language –data visualization.  |
|  |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
|  | **Total Lecture hours** | **60 hours** |
| **Text Books** |
| 1 |  Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O′Reilly Publishers, 2012. |
| 2 |  Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013. |
| 3 | Rik Van Bruggen, “Learning Neo4j”, Second Edition, Packt Publishers, 2014. |
| **Reference Books** |
| 1 | Andreas Francois Vermeulen, Ankurgupta, Cindy Gross, David Kjerrumgaard, and Scott Shaw, “Practical Hive: A Guide to Hadoop’s Data Warehouse System”, Apress Media publishers, 2016 |
| 2 | Eric Lubow and Russell Baradberry, Practical Cassandra: A Developer’s Approach, Addison-Wesley publishers, 2014. |
| 3 | Dirk deRoos, Paul Zikopoulos, Bruce Brown, Roman B. Melnyk, RafaelCoss, “Hadoop For Dummies”, John Wiley & Sons publishers, 2014 |
| 4 | Hunger, Michael, and Oliver Gierke. Good Relationships: The Spring Data Neo4j Guide Book. C4Media, 2012. |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | <https://nptel.ac.in/courses/106/104/106104189/> |
| 2 | <http://statweb.stanford.edu/~tibs/ElemStatLearn/> |
| 3 | <https://www.edureka.co/blog/big-data-tutorial> |
| 4 | <https://www.coursera.org/learn/big-data-introduction> |
| 5 | <https://cognitiveclass.ai/courses/what-is-big-data> |
| 6 | <https://www.tutorialspoint.com/hbase/index.htm> |
| 7 | https://www.guru99.com/hive-query-language-built-operators-functions.html |
|  |
| Course Designed By: **Dr. S. Vijayarani** |

Mapping with programme outcomes:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| CO1 | **S** | **M** | **S** | **S** | **M** | **L** | **M** | **L** | **M** | **L** |
| CO2 | **S** | **M** | **M** | **S** | **S** | **M** | **S** | **L** | **M** | **M** |
| CO3 | **S** | **L** | **S** | **M** | **S** | **L** | **L** | **M** | **S** | **M** |
| CO4 | **S** | **M** | **S** | **M** | **M** | **M** | **S** | **S** | **M** | **M** |
| CO5 | **S** | **L** | **S** | **M** | **M** | **S** | **M** | **S** | **S** | **M** |

**S- Strong; M-Medium; L-Low**

List of Programs

1. Installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as adding files and directories, retrieving files, and deleting files.
3. Data Manipulation Using HiveQL

To practice data manipulation operations in Hive using HiveQL: INSERT, UPDATE, ALTER, TRUNCATE, and DELETE.

1. Hive Join Operations

Perform the following HiveQL join operations and display the result: Inner Join, Left Outer Join, Right Outer Join, Full Outer Join

1. Implementation of Partitioning and Bucketing in Hive
2. Loading and Filtering Data in Apache Pig (load, display, join, filter, and group)
3. Aggregation and Sorting Using Apache Pig (Load, Distinct, Average (GROUP + AVG), Sort, Display)
4. Complete CRUD Operations in HBase Using HBase Shell

To perform table creation, data insertion, retrieval, updating, deletion, and scanning in HBase using HBase Shell

1. Managing HBase Table Metadata and Structure

To perform various administrative operations in HBase, including checking for table existence, listing tables, altering table schema, enabling/disabling tables, and truncating data.

1. Modeling a University Academic Network Using Neo4j

To model an academic environment using Neo4j, where people (students and professors) are linked to their departments and courses. Create and query the graph using Cypher.

1. Maintaining Product Information Using Cassandra (keyspaces and tables- INSERT, UPDATE, DELETE, and SELECT, filtering with WHERE)
2. MapReduce for Word Count using Python
3. MapReduce to Analyze Student Marks using Python

Write a MapReduce Python program to perform the following operations:

1. Calculate the average mark of each student across all subjects.
2. Identify the highest mark each student has obtained.
3. Identify the lowest mark each student has obtained.
4. Filter and list students whose average mark is above 80.