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BCA (Cloud Computing)

Semester – IV	**Course Category**
3BCC4-SE-004-T	**L T P C**
Programming with Python	2 0 0 2

Course Objectives

- To learn about Basics of Python programming.
- To know about Decision Making and Functions in Python.
- To learn about Object Oriented Programming using Python.
- To know about Files Handling in Python.
- To learn about GUI Programming and Database operations in Python.

Course Outcomes :

Course Outcomes(COs)	**Level***
CO1 Explain Python syntax including data types, control structures, and modules with basic programs.	L2
CO2 Develop Python programs using functions, lists, tuples, and dictionaries with appropriate methods.	L2 & L3
CO3 Implement object-oriented concepts including classes, inheritance, and exception handling in Python.	L2 & L3
CO4 Perform file and directory operations in Python through illustrative programs.	L2 & L3
CO5 Integrate GUI components using Tkinter and database operations using PyMySQL to build Python applications.	L4

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome..*

Articulation Matrix:-

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

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

High-3 Medium-2 Low-1

Unit I
Introduction, Origin, Comparison, Comments, Operators, Variables and Assignment, Numbers, Strings, Lists and Tuples, Dictionaries, if Statement, while Loop, for Loop and the range(),String and regular expressions. Module: Importing Module, Math Module, The sys Module, Random Module, and Package.

Unit II
Functions: Defining a function, calling a function, Types of functions, Function Arguments, Anonymous functions, Built-in functions, Lists and Tuple: Introduction to List and Tuple, Accessing List and Tuple, Operations, working with List and Tuple, Function and Methods. Dictionaries: Working with dictionaries, properties and functions.

Unit III
Object oriented programming and classes in Python - creating classes, instance objects, accessing members, Data hiding (the double underscore prefix), Built-in class attributes, Garbage collection: the constructor, Overloading methods and operators, Inheritance-implementing a subclass, overriding methods, Exceptions: try Statement, Exception Propagation, Except Clause, Try, Finally Clause, User Defined Exception, The raise statement.

Unit IV
Creating files, Operations on files (open, close, read, write), File object attributes, file positions, Listing Files in a Directory, Testing File Types, Removing Files and Directories, Copying and Renaming Files, Splitting Path names, Creating and Moving to Directories, Traversing Directory Trees, Illustrative programs: word count, copy file.

Unit V
Tkinter module, widgets and basics, Component, layout options, Button, Label, Entry, Listbox, Radio button, Check button, Scrollbar, Container Widgets: Frame, Event handling, Keyboard events, Mouse events etc. Introduction to MySQL, PYMYSQL Connections, using connect, cursor, execute & close functions, reading single & multiple results of query execution, executing different types of statements, understanding exceptions in database connectivity.

Examination Scheme: Total – 100 marks

Components Continuous Internal Assessment*	**External Assessment (EST #)**	**(A, Assignment I-V, Q, MST-I & II #)**
Weightage (%)	60	40

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (5 Quizzes), MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

Reference Books:

1. Python Essential by David M. Beazly.
2. Python Pocket by Mark Lutz.
3. Barry, Paul, Head First Python, 2nd Edition.

4. Python: The Complete Reference.

List of e-Learning Resources:

1. https://www.coursera.org/learn/python-programming-intro
2. https://www.codecademy.com/catalog/language/python
3. https://learn.microsoft.com/en-us/training/modules/intro-to-python/
4. https://developers.google.com/edu/python
5. https://www.python.org/about/gettingstarted/
6. https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/

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BCA (Cloud Computing)

Semester – IV	**Course Category**			
3BCC4-SE-004-P	**L**	**T**	**P**	**C**
Programming with Python Lab	0	0	2	1

Course Objectives

- To learn about Basics of Python programming.
- To know about Decision Making and Functions in Python.
- To learn about Object Oriented Programming using Python.
- To know about Files Handling in Python.
- To learn about GUI Programming and Database operations in Python.

Course Outcomes :

Course Outcomes(COs)	**Level***
CO1 Explain Python syntax including data types, control structures, and modules with basic programs.	L2
CO2 Develop Python programs using functions, lists, tuples, and dictionaries with appropriate methods.	L2 & L3
CO3 Implement object-oriented concepts including classes, inheritance, and exception handling in Python.	L2 & L3
CO4 Perform file and directory operations in Python through illustrative programs.	L2 & L3
CO5 Integrate GUI components using Tkinter and database operations using PyMySQL to build Python applications.	L4

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome.*

Articulation Matrix :

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

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

High-3 Medium-2 Low-1

Unit I : Fundamentals of Python Programming
Introduction to Python, Writing a simple Python program, Variables, data types, and input/output, Control structures (if-else, loops), Functions and modular programming

Unit II : Python Data Structures and Methods
Lists and their methods, Tuples and their methods, Dictionaries and their functions, Sets and their operations

Unit III : Advanced Python Programming Concepts
Anonymous functions (lambda), Modules and packages, Object-Oriented Programming (OOP) concepts, Classes and objects, Inheritance and method overriding, Special (double underscore) methods

Unit IV : Exception Handling and File Operations in Python
Exception handling basics, User-defined exceptions, File operations (read, write, copy), Working with text and binary files

Unit V : Python GUI Development and Database Connectivity
Introduction to Tkinter for GUI development, Creating basic GUIs (Login form, Registration form), Connecting Python to databases, Performing CRUD operations on databases

Examination Scheme: Total – 100 marks

Components Continuous Internal Assessment*	**External Assessment (EST #)**	**(A, LR, MST-I & II #)**
Weightage (%)	50	50

*A-Attendance; Lab Record Submission, MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

List of Experiments

1. Write a program to convert temperature from Fahrenheit to Celsius depending upon user choice.
2. Write a program to use a dictionary and its functions in python.
3. Write a program to check whether given no is prime or not.
4. Write a program to implement a list and use its methods.
5. Write a program to implement tuple and use its methods.
6. Write a program to import modules and use it.
7. Write a user defined function to implement factorial of a given no.
8. Write a program to show the use of anonymous functions.
9. Write a program to calculate the area of rectangle and circle using class.
10. Write a program to implement single level inheritance.
11. Write a program to override methods.

12. Write a program to implement double underscore methods.
13. Write a program to implement Exception Handling.
14. Write a program for user defined exceptions.
15. Write a program to copy a file.
16. Write a program to count no. of words in a file.
17. Write a program to make Login GUI in Tkinter.
18. Write a program to make registration form GUI in Tkinter.
19. Write a program to connect with the database and perform insert operation.
20. Write a program to perform select operation on database.
21. Write a program to perform delete operations on databases.
22. Write a program to perform update operations on databases.

Reference Books:

1. Python Essential by David M. Beazly.
2. Python Pocket by Mark Lutz.
3. Barry, Paul, Head First Python, 2nd Edition.
4. Python: The Complete Reference.

List of e-Learning Resources:

1. https://www.coursera.org/learn/python-programming-intro
2. https://www.codecademy.com/catalog/language/python
3. https://learn.microsoft.com/en-us/training/modules/intro-to-python/
4. https://developers.google.com/edu/python
5. https://www.python.org/about/gettingstarted/
6. https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/

BCA (Cloud Computing)

Semester – IV	**Course Category**			
3BCC4-DM-003-T	**L**	**T**	**P**	**C**
Principles of Virtualization	4	0	0	4

Course Objectives:

- To know about various virtualization technologies, including server, storage, I/O, network, client, application, and desktop virtualization.
- To learn about Install and set up Windows Virtual PC on different platforms.
- To learn about Install and configure the RD Session Host Role Service on the server.
- To know about the Configure Remote Desktop Web Access and role-based application provisioning.
- To Learn about the HYPER-V role and create virtual machines.

Course Outcomes:

Course Outcomes(COs)	**Level***
CO1 Configure Remote Desktop Web Access, role-based application provisioning, and client settings to enable access to virtualized desktops and published applications.	L2
CO2 Install and configure Windows Virtual PC by creating virtual hard disks and managing network resources on host machines.	L3
CO3 Deploy remote applications by packaging them using RemoteApp and configuring the RD Session Host Role Service.	L3
CO4 Configure Remote Desktop Web Access, role-based provisioning, and client settings to access virtualized desktops.	L3
CO5 Compare VMware vSphere, Microsoft Hyper-V, and Citrix XenDesktop to select and manage appropriate virtualization solutions.	L4

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome.*

Articulation Matrix:-

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

CO/PO/ PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO-1	3	1	1	–	–	–	2	–	–	1	3	1
CO-2	3	1	2	3	–	–	3	–	–	1	3	2
CO-3	3	1	2	3	–	–	3	–	–	1	3	2
CO-4	3	1	2	2	–	–	3	–	–	1	3	2
CO-5	3	2	3	3	1	–	3	–	–	2	3	3

High-3 Medium-2 Low-1

Unit-1: Exploring Virtualization Technologies **09 Hours**

Understanding Virtualization, Need of Virtualization and Virtualization Technologies: Server Virtualization, Storage Virtualization, I/O Virtualization, Network Virtualization, Client Virtualization, Application virtualization, Desktop virtualization, Understanding Virtualization Uses: Studying Server Consolidation, Development and Test Environments, Helping with Disaster Recovery.

Unit-II: Hardware Virtualization and Windows Installation **09 Hours**

Configure the BIOS to support hardware virtualization; Install and configure Windows Virtual PC: installing Windows Virtual PC on various platforms (32-bit, 64-bit), creating and managing virtual hard disks, configuring virtual machine resources including network resources, preparing host machines; create, deploy, and maintain images.

Unit-III: Remote App Deployment Management **09 Hours**

Prepare and manage remote applications: configuring application sharing, package applications for deployment by using RemoteApp, installing and configuring the RD Session Host Role Service on the server.

Unit-IV: Application Access and Configuration **09 Hours**

Access published applications: configuring Remote Desktop Web Access, configuring role based application provisioning, configuring Remote Desktop client connections. Configure client settings to access virtualized desktops: configuring client settings.

Unit-V: Exploring Virtualization Software Options **09 Hours**

List of virtualization Software available. Vmware- introduction to Vsphere, ESXi, CenterServer and Vsphere client. Creating Virtual Machines. Introduction to HYPER-V role. Create Virtual Machines. Create Hyper-v virtual networking, Use virtual Machine Snapshots. Monitor the performance of a Hyper-v server, Citrix XENDesktop fundamentals

Total Hours: 45

Examination Scheme: Total – 100 marks

Components Continuous Internal Assessment*	**External Assessment (EST #)**	**(A, Assignment I-V, Q, MST-I & II #)**
Weightage (%)	60	40

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (3 Quizzes), MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

Reference Books:

1. Virtualization with Microsoft Virtual Server 2005 by TwanGrotenhuis, RogierDittner, Aaron Tiensivu, Ken Majors, Geoffrey Green, David Rule, Andy Jones, Matthijs ten Seldam, Syngress Publications, 2006
2. Virtualization--the complete cornerstone guide to virtualization best practices, Ivanka Menken, Gerard Blokdijk, Lightning Source Incorporated, 2008
3. Virtualization: From the Desktop to the Enterprise, Chris Wolf, Erick M. Halter, EBook, 2005

List of e-Learning Resources:

1. https://www.udemy.com
2. https://www.edx.org
3. https://www.coursera.com/

BCA(Cloud Computing)
Detailed Syllabus

Semester – IV
3BCC4-DE-002-T-03
Software Engineering
Pre-requisites: None

Course Category

L	**T**	**P**	**C**
4	0	0	4

Course Objective:

- To understand different SDLC models and how they work.
- To analyze user needs and write clear software requirements.
- To apply design rules to build well-structured software.
- To create and run tests to find and fix software bugs.
- To evaluate software quality and check if it is reliable.

Course Outcomes:

Course Outcomes (COs)	**Level ***
CO1: Explain different SDLC models and their stages to choose the right process for a project.	L2
CO2: Analyze user needs to create clear and accurate software requirement documents.	L3
CO3:Apply basic design principles to build organized and easy-to-maintain software code.	L2
CO4: Develop and execute various test cases to find errors and ensure the software works correctly.	L3 & L4
CO5: Assess the final software to check its quality, reliability, and performance standards.	L5

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome.*

Articulation Matrix:-

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

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

High-3 Medium-2 Low-1

Course Contents:

Unit-I: Introduction to Software Engineering

Software definition, software characteristics, software evolution, software myths, software crisis, software engineering layers, software process, umbrella activities, process framework, Software Development Life Cycle (SDLC), Classical Waterfall Model, Iterative Waterfall Model, Prototyping Model, Rapid Application Development (RAD) Model, Evolutionary Process Models, Spiral Model, Win-Win Spiral Model, Component-Based Development, Concurrent Development Model, Agile Process Models, Scrum, Extreme Programming (XP), Adaptive Software Development (ASD), Dynamic Systems Development Method (DSDM), Crystal, Feature Driven Development (FDD), Lean Software Development, Agile Manifesto, Comparison of various process models.

Unit-II: Requirements Engineering

Requirements engineering process, inception, elicitation, elaboration, negotiation, specification, validation, management, Functional Requirements, Non-functional Requirements, User Requirements, System Requirements, Interface Requirements, Software Requirement Specification (SRS) document, IEEE 830 standards, characteristics of a good SRS, requirement traceability, Analysis Modeling, Data Flow Diagrams (DFD), Level-0 DFD, Level-1 DFD, Level-2 DFD, Data Dictionary, Entity Relationship Diagram (ERD), State Transition Diagram (STD), Control Flow Diagram (CFD).

Unit-III: Software Design

Design process, design quality, design principles, Abstraction, Refinement, Modularity, Software Architecture, structural partitioning, information hiding, functional independence, Cohesion, functional cohesion, sequential cohesion, communicational cohesion, procedural cohesion, temporal cohesion, logical cohesion, coincidental cohesion, Coupling, data coupling, stamp coupling, control coupling, external coupling, common coupling, content coupling, Architectural Styles, call and return architecture, data-centered architecture, data-flow architecture, object-oriented architecture, layered architecture, User Interface Design, golden rules, interface analysis, human-computer interaction (HCI).

Unit-IV: Software Testing

Testing fundamentals, testing objectives, principles of testing, Verification vs Validation, test plan, test case design, White-Box Testing, basis path testing, flow graph notation, Cyclomatic Complexity, control structure testing, condition testing, data flow testing, loop testing, Black-Box Testing, equivalence partitioning, Boundary Value Analysis (BVA), comparison testing, orthogonal array testing, Testing Strategies, unit testing, integration testing, top-down integration, bottom-up integration, regression testing, smoke testing, System Testing, recovery testing, security testing, stress testing, performance testing, Acceptance Testing, alpha testing, beta testing, debugging process.

Unit-V: Software Project Management

Project management spectrum, people, product, process, project, Software Metrics, process metrics, project metrics, size-oriented metrics, function-oriented metrics, Function Point (FP) Analysis, Software Estimation, COCOMO Model, basic COCOMO, intermediate COCOMO, detailed COCOMO, software equation, project scheduling, Work Breakdown Structure (WBS), Gantt Charts,

PERT/CPM Charts, Risk Management, risk identification, risk projection, risk refinement, RMMM plan, Software Quality Assurance (SQA), software reviews, formal technical reviews (FTR), ISO 9000 quality standards, CMMI levels, Software Maintenance, corrective maintenance, adaptive maintenance, perfective maintenance, preventive maintenance, Reverse Engineering, Software Re-engineering..

Examination Scheme: Total – 100 marks

Components	**Continuous Internal Assessment* (A, Assignment-I & II, Q, MST-I & II #)**	**External Assessment (EST #)**
Weightage (%)	40	60

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (5 Quizzes), MST-I, MST-II, EST. (# MST-I & II conducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

List of Books:

Text Book:

1. Pankaj Jalote ,"An Integrated Approach to Software Engineering", Narosa Pub, 2005

Reference Books:

1. Rajib Mall, "Fundamentals of Software Engineering" Second Edition, PHI Learning
2. R S. Pressman ,"Software Engineering: A Practitioner's Approach", Sixth edition2006, McGraw-Hill.
3. Sommerville,"Software Enginerring",Pearson Education.

Important Websites:

1. https://www.w3schools.com/php/
2. https://www.geeksforgeeks.org/php-tutorial/

BCA (Cloud Computing)

Semester – IV
3BCC4-DE-002-T-02
Cloud Migration
Pre-requisites: None

Course Category			
L	**T**	**P**	**C**
4	0	0	4

Course Objective:

- To explain the move from local physical servers to flexible cloud environments using the 6 R's strategy.
- To design smart cloud setups by mapping app dependencies and choosing the right resource sizes.
- To implement automated tools and code-based setups to move data and apps without errors.
- To analyze how new 2026 cloud trends change the way we manage Edge and Hybrid services.
- To evaluate if the migration was successful by checking cost savings and system speed.

Course Outcomes:

Course Outcomes (COs)	Level *
CO1: Apply the 6 R's framework to select the most efficient migration path for any business application.	L3
CO2: Build a detailed migration roadmap that identifies risks and maps all technical dependencies.	L3
CO3: Execute the move of databases and servers to the cloud using automation and migration tools.	L3
CO4: **Optimize** cloud costs and performance by using **auto-scaling** and usage-based billing audits.	L4
CO5: **Optimize** cloud costs and performance by using **auto-scaling** and usage-based billing audits.	L4 & L5

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Apply; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome.*

Articulation Matrix:-

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

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

High-3 Medium-2 Low-1

Course Contents:

Unit 1: Fundamentals & Strategic Planning

Introduction to Cloud Computing (Public, Private, Hybrid), Defining Cloud Migration (On-premise to Cloud), Building a Business Case (ROI, TCO), The 6 R's Strategy (Rehost, Replatform, Refactor, Rearchitect, Retire, Retain), Organizational Change Management (Cultural, Structural), Compliance & Legal Assessment (GDPR, HIPAA, SOC2), Cloud Provider Selection (AWS, Azure, GCP), Project Scoping (Timeline, Budget, Goals), Inventory Discovery (Hardware, Software), Risk Mitigation Planning (Technical, Business), Migration Center of Excellence (Governance, Team Roles), Pilot Planning (PoC, Sandbox).

Unit 2: Infrastructure Assessment & Design

Automated Discovery Tools (Agent-based, Agentless), Application Dependency Mapping (Tiers, Connections), Resource Right-Sizing (CPU, RAM, IOPS), Network Architecture Design (VPC, Subnets, Gateways), Hybrid Connectivity (VPN, Direct Connect, SD-WAN), Identity and Access Management (RBAC, MFA, SSO), Storage Strategy (Block, Object, File), Database Assessment (Schema, Compatibility, Version), Legacy Systems Analysis (Mainframe, Monolithic), Security Perimeter Design (WAF, Firewall, NSG), Cost Forecasting (Calculators, Quotas), Migration Roadmap Development (Priority, Wave-based).

Unit 3: Migration Execution & Data Transfer

Rehosting Techniques (Lift & Shift, VM Import), Replatforming Strategies (Managed Services, PaaS), Large Scale Data Transfer (Online, Offline Appliances), Database Migration Services (CDC, Schema Conversion), Application Refactoring (Code Change, Microservices), Containerization in Migration (Docker, Kubernetes), Serverless Integration (Lambda, Event-driven), Continuous Integration/Deployment (CI/CD Pipelines), Handling Unstructured Data (Buckets, Sync), Data Consistency & Integrity (Checksums, Validation), Migration Automation Scripts (Python, Bash, PowerShell), Infrastructure as Code (Terraform, CloudFormation).

Unit 4: Post-Migration Testing & Security

Post-Migration Validation (UAT, Functional), Performance Benchmarking (Latency, Throughput), Security Hardening (Encryption, Key Management), User Acceptance Testing (Business, Technical), Connectivity Troubleshooting (Ping, Trace, DNS), Disaster Recovery

Setup (RTO, RPO), Cloud Monitoring Configuration (Logs, Metrics, Alerts), Log Management & Auditing (Centralized, SIEM), Vulnerability Scanning (DAST, SAST), High Availability Testing (Failover, Load Balancing), Incident Response Planning (Procedure, Escalation), Compliance Verification (Audit, Certification).

Unit 5: Optimization & Final Transition

Cost Optimization (On-demand, Spot, Savings Plans), Auto-Scaling Implementation (Horizontal, Vertical), Final Cutover Strategies (Blue-Green, Canary), DNS Switchover (TTL, Record Update), Legacy Decommissioning (Shredding, Archiving), Reserved Instances & Savings Plans (1-year, 3-year), Advanced Automation (AI-Ops, Auto-remediation), Knowledge Transfer (Documentation, Training), Post-Migration Review (Lessons Learned, KPIs), Modernization Roadmap (Evolutionary, Revolutionary), Operational Excellence (Patching, Maintenance), Course Recap & Certification Prep (Mock Exams, Case Studies).

Examination Scheme: Total – 100 marks

Components Continuous Internal Assessment*	**External Assessment (EST #)**	**(A, Assignment I-V, Q, MST-I & II #)**
Weightage (%)	60	40

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (5 Quizzes), MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

List of Books:

Textbook:

1. **Cloud Security and Privacy**, Tim Mather and Subra Kumaraswamy, O'Reilly Media, 1st Edition, 2017.

Reference Books:

1. **Cloud Computing Security: Foundations and Challenges**, John R. Vacca, CRC Press, 2nd Edition, 2020.
2. **Practical Cloud Security: A Guide for Secure Cloud Design**, Chris Dotson, O'Reilly Media, 1st Edition, 2019.
3. **Virtualization Security: Protecting Virtualized Environments**, Dave Shackleford, John Wiley & Sons, 1st Edition, 2013.
4. **Serverless Architectures on AWS**, Peter Sbarski, Manning Publications, 2nd Edition, 2021.

Important Websites:

1. **Cloud Security Tutorial**, TutorialsPoint, https://www.tutorialspoint.com/cloud_computing/cloud_computing_security.htm, 2026.
2. **Introduction to Cyber Security**, GeeksforGeeks, https://www.geeksforgeeks.org/cloud-computing-security-challenges/, 2026.

3. **Cloud Computing and Distributed Systems**, Prof. Rajiv Misra, NPTEL (IIT Patna), https://nptel.ac.in/courses/106104182, 2026.
4. **AWS Cloud Security Concepts**, AWS Training Video, https://explore.skillbuilder.aws/learn/course/external/view/elearning/1927/aws-security-fundamentals, 2026.
5. **Serverless Framework Documentation**, https://www.serverless.com/framework/docs, 2026.

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BCA (Cloud Computing)

Semester – IV
3BCC4-DE-002-T-01
IT Infrastructure and Data Center
Pre-requisites: None

Course Category

L	T	P	C
4	0	0	4

Course Objective:

- To understand basics of data centers and their role in enterprises.
- To explain requirements like space, power, cooling, and location.
- To design a simple data center structure with security and standards.
- To analyze how modern cloud trends affect Edge and Hybrid services.
- To evaluate migration success using performance and reliability checks.

Course Outcomes:

Course Outcomes (COs)	Level *
CO1: Identify basic components of a data center and their functions.	L2
CO2: Explain key requirements for setting up a data center.	L2
CO3: Apply design principles to create a basic data center layout.	L3
CO4: Analyze different data center types and cloud-based solutions.	L4
CO5: Evaluate performance, security, and backup strategies in data centers.	L4 & L5

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome.*

Articulation Matrix:-

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

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

High-3 Medium-2 Low-1

Course Contents:

Unit-I: Introduction to Data Centers
Datacenters Defined, Datacenter Goals, Datacenter Facilities, Roles Datacenters in the Enterprise, Roles of Datacenters in the Service Provider Environment, Application Architecture Models. The Client/Server Model and Its Evolution, n-Tier Model, Multi Tier Architecture Application Environment, Data Center Architecture.

Unit-II: Requirements for Data Centers
Data Center Prerequisites, Required Physical Area for Equipment and Unoccupied Space, Required Power to Run All the Devices, Required Cooling and HVAC, Required Weight, Required Network Bandwidth, Budget Constraints, Selecting a Geographic Location, Safe from Natural Hazards, Safe from Man-Made Disasters, Availability of Local Technical Talent, Abundant and Inexpensive Utilities Such as Power and Water, Selecting an Existing Building (Retrofitting), tier standard.

Unit-III: Designing and Planning Data Center
Characteristics of an Outstanding Design, Guidelines for Planning a Data Center, Data Center Structures, No-Raised or Raised Floor, Aisles, Ramp, Compulsory Local Building Codes, Raised Floor Design and Deployment, Plenum, Floor Tiles, Equipment Weight and Tile Strength, Electrical Wire ways, Cable Trays, Design and Plan against Vandalism.

Unit-IV: Server Farms
Types of server farms and data centre, internet server farm, intranet server farm, extranet server farm, internet datacenter, corporate datacenter, software defined datacenter, datacenter topologies, Aggregation Layer, Access Layer, Front-End Segment, Application Segment, Back-End Segment, Storage Layer, Data Center Transport Layer, Data Center Services, IP infrastructure Services, Application Services, Security Services, Storage Services.

Unit-V: Backup and Recovery
Business continuance infrastructure services, the need for redundancy, Information availability , BC terminology, BC planning life cycle, BC technology solutions, backup and recovery considerations , backup technologies, Uses of local replicas , Local replication technologies , Restore and restart considerations, Modes of remote replications , remote replication technologies.

Examination Scheme: Total – 100 marks

Components Continuous Internal Assessment*	**External Assessment (EST #)**	**(A, Assignment I-V, Q, MST-I & II #)**

Weightage (%)	60	40

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (5 Quizzes), MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

List of Books:

Textbook:

1. **Data Center Fundamentals**, Mauricio Arregoces and Maurizio Portolani, Cisco Press, 1st Edition, 2003.

Reference Books:

1. **Data Center Handbook,** Hwaiyu Geng, John Wiley & Sons, 1st Edition, 2014.
2. **Build the Best Data Center Facility for Your Business,** Douglas Alger, CiscoPress, 1st Edition, 2013.
3. **Data Center Virtualization Fundamentals,** Gustavo A. A. Santana, Cisco Press, 1st Edition, 2014.
4. **Cloud and Data Center Management,** John W. Rittinghouse and James F. Ransome, CRC Press, 1st Edition, 2016.

Important Websites:

1. **Data Center Basics Tutorial**, TutorialsPoint, https://www.tutorialspoint.com/data_center_basics/index.htm, 2026.
2. **Data Center Infrastructure**, GeeksforGeeks, https://www.geeksforgeeks.org/data-center-infrastructure/, 2026.
3. **Data Center Networking**, NPTEL (IIT), https://nptel.ac.in/courses/, 2026.
4. **Google Data Center Overview**, Google Cloud, https://cloud.google.com/data-centers, 2026.
5. **AWS Data Center and Infrastructure**, AWS, https://aws.amazon.com/about-aws/global-infrastructure/, 2026.

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BCA (Cloud Computing)

Semester – IV	**Course Category**			
3BCC4-DC-001-T	**L**	**T**	**P**	**C**
DevOps Fundamentals	4	0	0	4

Course Objectives

- Understand the fundamentals of DevOps, its lifecycle, and the role of collaboration in modern software development
- Apply version control systems and collaborative workflows using Git-based platforms
- Develop and implement CI/CD pipelines to automate build, test, and deployment processes
- Utilize containerization and basic cloud services for application deployment and scalability
- Implement infrastructure automation, monitoring, and basic security practices in DevOps environments

Course Outcomes

Course Outcomes(COs)	**Level***
CO1: Explain DevOps concepts, lifecycle, and its role in modern software development	L2
CO2: Apply version control techniques and collaborative workflows using Git tools	L3
CO3: Apply CI/CD pipelines for automated software delivery	L3
CO4: Analyze containerization and cloud-based deployment strategies	L4
CO5: Evaluate infrastructure automation, monitoring, and DevSecOps practices	L5

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome..*

Articulation Matrix:-

(Program Articulation Matrix is formed by the strength of the correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

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

High-3 Medium-2 Low-1

Course Contents:

Unit 1: Introduction to DevOps
DevOps fundamentals, SDLC overview, Agile vs Waterfall, DevOps lifecycle, culture and collaboration, version control overview, Git basics, GitHub workflow

Unit 2: Version Control & Collaboration
Advanced Git (branching, merging, rebasing), Git workflows (GitFlow), pull requests, code review practices, GitHub/GitLab features, repository management, issue tracking, collaboration strategies

Unit 3: CI/CD & Automation
Continuous integration concepts, continuous delivery vs deployment, CI/CD pipelines, Jenkins basics, pipeline as code, build automation, testing integration, deployment strategies (blue-green, rolling)

Unit 4: Containerization & Cloud
Virtualization vs containerization, Docker architecture, Docker images and containers, Dockerfile, Docker Compose, container orchestration basics, introduction to Kubernetes, cloud basics (AWS/Azure), deployment on cloud

Unit 5: Infrastructure, Monitoring & Security
Infrastructure as Code (Terraform basics), configuration management (Ansible basics), monitoring (Prometheus, Grafana), logging systems, alerting, DevOps best practices, DevSecOps fundamentals, basic security practices

Examination Scheme: Total – 100 marks

Components Continuous Internal Assessment*	**External Assessment (EST #)**	**(A, Assignment I-V, Q, MST-I & II #)**
Weightage (%)	60	40

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (5 Quizzes), MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).

Text Books:

1. Learning DevOps, Mikael Krief, Learning DevOps: The Complete Guide to Accelerate Collaboration with Jenkins, Kubernetes, Terraform, and Azure, Packt Publishing, Latest Edition.
2. Effective DevOps, Jennifer Davis and Ryn Daniels, Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale, O'Reilly Media, 2016.

Reference Books:

1. The DevOps Handbook, Gene Kim, Jez Humble, Patrick Debois, and John Willis, The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, IT Revolution Press, 2016.
2. The Phoenix Project, Gene Kim, Kevin Behr, and George Spafford, The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win, IT Revolution Press, 2013.
3. Accelerate, Nicole Forsgren, Jez Humble, and Gene Kim, Accelerate: The Science of Lean Software and DevOps, IT Revolution Press, 2018.
4. Continuous Delivery, Jez Humble and David Farley, Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Addison-Wesley, 2010.

List of e-Learning Resources:

1. https://www.coursera.org/specializations/packt-devops-complete-course
2. https://www.coursera.org/learn/cloud-native-microservices-containers-devops-agile
3. https://docs.docker.com/

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BCA (Cloud Computing)

Semester-IV
3BCC4-DC-001-P
DevOps Fundamentals Lab
Pre-requisites: None

Course Category

L	**T**	**P**	**C**
0	0	4	2

Course Objectives

- Understand the fundamentals of DevOps, its lifecycle, and the role of collaboration in modern software development
- Apply version control systems and collaborative workflows using Git-based platforms
- Develop and implement CI/CD pipelines to automate build, test, and deployment processes
- Utilize containerization and basic cloud services for application deployment and scalability
- Implement infrastructure automation, monitoring, and basic security practices in DevOps environments

Course Outcomes

Course Outcomes(COs)	**Level***
CO1: Explain DevOps concepts, lifecycle, and its role in modern software development	L2
CO2: Apply version control techniques and collaborative workflows using Git tools	L3
CO3: Apply CI/CD pipelines for automated software delivery	L3
CO4: Analyze containerization and cloud-based deployment strategies	L4
CO5: Evaluate infrastructure automation, monitoring, and DevSecOps practices	L5

**Level of Learning: Level 1 (L1) - Remember ; Level 2 (L2) – Understand; Level 3 (L3) –Applye; Level 4 (L4) –Analyze; Level 5 (L5) -Evaluate;.Level 6 (L6) -Create. Mention the highest level that will be attained in the Course Outcome.*

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CO2	-	–	2		–	–	1	–	–	1	1	2
CO3	2	1	3		–	–	-	–	–	2	-	3
CO4	3	–	2	3	–	–	2	–	–	1	1	2
CO5	2	2	3	3	1	–	3	1	–	2	3	1

High-3 Medium-2 Low-1

List of Experiments

1. Install Git and configure user credentials
2. Create a local repository and perform basic Git operations (init, add, commit)
3. Work with GitHub: create repository and push code
4. Perform branching and merging in Git
5. Resolve merge conflicts in Git
6. Implement Git workflow using pull requests
7. Explore issue tracking and project boards in GitHub
8. Install and configure Jenkins
9. Create a simple Jenkins job for build automation
10. Configure Jenkins pipeline (Pipeline as Code)
11. Integrate GitHub repository with Jenkins
12. Automate build and test using Jenkins
13. Implement CI/CD pipeline for a sample application
14. Install Docker
15. Run and manage Docker containers
16. Create and manage Docker images
17. Write a Dockerfile for a sample application
18. Use Docker Compose for multi-container setup
19. Introduction to Kubernetes: install Minikube or kind
20. Deploy a containerized application on Kubernetes
21. Create and manage Pods and Services
22. Perform scaling and rolling updates in Kubernetes
23. Create a free-tier account on Amazon Web Services or Azure
24. Launch a virtual machine (EC2/Azure VM)
25. Deploy a web application on cloud VM
26. Configure basic networking and security groups
27. Install and use Terraform for provisioning resources
28. Write basic Terraform scripts for infrastructure setup
29. Install and configure Ansible
30. Implement basic monitoring using Prometheus and Grafana

Total Hours: 60

Examination Scheme: Total – 100 marks

Components Continuous	External Assessment	(A, Assignment I-V, Q,

Internal Assessment*	**(EST #)**	**MST-I & II #)**
Weightage (%)	50	50

*A-Attendance; Assignment I-V (Class Assignment/Home Assignments/Case Discussions/Term Papers/Mini Project); Q-Quiz (5 Quizzes), MST-I, MST-II, EST. (# MST-I & IIconducted at Department Level & EST (External Assessment) will be conducted by the CoE office at MU).