MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

Manipal School of Information Sciences (MSIS)

Manipal Academy of Higher Education, Manipal

Outcome Based Education (OBE) Framework

Two Year full time Postgraduate Program

Master of Engineering - ME (Cloud Computing)

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NATURE AND EXTENT OF THE PROGRAM

An engineering graduate skillset requirement is changing with invent of the new technologies. In particular, the impact of Cloud Computing provide a high employability in the industry. Objectives of this program is to provide hands on experience to work, manage and deployment of cloud infrastructure based on best practices and protocols, understanding security issues in cloud, handling of Big data on cloud and to provide end to end cloud business solutions..

ME (Cloud Computing) Program is a comprehensive two-year postgraduate program, which aims to provide hands-on experience to prepare industry-ready Cloud Computing professionals. Foundational IT courses included to learn the basic skillsets required for any IT industry domain. Program covers Cloud architecture, Virtualization techniques, Cloud security and Networks which will lay good platform for Cloud engineers. Cloud based application development is included in the program to meet the requirements of application development for web/Internet which is an emerging technology. Big data is a trending technology and majority of Big Data applications are cloud based. So Big data analytics, Visualization and Machine learning are also part of the curriculum. Imparting skills for engineers to be street smart and motivate them to be Entrepreneurs to start a Cloud Enterprises.

ME (Cloud Computing) postgraduate degree would welcome graduates from any discipline with 50% mark in qualifying exam. Students after successfully completing the program will get career opportunities as a Cloud architect, full stack developer, Cloud engineer, cloud system administrator, cloud network engineer.

PROGRAM EDUCATION OBJECTIVE (PEO)

The overall objectives of the Learning Outcomes-based Curriculum Framework (LOCF) for **ME (Cloud Computing) program are as follows.**

PEO No	Education Objective
PEO 1	Graduates are employed in the field of Cloud Architect, Security Analyst, Software Application Engineer, Consultant, Administrator and Full Stack Developer.
PEO 2	Introduce state of art technologies in the area of Cloud Computing and inculcate ethical practices to make industry ready professional or pursue their interest in research /Higher Education.
PEO 3	Engineers who have leadership qualities and inclination, become entrepreneurs.

GRADUATE ATTRIBUTES

S No.	Attribute	Description
1	**Scholarship of Knowledge**	Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
2	**Critical Thinking**	Analyse complex engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3	**Problem Solving**	Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4	**Research Skill**	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5	**Usage of modern tools**	Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
6	**Collaborative and Multidisciplinary work**	Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7	**Project Management and Finance**	Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

8	**Communication**	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9	**Life-long Learning**	Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10	**Ethical Practices and Social Responsibility**	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11	**Independent and Reflective Learning**	Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

QUALIFICATIONS DESCRIPTORS

1. Demonstrate
   (i) A systematic, extensive and coherent knowledge and understanding of Cloud Computing and its applications, and links to related Computing discipline, including a critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues in the field of Cloud Computing
   (ii) Procedural knowledge that creates different types of professionals related to the Cloud Computing industry, including research and development, teaching, Entrepreneurship, government and public service.
   (iii) Professional and communication skills in the domain of Cloud Architect /Cloud Engineer, Cloud Security Engineer, Cloud Developer, DevOps Architect, data analytics, including a critical understanding of the latest developments, and an ability to use established techniques in the domain of Cloud Computing .

2. Demonstrate comprehensive knowledge about materials, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to the Cloud Computing field of study, and techniques and skills required for identifying problems and issues related.

3. Demonstrate skills in Enabling and Foundation technologies like Virtualization, Network, Service Oriented Architecture, Webservers for Evolution of Cloud Computing

4. Methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments in Cloud Computing Domain

5. Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the field of Cloud Computing

6. Communicate the results of studies undertaken in Architecture of Cloud, Security, Automation, Orchestration, Virtualization technologies using the main concepts, constructs and techniques of the Cloud Computing

7. Address one's own learning needs relating to current and emerging areas of study, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge.

8. Apply one's disciplinary knowledge and transferable skills to new/unfamiliar contexts and to identify and analyse problems and issues and seek solutions to real-life problems.

PROGRAM OUTCOMES

After successful completion of Master of Engineering - ME (Cloud Computing), Students will be able to:

PO No	Attribute	Competency
PO 1	**Scholarship of Knowledge**	Acquire in-depth knowledge of Cloud Computing domain, with an ability to discriminate, evaluate, analyze, synthesize the existing and new knowledge, and integration of the same for enhancement of knowledge.
PO 2	**Critical Thinking**	Analyze complex Cloud Computing Eco System critically, apply independent judgement for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
PO 3	**Problem Solving**	Think laterally and originally, conceptualize and solve Cloud Computing problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
PO 4	**Research Skill**	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
PO 5	**Usage of modern tools**	Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
PO 6	**Collaborative and Multidisciplinary work**	Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
PO 7	**Project Management and Finance**	Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors

PO 8	**Communication**	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions
PO 9	**Life-long Learning**	Recognize the need for and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
PO 10	**Ethical Practices and Social Responsibility**	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
PO 11	**Independent and Reflective Learning**	Observe and examine critically the outcomes of one's actions and make corrective measures subsequently and learn from mistakes without depending on external feedback.

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COURSE STRUCTURE, COURSEWISE LEARNING OBJECTIVE AND COURSE OUTCOMES (COS)

FIRST YEAR: ME (Cloud Computing)

Semester: 1 **Semester: 2**

Subject Code	Subject Title	L	T	P	C	Subject Code	Subject Title	L	T		P	C
CSE 601	Data Structures and Algorithms	3	-	-	3	BDA 614	Big Data and Data Visualization	3	-		-	3
CSE 602	Real Time Operating Systems	3	-	-	3	CDC 604	Cloud Networks	3	-		-	3
CDC 602	Cloud Architecture and Management	3	-	-	3	CDC 605	Cloud Security	3	-		-	3
CDC 603	Cloud Application Development with Java	3	-	-	3	CDC 606	Cloud Database Management	3	-		-	3
	Elective - 1	3	-	-	3		Elective - 2	3	-		-	3
CSE-601L	Data Structures and Algorithms Lab	-	-	3	1	BDA-614L	Big Data and Data Visualization Lab	-	-		3	1
CSE-602L	Real Time Operating Systems Lab	-	-	3	1	CDC-604L	Cloud Networks Lab	-	-		3	1
CDC-602L	Cloud Architecture and Management Lab	-	-	3	1	CDC-605L	Cloud Security Lab	-	-		3	1
CDC-603L	Cloud Application Development with Java Lab	-	-	3	1	CDC-606L	Cloud Database Management Lab	-	-		3	1
	Elective - 1 Lab	-	-	3	1		Elective - 2 Lab	-	-		3	1
CDC 695	Mini Project - 1	-	-	-	4	CDC 696	Mini Project -2	-	-		-	4
CDC 697	Seminar - 1	-	-	-	1	CDC 698	Seminar - 2	-	-		-	1
Total		**15**	**-**	**15**	**25**	**Total**		**15**	**-**		**15**	**25**

SECOND YEAR (FINAL YEAR): ME (Cloud Computing)

III and IV Semester		
CDC 799	Project Work	25
Total Number of Credits to Award Degree		75

List of Electives (Theory)

Elective - 1		Elective - 2	
Code	**Subject**	**Code**	**Subject**
CSE 628	Client Side Internet Technology	CSE 629	Server Side Internet Technology
BDA 601	Fundamentals of Machine Learning	CSE 630	Data Warehousing and Data Mining
CDC 607	DevOps for Cloud	BDA 605	Machine Learning for Big Data
		ENP 601	Entrepreneurship
		CSE 631	IT Project Management

List of Electives (Lab)

Elective - 1		Elective - 2	
Code	**Subject**	**Code**	**Subject**
CSE-628L	Client Side Internet Technology Lab	CSE-629L	Server Side Internet Technology Lab
BDA-601L	Fundamentals of Machine Learning Lab	CSE-630L	Data Warehousing and Data Mining Lab
CDC-607L	DevOps for Cloud Lab	BDA-605L	Machine Learning for Big Data Lab
		ENP-601L	Entrepreneurship Lab
		CSE-631L	IT Project Management Lab

Name of the Institution / Department: Manipal School of Information Sciences (MSIS)

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Data Structures and Algorithms
Course Code: CSE 601	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:** Basic Programming – preferably C
Synopsis:	This Course provides insight on 1. This course introduces students to elementary data structures and design of algorithms. 2. Students learn how to design optimal algorithms with respect to time and space 3. Students learn how to implement link list, stack, queues, searching and sorting techniques, sets, trees and graphs. 4. Students learn the design of divide and conquer technique, dynamic programming, greedy technique and back tracking.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Specify and analyse algorithms.
CO 2:	Learn and design programs for implementation of linear and nonlinear data structure.
CO 3:	Learn and design programs for sorting and searching.
CO 4:	Illustrate application of divide and conquer technique, dynamic programming, greedy technique and back tracking.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*			*							
CO 2	*	*				*					
CO 3	*					*					
CO 4	*	*				*					

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Algorithm Specification, Performance Analysis	At the end of the topic student should be able to: 1. Define algorithms (C1) 2. Analyse algorithms. (C6)
Unit 2: Algorithm Analysis Techniques	
Analysis of Recursive Programs, Solving Recurrence Equations, General Solution for a large class of Recurrences.	1. Define recursive programs (C2) 2. Design simple recursive programs (C6) 3. Solve recurrence relations (C6)
Unit 3: Elementary data structures	
Implementation of Lists, Stacks, Queues	1. Design singly linked list (C6) 2. Design doubly linked list(C6) 3. Explain the concepts of array-based stacks (C2) 4. Explain the concepts of pointer-based stacks (C2) 5. Design and implement Queues. (C6)
Unit 4: Sorting & Searching Techniques	
Quick sort, Heap sort, Merge sort, Binary search, linear search, Fibonacci search	1. Develop algorithm for insertion sort, bubble sort and selection sort. (C6) 2. Develop and analyse algorithm for quick sort (C6) 3. Develop and analyse algorithm for heap sort (C6) 4. Develop and analyse algorithm for merge sort (C6) 5. Design and analyse algorithms for binary, linear and Fibonacci search (C6)
Unit 5: Operations on Sets	
Introduction to Sets, A Linked- List implementation of Set, The Dictionary, The Hash Table Data Structure	1. Develop data structures for sets (C6) 2. Design a linked list-based implementation of sets (C6) 3. Design a Dictionary (C6) 4. Design Data structure for hash table (C6)
Unit 6: Trees	
Basic Terminology, Implementation of Trees, Binary Trees, Binary Search Trees	1. Examine the concepts of trees. (C3) 2. Design and implement general trees (C6) 3. Design and implement binary trees (C6) 4. Design and implement binary search trees (C6)

Unit 7: Graphs	
Basic definitions, Representation of Graphs, Minimum Cost Spanning Tree, Single Source Shortest Paths, All-Pairs Shortest Path	1. Define graphs (c6) 2. Design data structure for graphs (c6) 3. Formulate an algorithm to solve minimum cost spanning tree(c6) 4. Formulate an algorithm to solve Single source shortest path (c6) 5. Formulate an algorithm to solve All- pair shortest path(c6)
Unit 8: Algorithm Design Techniques	
Divide-and-Conquer Algorithms, Dynamic Programming, Greedy Algorithms, Backtracking	1. Design of divide and conquer algorithms (C6) 2. Solve max min, Strassen's matrix multiplication, multiplication of long integer's problem. (C6) 3. Design of dynamic programming techniques (C6) 4. Solve matrix chain order problem (C6) 5. Design of greedy algorithms(C6) 6. Solve Knap-sack, job scheduling with deadlines and optimal storage on tapes problems. (C6) 7. Design of Back tracking algorithms (C6)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Seminar	-	-
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Clinic	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2		*	*	*	
Assignment/Presentation	*	*	*	*	
End Semester Examination	*	*	*	*	

Feedback Process	• End-Semester Feedback
Reference Material	• "Introduction to Algorithms" Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest. • "Data Structures& Algorithms" Aho, Hopcroft and Ulmann • "Data structures and algorithm analysis in C" Mark Allen Weiss • "Computer Algorithms" : Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Real Time Operating Systems
Course Code: CSE 602	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:** Basic Programming – preferably C
Synopsis:	This Course provides insight on
Course Outcomes (COs):	On successful completion of this course, students will be able to 1. This course introduces students to basics of operating systems and real operating systems. 2. This course helps the student to understand the concepts of process management, scheduling, synthetization and dead locks. 3. This course helps the students to learn thread-based programming. 4. Students learn the concept of memory management. 5. Students learn the salient features of real time operating systems
CO 1:	Examine the evolution of operating systems and real time operating systems.
CO 2:	Design programs based on threads.
CO 3:	Explain the concepts involved in process management, scheduling, synthetization of processes.
CO 4:	Explain the concepts involved in memory management, detecting, avoiding and recover from dead locks.
CO 5:	Explain the concepts of real time systems and real time operating systems

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*	*								
CO 2	*	*	*								
CO 3	*		*								
CO 4	*		*								
CO 5		*	*	*							

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction to OS and RTOS	
Essential features of an OS, Single Processor Systems and Multiprocessor Systems, Essential Features of Batch Processing, Time sharing, Multiprogramming, Interactive systems, User mode and Kernel Mode operations, Distinction between function call and system call, Real time operating system and real time embedded systems.	At the end of the topic student should be able to: 1. Identify the features of OS and RTOS (C2) 2. Distinguish between single processor and multi-processor systems (C2) 3. Identify the features of batch processing, time sharing, multi programming and interactive systems (C2) 4. Distinguish between user and kernel modes (C2) 5. Distinguish between function and system calls (C2)
Unit 2: Process Management	
A process in memory, process state, PCB, Process scheduling, scheduling Queues, Types of schedulers, Process system calls - IPC using Shared Memory, IPC using Sockets.	1. Describe a process, process state, process control block (C2) 2. Illustrate scheduling algorithms, scheduling queues (C3) 3. Examine process related system calls (C1) 4. Illustrate methods for inter process communication through share memory and sockets (C3)
Unit 3: Multithreaded Programming	
Introduction, benefits, multithreading models, Pthreads, Win32 threads, Threading Issues, Thread pools Linux threads.	1. Summarize the benefits of multi-threading (C2) 2. Discover threading issues (C2) 3. Illustrate programs using p threads (C3) 4. Examine the benefits of thread pools (C3)
Unit 4: Process Scheduling	
Introduction, scheduling criteria, scheduling Algorithms – FCFS, SJF, PS, RR, Multilevel Queues, Multilevel feedback Queue Scheduling, Scheduling evaluations.	1. Distinguish between scheduling algorithms (C2) 2. Examine the criteria for scheduling (C3) 3. Explain FCFS, SJF, PS, RR, Multi-level queues, multi-level feedback queues scheduling algorithms (C2) 4. Evaluate the scheduling algorithms (C5)
Unit 5: Synchronization	
Introduction, Critical Section Problem, Petersons Solutions, synchronization hardware, Semaphores, usage, implementations; Deadlocks and	1. Define critical section problem (C1) 2. Demonstrate Software solutions to critical section problems (C3)

starvation, Classical problem of synchronization– Bounded Buffer problem, Reader's Writer's problem, Dining Philosophers problem, sleeping barbers problem; Monitors.	3. Demonstrate hardware solution for process synchronization (C3) 4. Describe the usage and implementation of semaphores (C1) 5. Define dead locks and starvation (C1) 6. Illustrate solutions to classical synchanization problems like bounded buffer, readers writers, dining philosophers and sleeping barbers (C3)
Unit 6: Deadlocks	
Introduction, deadlock, characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, recovery from deadlock.	7. Define dead locks (C2) 8. Examine methods for handling dead locks (C4) 9. Illustrate various dead lock algorithms (C3)
Unit 7: Memory Management	
Memory Management Strategies, Virtual Memory Management.	1. Examine various memory management strategies(C4) 2. Examine the evolution of memory management (C4) 3. Illustrate the benefits of paging and segmentation(C3) 4. Examine the implementation of demand paging(C4) 5. Examine the various virtual memory concepts (C4)
Unit 8: Real Time Systems	
Overview of Real Time Systems, Real Time clocks and Real Time Scheduling Algorithms	1. Examine the concepts involved in the design of real time systems (C3) 2. Design of real time clocks in various real time languages (C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	
Assignment/Presentation				*	*
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• "Operating System principles", Seventh Edition, Abraham Silberschatz, Peter Galvvin, Grag Gagne. John Wiley Publications • "Real – Time Systems and Programming Languages", Allan Burns, Andy Wellings. • "Operating Stems Concepts and Design", Milan Milenkovic • "Design of Unix Operating System", Maurice Bach (IPC) • "The C Programming Language", Kerninghan & Ritchie 5. Kerninghan & Ritchie, "The C Programming Language", Second Edition, Prentice-Hall, 1988.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Architecture and Management
Course Code: CDC 602	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:** Ubuntu OS, Networking and Virtualization Concepts, Parallel/Distributed Computing
Synopsis:	This Course provides insight on 1. Foundation and enabling technologies of Cloud Computing. 2. Cloud Computing service models. 3. Cloud economics and management.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe the need and architecture Distributed Computing paradigms.
CO 2:	Explain the Characteristics and architecture of Cloud Computing.
CO 3:	Compare and contrast service models and deployment models of Cloud.
CO 4:	Explain the concept of Virtualization, Web Services as a prime Enabling Technology of Cloud Computing.
CO 5:	Design an Infrastructure in Cloud for High availability and Fault Tolerant Web applications.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*	*								
CO 2		*	*								*
CO 3					*	*		*			
CO 4		*	*						*		
CO 5		*					*			*	

Course content and outcomes:	
Content	***Competencies***
Unit 1: Overview of Computing Paradigm	
Recent trends in Computing, Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing - Evolution of cloud computing: Business driver for adopting cloud Computing.	At the end of the topic student should be able to: 1. Describe evolution of Cloud Computing(C2) 2. Examine the differences between computing paradigms (C3) 3. Examine the overview of Cloud Computing (C2)
Unit 2: Introduction to Cloud Computing	
A Cloud Computing (NIST Model), Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers - Properties, Characteristics & Disadvantages: Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing - Role of Open Standards.	1. Describe Cloud computing characteristics (C2) 2. Illustrate Cluster vs Grid Computing (C3) 3. Explain the Comparisons between Grid vs Cloud Computing (C1)
Unit 3: Cloud Computing Fundamentals	
Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.	1. Explain Cloud Computing Service models (C2) 2. Describe the types of Cloud (C1) 3. Illustrate Cloud Computing overview (C3) 4. Demonstrate Private Cloud using Openstack Cloud Suite (C4) 5. Illustrate pros and cons of Cloud Computing (C2) 6. Demonstrate need of Cloud Computing w.r.t to High Availability ,Scalability and Fault Tolerant web architectures (C4)
Unit 4: Overview of Virtualization	
Basics of Virtualization, Types of Virtualization Techniques, Merits and demerits of Virtualization, Full Vs Para-virtualization, Virtual Machine Monitor/Hypervisor, Virtual Machine Basics, Taxonomy of Virtual machines, Ring Levels, Process Vs System Virtual Machines , Emulation: Interpretation and Binary Translation, HLL Virtual Machines.	1. Explain how Virtualization is Enabling Technology for Cloud Computing (C2) 2. Demonstrate the need and architecture of Virtualization technology (C1) 3. Explain the types of Virtualization layers (C2) 4. Describe CPU ring levels (C2) 5. Design a Virtualized infrastructure using Hypervisor (C3)

Unit 5: Server Virtualization	
Virtual Hardware Overview - Server Consolidation – Partitioning Techniques - Uses of Virtual server Consolidation – Server Virtualization Platforms.	1. Explain the need of Server Virtualization and its Benefits (C2) 2. Demonstrate Server Virtualization using ESXI Hypervisor (C3)
Unit 6: Network Virtualization	
Design of Scalable Enterprise Networks – Layer2 Virtualization – VLAN - VFI - Layer 3 Virtualization – VRF - Virtual Firewall Contexts - Network Device Virtualization - Data- Path Virtualization – Routing Protocols	1. Explain need and benefits of Network Virtualization (C2) 2. Demonstrate Virtual Network Virtualization (C3)
Unit 7: Management and Cloud Services	
Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics: Cloud Computing infrastructures available for implementing cloud based services. Service Management in Cloud Computing, Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud - Economics of scaling: Benefitting enormously - Managing Data - Looking at Data, Scalability & Cloud Services - Database & Data Stores in Cloud - Large Scale Data Processing - Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, IBM Bluemix)	1. Explain the SOA (C2) 2. Explain SLA (C2) 3. Describe need of Cloud Economics (C3) 4. Demonstrate Web services with example (C3) 5. Demonstrate Cloud Services using Public Cloud Service providers (C3)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	
Assignment/Presentation		*		*	
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010 • Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, ",Cloud Computing: Principles and Paradigms", Wiley, 201 • Nikos Antonopoulos, Lee Gillam, "Cloud Computing: Principles, Systems and Applications", Springer, 2012. • Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley-India, 2010

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Application Development with Java
Course Code: CDC 603	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:** Cloud Application Basics, OOP's concepts, Java programming language, IoT Basics
Synopsis:	This Course provides insight on 1. Cloud application development with IoT devices using Java Programming. 2. To provide practical knowledge of design and develop of Java application with WebSocket, MQTT protocol and create RESTful API's.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Write Java application using swings.
CO 2:	Model Relational database to communicate with Java application.
CO 3:	Show interactive communication with IoT enabled devices.
CO 4:	Model application as RESTful API and deploy in Cloud Application Platform.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2	*		*								
CO 3	*	*									
CO 4	*				*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Design Considerations for cloud Applications: Scalability – Reliability & Availability – reference Architecture for Cloud Applications – cloud Application Design Methodologies: Service Oriented Architecture – Cloud Component Model – Services of cloud Applications – Model View Controller – Restful Web Services – Data Storage Approaches: SQL – NOSQL Approaches.	At the end of the topic student should be able to: 1. Explain Design Considerations for cloud Applications(C2) 2. Discuss Reference Architecture for Cloud Applications like CDN, analytics etc... (C2) 3. Explain cloud Application Design Methodologies like SOA, CCM, MVC etc.(C3) 4. Discuss Data Storage Approaches Relational and Non-Relational.(C2)
Unit 2: Introduction to OOPS	
OOPS – Procedural vs Object Oriented languages – Abstraction – Encapsulation – Polymorphism – Inheritance.	1. Explain advantages of object-oriented programming over Procedural oriented programming language. (C1) 2. Explain OOPS concepts like Class, Object Abstraction, Encapsulation, Polymorphism, and Inheritance. (C1)
Unit 3: Introduction to JAVA	
JAVA Features – Present JAVA language and - JVM – JVM Architecture - JAVA Datatypes, Variables, Arrays– JAVA Basic Constructs.	1. Know about JAVA Features, advantages of Java over other programming languages. (C1) 2. Explain what is JVM and its Architecture. (C2) 3. Discuss Java basics - Datatypes, Variables, Arrays, Operators, methods, reserved Java keywords. (C1) 4. Explain “this” keyword, Exception handling, Constructs, access specifiers. (C1) 5. Discuss about Encapsulation and Abstraction in java. (C1)
Unit 4: Class Concepts	
Objects – Methods – Revisiting Inheritance – Multilevel – Method Overriding – Abstract Class – Interface – Package-IO.	1. Explain Inheritance and its types in Java. (C1) 2. Why multiple inheritance cannot be achieved? (C1) 3. Discuss about implementing of method overloading and method overriding. (C1) 4. Importance of using Packages in java. (C1) 5. Explain Abstract class and why it is important. (C1)

	6. Achieve Multiple inheritance using Interfaces. (C1) 7. Major Differences between Abstract class and Interfaces. (C1)
Unit 5: Internet of Things	
Introduction – IoT Architecture – Physical Design – Logical Design – IoT Enabling technologies – IOT Levels and Deployment Templates – IoT-Cloud Platform - IoT Protocols: MQTT – WebSockets.	1. Outline the integration of various elements of IoT ecosystem. (C2)
Unit 6: JAVA Websockets	
Websocket Lifecycle – Basic Messaging – Advanced Messaging – Securing Web Sockets.	1. Outline Client Server Architecture using Java. (C1)
Unit 7: REST API	
REST Style Architecture – http – URI – Request Methods – Status Codes – JAVA JSON Processing – JAX RS API.	1. Illustrate REST API. (C3)
Unit 8: JAVA MQTT	
M2M with JAVA – MQTT Applications with PAHO	1. Illustrate MQTT Protocol. (C3)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs				
Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination 1	*	*		
Sessional Examination 2		*	*	
Assignment/Presentation		*		*
End Semester Examination	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• William Hohl, Christopher Hinds, "ARM Assembly Language: Fundamentals and Techniques",2nd Edition, ISBN-13: 978-1482229851, ISBN-10: 1482229854 • Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software",1st Edition, The Morgan Kaufmann Series in Computer Architecture and Design, ISBN-13: 978-1558608740, ISBN-10: 1558608745 • David Seal, "ARM Architecture Reference Manual", 2nd Edition, Addison-Wesley Professional. • Steve Furber, "ARM System-on-Chip Architecture",2nd Edition, Addison-Wesley Professional, ISBN-13: 078-5342675191,ISBN-10: 0201675196 • Douglas V. Hall, "Microprocessors and Interfacing", Mcgraw Hill Educatin, ISBN-10 1259006158, ISBN-13 9781259006159, 2012. • Websites & Transaction Papers

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(Deemed to be University under Section 3 of the UGC Act, 1956)

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Data Structures and Algorithms Lab
Course Code: CSE-601L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites:** C Programming
Synopsis:	This Course provides insight on 1. This course introduces students to elementary data structures and design of algorithms. 2. Students learn how to design optimal algorithms with respect to time and space 3. Students learn how to implement link list, stack, queues, searching and sorting techniques, sets, trees and graphs. 4. Students learn the design of divide and conquer technique, dynamic programming, greedy technique and back tracking
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Specify and analyse algorithms
CO 2:	Learn and design programs for implementation of linear and nonlinear data structure.
CO 3:	Learn and design programs for sorting and searching.
CO 4:	Illustrate application of divide and conquer technique, dynamic programming, greedy technique and back tracking.
CO 5:	Learn to organise the code for scalability and maintainability.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1		*									
CO 2		*	*		*			*			
CO 3		*	*		*			*			
CO 4		*	*		*			*			
CO 5		*	*		*			*			

Course content and outcomes:	
Content	***Competencies***
Unit 1: Elementary data structures	
Implementation of Lists, Stacks, Queues	At the end of the topic student should be able to: 1. Design and Implement singly linked list. 2. Design and Implement doubly linked list. 3. Design and Implement array-based stack. 4. Design and Implement pointer-based stack. 5. Design and Implement array-based queues. 6. Design and Implement pointer-based queues.
Unit 2: Sorting & Searching Techniques	
Quick sort, Heap sort, Merge sort, Binary search, linear search, Fibonacci search	1. Design and implement programs for insertion sort, bubble sort and selection sort. 2. Design and implement programs for quick sort. 3. Design and implement programs for heap sort. 4. Design and implement programs for merge sort. 5. Design and implement programs for binary, linear and Fibonacci search.
Unit 3: Trees	
Basic Terminology, Implementation of Trees, Binary Trees, Binary Search Trees	1. Write a program to implement binary trees. 2. Write a program to implement binary search trees. 3. Tree traversal technique.
Unit 4: Graphs	
Basic definitions, Representation of Graphs, Minimum Cost Spanning Tree, Single Source Shortest Paths, All-Pairs Shortest Path	1. Write programs to represent a graph using adjacency matrix and adjacency list techniques. 2. Write a program to implement minimum cost spanning tree. 3. Write a program to solve Single source shortest path problem. 4. Write a program to solve All- pair shortest path problem.
Unit 5: Algorithm Design Techniques	
Divide-and-Conquer Algorithms, Dynamic Programming, Greedy Algorithms, Backtracking	1. Write a program to solve max min problem. 2. Write a program to solve Strassen's matrix multiplication problem. 3. Write a program to solve matrix chain order problem.

	4. 4. Write programs to solve knap-sack, job scheduling with dead line and optima storage on taps problems. 5. 5. Write programs to solve n queens and graph colouring problems.

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2		*	*	*	
Assignment/Presentation	*	*	*	*	*
Laboratory Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• "Introduction to Algorithms" Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest. • "Data Structures& Algorithms" Aho, Hopcroft and Ulmann • "Data structures and algorithm analysis in C" Mark Allen Weiss • "Computer Algorithms" : Ellis Horowitz, SartajSahni , Sanguthevar Rajasekaran

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Real Time Operating Systems Lab
Course Code: CSE-602L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites:** Knowledge on C programming, Operating System concepts
Synopsis:	This Course provides insight on 1. Basics of operating systems and real operating systems. 2. Understand the concepts of process management, scheduling, synthetization and dead lock. 3. Learn thread-based programming. 4. Learn the concept of memory management. 5. Learn the salient features of real time operating systems
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Experiment process creation, process hierarchies and multi-thread concepts.
CO 2:	Apply process-scheduling algorithms and process synchronization concepts on various scenarios.
CO 3:	Apply memory management techniques on various scenarios

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*	*		*						
CO 2	*	*	*		*						
CO 3	*	*	*		*						

Course content and outcomes:	
Content	***Competencies***
Unit 1:	
Basics of C programming: String manipulation, file handling.	At the end of the topic student should be able to: 1. Practice basic C programming concepts (C3)
Unit 2:	
Process creation, fork, exec, wait, multi thread concepts.	1. Experiment process creation, process hierarchies and multi-thread concepts. (C4)
Unit 3:	
Process scheduling algorithms	1. Apply process-scheduling algorithms on various scenarios. (C3)
Unit 4:	
Process synchronization concepts.	1. Experiment process synchronization concepts (C4)
Unit 5:	
Memory management techniques	1. Apply memory management techniques on various scenarios (C3)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*	*	
Assignment/Presentation			*
Laboratory Examination	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Text mining handbook: advanced approaches in analyzing unstructured data Feldman, Ronen and James Sanger, 9780521836579, CUP, 2008 • Linked Lexical Knowledge Bases Iryna Gurevych, Judith Eckle-Kohler, Michael Matuschek,9781627059749, Morgan & Claypool, 2016 • Introduction to information retrieval Manning, Christopher D. and Prabhakar Raghavan and Hinrich Schutze, 9780521865715, Cambridge University Press,2008 • Text mining: classification, clustering and applications Srivastava, Ashok and Mehran Sahami (eds.)., 9781420059403, Chapman & Hall,2009 • Weiss, S. M., Indurkhya, N., Zhang, T. (2010). Fundamentals of Predictive Text • Mining. Springer: New York. ISBN: 978-1849962254 • Pustejovsky, J. and Stubbs, A. (2012). Natural Language Annotation for Machine • Learning. O'Reilly. • Foundations and Trends in Information Retrieval, 2(1-2): 1–135. Available online at: • http://www.cs.cornell.edu/home/llee/opinion-mining-sentiment-analysis-survey.html. • Manning, C. D., Raghavan, P., and Schutze, H. (2008). Introduction to Information Retrieval, Chapters 6 and 13-18, Cambridge University Press. Available online at: http://nlp.stanford.edu/IR-book/ • Articles: https://www.healthcatalyst.com

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Architecture and Management Lab
Course Code: CDC-602L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites:** Ubuntu OS, Networking and Virtualization Concepts, Parallel/Distributed Computing
Synopsis:	This Course provides insight on 1. Virtualization and web services of Cloud Computing. 2. Cloud computing service models. 3. Building a private cloud.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe the need and architecture Distributed Computing paradigms.
CO 2:	Explain the concept of Web Services as a prime Enabling Technology of Cloud Computing.
CO 3:	Design an Infrastructure in Cloud for High availability and Fault Tolerant Web applications.
CO 4:	Demonstrate the Management of Cloud services for Infrastructure, Platform and Software.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2	*		*		*						
CO 3		*			*						
CO 4			*		*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: Overview of Computing Paradigm	
Recent trends in Computing, Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing - Evolution of cloud computing: Business driver for adopting cloud Computing.	At the end of the topic student should be able to: 1. Design a Cluster using node of Computers to understand Distributed Computing (C3)
Unit 2: Introduction to Cloud Computing	
A Cloud Computing (NIST Model) , Introduction to Cloud Computing , History of Cloud Computing , Cloud service providers - Properties, Characteristics & Disadvantages: Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing - Role of Open Standards.	1. Demonstrate open source cloud like Openstack to understands basic characteristics and overview of Cloud Computing (C2)
Unit 3: Cloud Computing Fundamentals	
Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.	1. Design Private Cloud using open source tools like Openstack / Eucalyptus (C4) 2. Demonstrate different services offered by cloud to understand Cloud service models and Cloud types (C2)
Unit 4: Overview of Virtualization	
Basics of Virtualization – Types of Virtualization Techniques – Merits and demerits of Virtualization –Full Vs Para-virtualization – Virtual Machine Monitor/Hypervisor - Virtual Machine Basics – Taxonomy of Virtual machines – Ring Levels – Process Vs System Virtual Machines – Emulation:	1. Design Virtualized Server using Type 2 Hypervisor like Oracle Virtual Box / VMware Workstation to understand concepts of Virtual machine (C3) 2. Design Virtualized Server using VMware ESXI Hypervisor to understand concepts of Virtual machine (C3)

Interpretation and Binary Translation - HLL Virtual Machines.	
Unit 5: Server Virtualization	
Virtual Hardware Overview - Server Consolidation – Partitioning Techniques - Uses of Virtual server Consolidation – Server Virtualization Platforms.	1. Design Virtualized Server using VMware ESXI Hypervisor to understand concepts of Server Virtualization (C3)
Unit 6: Network Virtualization	
Design of Scalable Enterprise Networks – Layer2 Virtualization – VLAN - VFI - Layer 3 Virtualization – VRF - Virtual Firewall Contexts - Network Device Virtualization - Data- Path Virtualization – Routing Protocols	1. Design Virtualized Server using VMware ESXI Hypervisor to understand concepts of Network Virtualization (C3)
Unit 7: Management and Cloud Services	
Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics: Cloud Computing infrastructures available for implementing cloud based services. Service Management in Cloud Computing - Service Level Agreements(SLAs) - Billing & Accounting - Comparing Scaling Hardware: Traditional vs. Cloud - Economics of scaling: Benefitting enormously - Managing Data - Looking at Data, Scalability & Cloud Services - Database & Data Stores in Cloud - Large Scale Data Processing - Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google,Salesforce.com, IBM Bluemix)	1. Hands on exercise wit AWS Cloud to understand different services offered by Public Cloud (C3) 2. Design a Web services to understand how Cloud Computing works (C3) 3. Explore AWS Cloud to understand Cloud economics and SLA's (C4) 4. Design a High availability, Scalable and Fault tolerant architecture for web application using AWS Services (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs				
Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination 1	*	*		
Sessional Examination 2			*	*
Assignment/Presentation	*		*	
Laboratory Examination	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010 • Rajkumar Buyya, James Broberg ,Andrzej M. Goscinski, " Cloud Computing: Principles and Paradigms", Wiley, 201 • Nikos Antonopoulos, Lee Gillam, "Cloud Computing: Principles, Systems and Applications", Springer, 2012. • Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley-India, 2010

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Application Development with Java
Course Code: CDC-603L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites:** Cloud Application Basics, OOP's concepts, Java programming language, IoT Basics
Synopsis:	This Course provides insight on 1. Cloud application development with IoT devices using Java Programming. 2. To Provide practical knowledge of design and develop of Java application with WebSocket, MQTT protocol and create RESTful API's.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Develop java application using MySQL database.
CO 2:	Develop Java Web application for client server communication.
CO 3:	Deploy web application to cloud.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*		*		*						
CO 2	*				*						
CO 3	*				*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: Basic Java Programming	
OOPS Concepts, Basics of Java Programming, IDE usage.	At the end of the topic student should be able to: 1. Basic Java program to Implement mathematical calculation concepts. (C1)
Unit 2: Databases Using Java	
CRUD Operations	1. Using MySQL database to implement create, select, update and delete operations. (C1) 2. Develop java application to connect to MySQL database and interact. (C1)
Unit 3: Web Application Development	
Web Application Development using Swings.	1. Develop Java Application to create student registration portal using swings and MySQL database. (C2) 2. Deploy web application to cloud hosing. (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*	*	*
Assignment/Presentation	*	*	
Laboratory Examination	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• William Hohl, Christopher Hinds, "ARM Assembly Language: Fundamentals and Techniques", 2nd Edition, ISBN-13: 978-1482229851, ISBN-10: 1482229854 • Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software",1st Edition,The Morgan Kaufmann Series in Computer Architecture and Design, ISBN-13: 978-1558608740, ISBN-10: 1558608745 • David Seal, "ARM Architecture Reference Manual", 2nd Edition, Addison-Wesley Professional. • Steve Furber," ARM System-on-Chip Architecture", 2nd Edition, Addison- Wesley Professional, ISBN-13: 078-5342675191,ISBN-10: 0201675196 • Douglas V. Hall,"Microprocessors and Interfacing", Mcgraw Hill Educatin , ISBN-10 1259006158,ISBN-13 9781259006159,2012. • Websites & Transaction Papers

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Client Side Internet Technology
Course Code: CSE-628	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:** Networking
Synopsis:	This Course provides insight on 1. Client server architecture and able to develop a web application using HTML, JavaScript, XML and JSON. 2. Students will gain the skills and project-based experience needed for entry into web application and development careers.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Recall the history, standards, and technology associated with Internet.
CO 2:	Apply HTML, HTML5 Cascading Style Sheets (CSS) to develop a multimedia website for all domain needs.
CO 3:	Apply Javascript to optimize website on client side.
CO 4:	Use various data representation formats to store data.
CO 5:	Describe different frameworks like bootstrap and anjular.js.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2	*	*			*						
CO 3	*	*			*						
CO 4	*				*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Introduction to Internet, History of Internet, Internet Standards, Introduction to web, Web1.0 vs Web2.0, web development strategies, Web applications, Types of Servers, Client Server Model, Protocols for Internet.	At the end of the topic student should be able to: 1. Explain the concept of Internet (C5). 2. Describe the history of Internet (C4). 3. List out the Internet Standards (C2). 4. Explain the concept of web (C4). 2. Explain the protocols governing the web(C4) 3. Appraise the web development strategies (C5) 4. List out the Web applications (C1)
Unit 2: HTML	
Basic tags of HTML, Common Tags, Formatting Tags, Images and Linking, List and Table Structure, Forms and control: Text, Radio, Checkbox, Select, Button, Input.	1. Construct the Basic web page using tags of HTML (C4). 2. Compare the difference between semantic and non-semantic tags (C5) 3. Design web page using Common Tags, Formatting Tags, Images and Linking, List and Table Structure (C4) 4. Forms and control Text, Radio, Checkbox, Select, Button, Input(C5)
Unit 3: HTML5	
HTML Graphics, HTML Media, HTML API	1. Explain the importance of HTML Graphics, HTML Media, HTML API (C4)
Unit 4: CSS3	
Inline styles, internal style sheets, linking external style sheets, positioning elements, backgrounds, element dimensions, Box Model and text flow, Media Types, Building a CSS drop-down menu.	1. Design web pages using Inline styles, internal style sheets, linking external style sheets(C5) 2. Differentiate between absolute and relative positioning elements(C4) 3. Apply backgrounds to web pages (C5). list out the different element dimensions (C1) 4. Importance of Box Model and text flow, Media Types (C2) 5. Building a CSS drop-down menu(C5)
Unit 5: Javascript	
Elements of Java Script - Variables, Data Types, Operators, Control Statements, Functions, Dialog - obtaining user input with prompt dialogs, Document Object Model(DOM) - Document, Form, Event Handling, JQUERY, AJAX.	1. List out the applications of JavaScript (C1). 2. Explain the elements of Java Script - Variables, Data Types, and Operators (C3). 3. Develop web page by using conditional statement to control the execution (c5).

	4. Create web page to perform repetitive task using looping statements (C5) 5. Develop web page using Functions Dialog - obtaining user input with prompt dialogs. (C5)
Unit 6: XML vs JSON vs YAML	
Introduction and Introduction and Features , Use of XML, XML document, Creating XML, DTD, Reading XML, Introduction to JSON, JSON Structure, Object Representation, YAML, YAML structure, USE Case.	1. Explain the importance of XML.(C3) 2. List out the applications of XML (C1) 3. Construct XML document and Reading XML (C4) 4. Explain the importance of JSON (C3). 5. Describe to represent object(C3) 6. Compare the difference between JSON and XML (C4)
Unit 7: Frameworks	
Bootstrap, Angular.js	1. Describe the main features of Bootstrap(C1) 2. Write HTML code using the Bootstrap library(C3) 3. Create a responsive layout with the Bootstrap grid system(C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	36	72
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	36	72
Revision	-	-
Assessment	6	-
TOTAL	**78**	**144**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs				
Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination 1	*	*		
Sessional Examination 2			*	*
Assignment/Presentation	*		*	*
End Semester Examination	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• "Internetworking with TCP/IP Vol I: Principles, Protocols and Architecture", Douglas E Comer, III Ed. PHI, 1997. • "Microsoft TCP/IP on Windows NT 4.0", MCSE. • "Internetworking with TCP/IP Client–Server Programming and applications, BSD Socket version", Douglas E Comer and David L Stevens, Vol. III. • "TCP/IP Illustrated, Volume I, The Protocols", W Richard Stevens, International Student Edition, 1999. • "Advanced Internet Technologies", Uyless Black, PHI • "High Performance Communication Networks", Jean Warland & Praveen Varaiya – Morgan Kaufmann

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Fundamentals of Machine Learning
Course Code: BDA-601	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:** Basic Programming – preferably Python
Synopsis:	This Course provides insight on 1. This course provide the concept of machine learning, applications, techniques, design issues and approaches to machine learning. 2. This course provide the fundamental knowledge about concept learning, hypothesis and bias. 3. To implement machine learning algorithms such as Decision Tree learning, Probably Approximately Correct (PAC) learning, Bayesian learning, Instance-based learning, Principal Component Analysis (PCA) and Ensemble methods in real time data set for various analysis.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Identify the goals, applications, types and design issues of machine learning techniques.
CO 2:	Relate concept learning and hypothesis space.
CO 3:	Apply PCA learning approach to reduce the dimension.
CO 4:	Analyse different machine learning algorithms.
CO 5:	Design ensemble methods.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2		*									
CO 3			*								
CO 4				*							
CO 5				*							

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Definition of Machine Learning, Goals and applications of machine learning, Basic design issues and approaches to machine learning, Types of machine learning techniques	At the end of the topic student should be able to: 1. Define Machine Learning (C1) 2. Describe about any three applications for which machine learning approaches seem appropriate. (C2) 3. Illustrate different types of machine learning techniques (C3)
Unit 2: Inductive Classification	
The concept learning task, Concept learning as search through a hypothesis space, General-to-specific ordering of hypotheses, Finding maximally specific hypotheses, Version spaces and the Candidate elimination algorithm, Inductive bias.	1. Relate concept learning and hypothesis space (C4). 2. Apply different algorithms to obtain most general and most specific hypotheses from the training examples. (C3)
Unit 3: Decision Tree learning	
Representing concepts as decision trees, Recursive induction of decision trees, Picking the best splitting attribute, Entropy and information gain, Searching for simple trees and computational complexity.	1. Apply decision tree algorithm to find the hypothesis space (C3) 2. Construct decision tree machine learning algorithm (C5) 3. Explain the method of choosing training examples and target function in the design of a machine learning system (C2) 4. Explain different validation technique to find the accuracy in training and testing of data set (C5)
Unit 4: Computational learning theory	
Models of learnability: learning in the limit, Probably Approximately Correct (PAC) learning, Sample Complexity: quantifying the number of examples needed to PAC learn, Computational complexity of training. Sample complexity for finite hypothesis spaces, Noise Learning Multiple Classes, Bias-variance trade-off, under-fitting and over-fitting concepts.	1. Define various terms related to computational learning approach (C1). 2. Describe different models learning in the limit (C2) 3. Calculate the number of training examples required in different types of learning approaches (C).

Unit 5: Bayesian learning	
Probability theory and Bayes rule, Naive Bayes learning algorithm - Parameter smoothing, Generative vs. discriminative training, Logistic regression, Bayes nets and Markov nets for representing dependencies	1. Write the applications of Bayes theorem (C3) 2. Describe the use of Logistic Regression in Machine Learning (C2) 3. Predict the target value for the new instance using Naïve Bayes classifier. (C3)
Unit 6: Instance-based learning	
Constructing explicit generalizations versus comparing to past specific examples, K-Nearest Neighbour learning algorithm, Case-based reasoning (CBR) learning	1. Construct explicit generalizations (C5) 2. Discriminate Instances Based and Case-based learning (C4) 3. Explain K-nearest neighbour learning (C5)
Unit 7: Continuous Latent Variables	
Principal Component Analysis (PCA), Applications of PCA	1. Describe use of Principal Component Analysis for the complex data set (C2). 2. Apply PCA to choose principal components for the given data set (C3)
Unit 8: Ensemble methods (bagging and boosting)	
Using committees of multiple hypotheses, Bagging, Boosting, DECORATE, Active learning with ensembles	1. Choose a suitable method of ensemble learning approach (C3). 2. Explain various ensemble techniques (C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	
Assignment/Presentation	*	*	*	*	
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• T. Mitchell, "Machine Learning", McGraw-Hill, 1997. • E. Alpaydin, "Machine Learning", MIT Press, 2010. • C. Bishop," Pattern Recognition and Machine Learning", Springer, 2006. • E. Hart, R. Duda and D. Stork, "Pattern Classification", Wiley-Interscience, 2000. • T. Hastie, R. Tibshirani and J. Friedman, "The Elements of Statistical Learning: Data Mining, • Inference and Prediction", Springer, 2nd Edition, 2009. • Jason Bell, "Machine Learning for Big Data", Wiley Big Data Series, 2016. • Rama Murthy G," Multidimensional Neural Networks Unified Theory", New Age International, 2008.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	DevOps for Cloud
Course Code: CDC-607	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 3	**Prerequisites:**
Synopsis:	This Course provides insight on: 1. DevOps Product Life Cycles Stage. 2. Automation of product lifecycle.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the concept of automation of Product Life Cycle stages.
CO 2:	Demonstrate Continuous Integration / Continuous Testing / Continuous Deployment of Product.
CO 3:	Compare and contrast existing Software Methodologies with DevOps Life Cycle stages.
CO 4:	Design and DevOps methodologies for Product development and Release
CO 5:	Explain the concepts of Tools used in each stages of DevOps.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*									
CO 2			*		*						
CO 3		*	*								
CO 4	*										
CO 5	*										

Course content and outcomes:	
Content	***Competencies***
Unit 1: DevOps Introduction	
Understanding Development- Developement SDLC: WaterFall & Agile - Understanding Operations - Dev vs Ops - DevOps to the rescue - What is DevOps - DevOps SDLC - Continous Delivery model - DevOps tools for DevOps SDLC - DevOps Roles & Responsiblities.	At the end of the topic student should be able to: 1. Explain about the Product Life Cycle Software methodologies (C2) 2. Describe DevOps life cycle for Product Development and Release (C2) 3. Explain the stages of DevOps (C2) 4. Describe about Continuous Integration / Continuous Deployment pipeline. (C2) 5. Write the significance of automation in Product life cycle management. (C3) 6. Describe different between standard software methodologies and DevOps software methodologies. (C2)
Unit 2: Linux	
Linux Introduction, Principles & Linux distro – Booting - Command line utililities & Basic commands - Linux Filesystem - Filters & I/O Redirections - Users & Group administration - File permissions & Ownerships - Sudo - Software Managemen - Useful tools: ssh, telnet, scp, rsync, disk utils, backups etc - Service & Process management - Shell Scripting - Systems and HW stats – Linux Containers (lxc) - Dockers – Kubernetes and Microservices .	1. Explain the evolution of Linux OS (C2) 2. Explain Linux File System (C2) 3. Demonstrate Linux Users and Groups (C3) 4. Describe OS Level Virtualization techniques like Containers (C3) 5. Demonstrate basic Linux Commands (C4)
Unit 3: Networking fundamentals	
Components of computer networks - Classification: LAN, WAN, Peer to Peer network, Server based – Switches, Routers - Network Architecture - Protocols - Port numbers - DNS - DHCP - IP Addresses - Ip Addresses & Subnet Masks - IP Address Ranges - Subnetting - Private Vs Public networks - High Availaiblity - Firewalls & NACL - Web Application Architecture - Infrastructure - Network layout - Services & Components - Architecture from a DevOps perspective.	1. Explain Computer network and devices (C2) 2. Demonstrate subnetting and its need (C3) 3. Explain IPV4 Addressing scheme (C2) 4. Demonstrate type of Network Devices like Switches , Hub , Router using Simulator Tools (C4) 5. Describe networking Services like DNS , DHCP , NACL , FTP etc (C4)

Unit 4: Automation, Orchestration & Config Management	
Version control system with Git : What is VCS & why it is needed - DevOps use cases - Setup your own repo with git - Manage your code base/source code with GIT & GITHUB	1. Explain need and types of version control software (C1) 2. Describe architecture of Distributed version control systems (C2) 3. Explain Git and Github as case study (C3)
Unit 5: Continuous Integration with Jenkins	
Introduction to continuous integration. - Build & Release and relation with DevOps - Understanding development and developers - Why Continuous integration Jenkins introduction and setup - Jenkins projects/jobs - Jenkins plugins | Jenkins administration: Users - Nodes/slaves - Managing plugins - Managing software versions - Introduction - Phases - Java builds - Build and Release job/project setup | Nexus: Intro & Setup - Software versioning & Hosted repository - Integration with Jenkins - Continuous integration job/project setup | Complete Jenkins project: Packinging Artifacts - Static code Analysis - Tomcat setup Staging & productions - Artifacts deployments to webservers from Jenkins - Build Pipeline - Jenkins not just CI tool anymore - More DevOps use cases of Jenkins	1. Describe about Continuous Integration / Continuous Deployment pipeline. (C2) 2. Write the significance of automation in Product life cycle management. (C3) 3. Describe different between standars software methodologies and DevOps software methodologies. (C2) 4. Give examples for Automation of stages of Product development using DevOps . (C2) 5. Write the limitation of Current Software methodologies for Product Development. (C3) 6. Describe the architecture of Continuous Integration server. (C2) 7. Apply DevOps methodologies for Product Development and Release(C3
Unit 5: Ansible	
Configuration Management & Automation - What is Ansible & its features - Ansible setup on local & cloud - Understanding Ansible architecture & Execution - Inventory | Ad hoc commands: Automating Change Management with Ad Hoc commands- Playbook Introduction- Ansible configuration with ansible.cfg- Ansible documentation- Modules, modules & lots of modules- Writing playbook for webserver & DB server deployments- Tasks - Variables - Templates - Loops - Handlers - Conditions- Register- Debugging - Ansile Roles- Identify server roles - Roles	1. Write the steps in Automation of Testing in Web development. (C3) 2. Explain the operations Continuous Testing. (C5) 3. Write the taxonomy of Continuous Integration / Continuous Delivery / Continuous Deployment (C3) 4. Design a Workflow for Automation of Product life cycle using DevOps (C5, P3). 5. Construct a Continuous Integration / Continuous Deployment pipeline (C5) 6. Compare Standard Software methodologies vs DevOps methodologies for Product Development. (C6, P2)

structure-Creating, Managing and executing roles- Ansible Galaxy- Exploring Roles from Galaxy- Download Galaxy roles and integrate with your code- Ansible Advanced Execution - Improving execution time- Limiting and selecting tasks- Troubleshooting and Testing.	7. Describe about Containers and Container Orchestration Services. (C2) 8. Examine the advantages of using Containers in Web development(C4) 9. Describe Container orchestration services architecture(C2) 10. Show the function of Container orchestration services(C3) 11. Define Configuration Management tools and its need. (C1) 12. Describe the features of Configuration Management. (C2) 13. Explain the architecture of Configuration Management (C5) 14. Design a Configuration Management Codes to administrate infrastructure of organization (C5) 15. Explain the need of Continuous Monitoring tools (C5) 16. Design an Architecture Continuously Monitor infrastructure. (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	*
Assignment/Presentation	*		*		
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Eric Foster-Johnson , John C. Welch , Micah Anderson, Beginning Shell Scripting (Programmer to Programmer), Wrox Publications • Randal K. Michael "Mastering Unix Shell Scripting: Bash, Bourne, and Korn Shell Scripting for Programmers, System Administrators, and UNIX Gurus", 2nd Edition, Wiley Publications • Bintu Harwani, "UNIX & Shell Programming", Oxford Publications, 2013 • John Ferguson Smart, "Jenkins: The Definitive Guide", O'reilly Publications • Mitesh Soni, "Jenkins Essentials", Packt Publications • Rafal Leszko, "Continuous Delivery with Docker and Jenkins", Packt Publications • Veselin Kantsev, "Implementing DevOps on AWS", Packt Publications • Randall Smith, "Docker Orchestration", Packt Publications • Alan Berg, "Jenkins Continuous Integration Cookbook", Packt Publications • Kumaran S., Senthil, " Practical LXC and LXD Linux Containers for Virtualization and Orchestration", Apress Publications • Konstantin Ivanov, " Containerization with LXC" , Packt Publications • Karl Matthias, Sean Kane, "Docker: Up & Running: Shipping Reliable Containers in Production", O'Reilly Media

Name of the Program:		Master of Engineering - ME (Cloud Computing)
Course Title:		Client Side Internet Technology Lab
Course Code: CSE-628L		**Course Instructor:**
Academic Year: 2020 - 2021		**Semester:** First Year, Semester 1
No of Credits: 1		**Prerequisites:** No prerequisite
Synopsis:	This Course provides insight on	
Course Outcomes (COs):		
CO 1:	Insert graphic, link table in web page, create web page	
CO 2:	Use cascading style sheets to create layout	
CO 3:	Create dynamic web page using JavaScript and Dom Elements	

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*				*						
CO 2	*				*						
CO 3	*	*			*						

Course content and outcomes:	
Content	***Competencies***
Unit 1:	
HTML	At the end of the topic student should be able to: 1. Design web page using HTML tags. (C6)
Unit 2:	
CSS	1. Design layout for web page. (C6)
Unit 3:	
Java Script	1. Illustrate Dynamic web page using Javascript. (C2)
Unit 4:	
JSON and XML	1. Utilize JSON and XML objects in web page. (C3)
Unit 5:	
Framework	1. Develop rapid website development using Bootstrap and Angular JS framework. (C3)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*	*	
Sessional Examination 2		*	*
Assignment/Presentation	*	*	
Laboratory Examination	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• "Internetworking with TCP/IP Vol I: Principles, Protocols and Architecture", Douglas E Comer, III Ed. PHI, 1997. • "Microsoft TCP/IP on Windows NT 4.0", MCSE. • "Internetworking with TCP/IP Client–Server Programming and applications, BSD Socket version", Douglas E Comer and David L Stevens, Vol. III. • "TCP/IP Illustrated, Volume I, The Protocols", W Richard Stevens, International Student Edition, 1999. • "Advanced Internet Technologies", Uyless Black, PHI • "High Performance Communication Networks", Jean Warland & Praveen Varaiya – Morgan Kaufmann

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(Deemed to be University under Section 3 of the UGC Act, 1956)

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Fundamentals of Machine Learning Lab
Course Code: BDA-601L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites**: Basics of Programming

Synopsis:	This Course provides insight on
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Identify the software and tools for designing machine learning applications.
CO 2:	Apply concept learning and hypothesis space.
CO 3:	Apply machine learning approach to reduce the dimension.
CO 4:	Analyse different machine learning algorithms.
CO 5:	Design ensemble methods.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2		*									
CO 3			*								
CO 4				*							
CO 5				*							

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Definition of Machine Learning Goals and applications of machine learning Basic design issues and approaches to machine learning Types of machine learning techniques	At the end of the topic student should be able to: 1. Identify programming environments available for the machine learning (C1) 2. Classify the pros and cons of various environments for ML coding (C2)
Unit 2: Inductive Classification	
The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Inductive bias.	1. Design a machine learning model to get a Maximally Specific Hypothesis for the given training examples (C5). 2. Construct a machine learning model to obtain most general and most specific hypotheses for the given training examples (C5)
Unit 3: Decision Tree learning	
Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute Entropy and information gain. Searching for simple trees and computational complexity.	1. Develop a machine learning classifier using decision tree and random forest (C5) 2. Examine different applications of decision tree and random forest (C4)
Unit 4: Computational learning theory	
Models of learnability: learning in the limit. Probably Approximately Correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. Noise. Learning Multiple Classes. Bias-variance trade-off, under-fitting and over-fitting concepts.	1. Design a learning method to determine the sample complexity of training examples (C5) 2. Analyse bias-variance trade-off, under-fitting and over-fitting concepts (C4)
Unit 5: Bayesian learning	
Probability theory and Bayes rule. Naive Bayes learning algorithm - Parameter smoothing.	1. Design a machine learning model using Bayes learning (C5).

Generative vs. discriminative training Logistic regression. Bayes nets and Markov nets for representing dependencies	2. Develop a machine learning classifier models using different approach (C5) 3. Design Bayes nets and Markov nets for representing dependencies (C5)
Unit 6: Instance-based learning	
Constructing explicit generalizations versus comparing to past specific examples. K-Nearest Neighbour learning algorithm. Case-based reasoning (CBR) learning.	1. Design machine learning models to classify the instances using K-NN and CBR approaches (C5).
Unit 7: Continuous Latent Variables	
Principal Component Analysis (PCA), Applications of PCA	1. Apply PCA for different complex applications (C3)
Unit 8: Ensemble methods (bagging and boosting)	
Using committees of multiple hypotheses. Bagging Boosting DECORATE Active learning with ensembles.	1. Design a Bayesian Networks (C5) 2. Develop machine learning models using Ensemble models. (C5)

Learning strategies, contact hours and student learning time		
Lecture	*Contact hours*	*Student learning time (Hrs)*
Seminar	12	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	03	-
Practical	-	-
Revision	24	-
Assessment	03	-
TOTAL	06	-

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	
Assignment/Presentation	*	*	*	*	*
Laboratory Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Machine Learning, T. Mitchell, McGraw-Hill, 1997 • Machine Learning, E. Alpaydin, MIT Press, 2010 • Pattern Recognition and Machine Learning, C. Bishop, Springer, 2006 • Pattern Classification, R. Duda, E. Hart, and D. Stork, Wiley-Interscience, 2000 • T. Hastie, R. Tibshirani and J. Friedman, The Elements of Statistical Learning: Data Mining, • Inference and Prediction. Springer, 2nd Edition, 2009 • Machine Learning for Big Data, Jason Bell, Wiley Big Data Series • Multidimensional Neural Networks Unified Theory, Rama Murthy G • Current literature

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	DevOps for Cloud Lab
Course Code: CDC-607L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites:** Ubuntu OS, Networking and Software Life Cycle
Synopsis:	This Course provides insight on 1. DevOps Product Life Cycles Stage. 2. Automation of product lifecycle.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	3. Explain the concept of automation of Product Life Cycle stages.
CO 2:	4. Design an DevOps methodologies for Product development and Release
CO 3:	5. Demonstrate Continuous Integration / Continuous Testing / Continuous Deployment of Product.
CO 4:	6. Explain the concepts of Tools used in each stages of DevOps.
CO 5:	7. Demonstrate Continuous Monitoring of Production Environment.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*	*								
CO 2	*	*	*								
CO 3	*	*	*								
CO 4		*	*		*						
CO 5		*	*		*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: DevOps Introduction	
Understanding Development-Development SDLC : Waterfall & Agile - Understanding Operations - Dev vs Ops - DevOps to the rescue - What is DevOps - DevOps SDLC - Continuous Delivery model - DevOps tools for DevOps SDLC - DevOps Roles & Responsibilities.	At the end of the topic student should be able to: 1. Demonstrate differences between Waterfall and agile software development methodologies (C2)
Unit 2: Linux	
Linux Introduction, Principles & Linux distro – Booting - Command line utilities & Basic commands - Linux File system - Filters & I/O Redirections - Users & Group administration - File permissions & Ownerships- Sudo - Software Mana gement - Useful tools: ssh, telnet, scp, rsync, disk utils, backups etc - Service & Process management - Shell Scripting - Systems and HW stats – Linux Containers (lxc) - Dockers – Kubernetes and Microservices	1. Design Ubuntu based VM using hypervisor to understand booting process , linux file system , linux networking , Users , Groups and Permissions, tools (ssh , scp etc) (C3) 2. Design a docker environment to containerize web application (C3) 3. Design a Kubernetes cluster to deploy containerized application using Kubernetes deployment and service models (C4)
Unit 3: Networking fundamentals	
Components of computer networks - Classification: LAN, WAN, Peer to Peer network, Server based - Switches - Routers - Network Architecture - Protocols - Port numbers - DNS - DHCP - IP Addresses - IP Addresses & Subnet Masks - IP Address Ranges - Subnetting - Private Vs Public networks - High Availaiblity - Firewalls & NACL - Web Application Architecture - Infrastructure - Network layout - Services & Components - Architecture from a DevOps perspective.	1. Design a College/ University network using packet tracer to understand computer networking devices like Hub , Switches , Routers and Firewalls (C3) 2. Design a Network project using Packet tracer to understand Networking services like DNS , DHCP , FTP etc (C3)

Unit 4: Automation, Orchestration & Config Management	
Version control system with Git : What is VCS & why it is needed - DevOps use cases - Setup your own repo with git - Manage your code base/source code with GIT & GITHUB	1. Create Github account and set up repository and use git commands to Clone , Fork and commit files to Github repositories (C4)
Unit 5: Continuous Integration with Jenkins	
Introduction to continuous integration. - Build & Release and relation with DevOps - Understanding development and developers - Why Continuous integration Jenkins introduction and setup - Jenkins projects/jobs - Jenkins plugins| Jenkins administration : Users - Nodes/slaves - Managing plugins - Managing software versions - Introduction - Phases - Java builds - Build and Release job/project setup | Nexus: Intro & Setup - Software versioning & Hosted repository - Integration with Jenkins - Continuous integration job/project setup | Complete Jenkinsproject Packinging Artifacts - Stat ic code Analysis - Tomcat setup Staging & productions - Artifacts deployments to webservers from Jenkins - Build Pipeline - Jenkins not just CI tool anymore - More DevOps use cases of Jenkins	1. Design a Continuous Integration server using Jenkins in Master Slave architecture (C3) 2. Demonstrate CI/CD for JAVA/PHP/nodejs web application (C4) 3. Design an Eclipse Selenium testing project to automate Web application Testing Process (C4)
Unit 6: Ansible	
Configuration Management Automation - What is Ansible & its features - Ansible setup on local & cloud - Understanding Ansible architecture & Execution - Inventory | Ad hoc commands: Automating change Management with AdHoc commands - Playbook Introduction - Ansible configuration with ansible.cfg - Ansible documentation -Modules, modules & lots of modules - Writing playbook for webserver & DB server deployments	1. Design a Configuration management service using Ansible to administer group of nodes in lab (C2) 2. Demonstrate installation of Software packages like git , Eclipse , Mysql on group of nodes using Ansible (C4) 3. Design a Continuous monitoring server using Nagios to monitor group of servers for different dervices like CPU Utilization , RAM Usage , Network Bandwidth , Apache server logs , Database server logs etc (C5)

- Tasks - Variables - Templates - Loops - Handlers - Conditions - Register - Debugging - Ansile Roles - Identify server roles - Roles structure - Creating, Managing and executing roles - Ansible Galaxy - Exploring Roles from Galaxy - Download Galaxy roles and integrate with your code - Ansible Advanced Execution - Improving execution time - Limiting and selecting tasks - Troubleshooting and Testing	

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal Practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*	*	*	*
Assignment/Presentation				*	*
Laboratory Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Eric Foster-Johnson , John C. Welch , Micah Anderson, Beginning Shell Scripting (Programmer to Programmer), Wrox Publications • Randal K. Michael "Mastering Unix Shell Scripting: Bash, Bourne, and Korn Shell Scripting for Programmers, System Administrators, and UNIX Gurus", 2nd Edition, Wiley Publications • Bintu Harwani, "UNIX & Shell Programming", Oxford Publications, 2013 • John Ferguson Smart, "Jenkins: The Definitive Guide" ,O'reilly Publications • Mitesh Soni, "Jenkins Essentials", Packt Publications • Rafal Leszko, "Continuous Delivery with Docker and Jenkins", Packt Publications • Veselin Kantsev, "Implementing DevOps on AWS" , Packt Publications • Randall Smith, "Docker Orchestration", Packt Publications • Alan Berg, "Jenkins Continuous Integration Cookbook" , Packt Publications • Kumaran S., Senthil, " Practical LXC and LXD Linux Containers for Virtualization and Orchestration", Apress Publications • Konstantin Ivanov, "Containerization with LXC", Packt Publications • Karl Matthias, Sean Kane, "Docker: Up & Running :Shipping Reliable Container in Production" ,O'Reilly Media

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Mini Project - 1
Course Code: CDC 695	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester1
No of Credits: 4	**Prerequisites:** Any programming language and circuit basics
Synopsis:	Students are expected to select a problem in the area of their interest and the area of their specialization that would require an implementation in hardware / software or both in a semester
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Apply the objectives of the project work and provide an adequate background with a detailed literature survey
CO 2:	Breakdown the project into sub blocks with sufficient details to allow the work to be reproduced by an independent researcher
CO 3:	Compose hardware/software design, algorithms, flowchart, methodology, and block diagram
CO 4:	Evaluate the results
CO 5:	Summarize the work carried out

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1				*							
CO 2					*			*			
CO 3							*			*	
CO 4						*					*
CO 5							*				

Course content and outcomes:	
Content	***Competencies***
Phase 1	
Problem identification, synopsis submission, status submission, mid evaluation.	At the end of the topic student should be able to: 1. Identify the problem/specification (C1) 2. Discuss the project (C2) 3. Prepare the outline (C3) 4. Describe the status of the project (C2) 5. Prepare a mid-term project presentation report (C3) 6. Prepare and present mid-term project presentation slides (C3, C5) 7. Develop project implementation in hardware/software or both in chosen platform (C5)
Phase 2	
Status submission, final evaluation.	1. Prepare the progress report (C3) 2. Prepare the final project presentation report (C3) 3. Prepare and present final project presentation slides (C3, C5) 4. Modify and Develop implementation in hardware/software or both in chosen platform (C3, C5) 5. Justify the methods used and obtained results (C6)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	48	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	03	-
TOTAL	**51**	**09**

Assessment Methods:	
Formative:	**Summative:**
Project Problem Selection	Mid-Term Presentation
Synopsys review	Second status review
First status review	Demo & Final Presentation

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Mid Presentation	*	*			
Presentation	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Particular to the chosen project

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Seminar - 1
Course Code: CDC 697	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 1
No of Credits: 1	**Prerequisites:** Communication Skill
Synopsis:	1. To select, search and learn technical literature. 2. To identify a current and relevant research topic. 3. To prepare a topic and deliver a presentation. 4. To develop the skill to write a technical report. 5. Develop ability to work in groups to review and modify technical content.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Show competence in identifying relevant information, defining and explaining topics under discussion.
CO 2:	Show competence in working with a methodology, structuring their oral work, and synthesizing information.
CO 3:	Use appropriate registers and vocabulary, and will demonstrate command of voice modulation, voice projection, and pacing.
CO 4:	Demonstrate that they have paid close attention to what others say and can respond constructively.
CO 5:	Develop persuasive speech, present information in a compelling, well-structured, and logical sequence, respond respectfully to opposing ideas, show depth of knowledge of complex subjects, and develop their ability to synthesize, evaluate and reflect on information.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1											
CO 2											
CO 3											
CO 4											
CO 5											

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	14	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
TOTAL	**14**	**-**

Assessment Methods:	
Formative:	**Summative:**
Seminar Topic Selection	
Synopsys review	
PPT Review	

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Presentation	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Particular to the chosen Seminar

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Big Data and Data Visualization
Course Code: BDA 614	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:** Programing in Python or Java
Synopsis:	This Course provides insight on 1. This course aims to help students get started with Architectures of distributed file systems and distributed computing. 2. Students learn probability and statistical Inference techniques. 3. Students learn machine learning algorithms required for big data applications. 4. Students learn to map data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Understand the architecture of distributed systems and distributed computing.
CO 2:	Identify the characteristics of datasets and compare the trivial data and big data for various applications.
CO 3:	Explain concept learning task and hypothesis space, distinguish between general and specific hypotheses, identify the maximally specific hypotheses, Describe version spaces and candidate elimination algorithm.
CO 4:	To solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
CO 5:	Practical experience building and evaluating visualization systems.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*	*								
CO 2	*	*	*								
CO 3	*	*	*	*							
CO 4	*	*	*								
CO 5	*	*	*				*				

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction to Big Data	
Terminology – Challenges - Architectures – Distributed File Systems – Google File System – Hadoop File Systems - Hadoop Ecosystems.	At the end of the topic student should be able to: 1. Describe architecture of Google file system. (C2) 2. Describe architecture of Hadoop systems. (C2)
Unit 2: Statistics	
Sampling Techniques - Data classification, Tabulation, Frequency and Graphic reporesentation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.	1. Define True Error of a hypothesis, ε-exhausted Version Space, PAC Learning and Agnostic Learning (C1). 2. Describe data sampling techniques. (C2)
Unit 3: Databases for Big Data	
Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation – Big Table vs HBase introduction to NoSQL - HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts- Advanced Usage, Schema Design, Advance Indexing.	1. Describe is Data Science. (C2) 2. Describe the characteristics of NoSQL. (C2) 3. Describe the principle of Map Reduce technique. (C2)
Unit 4: Machine Learning for Big Data	
Choosing and evaluating models – mapping problems to machine learning, evaluating clustering models, validating models – cluster analysis – K-means algorithm, Naïve Bayes – Memorization Methods – Linear and logistic regression – supervised and unsupervised learning - Issues regarding classification and prediction, Bayesian Classification, Classification by backpropagation, Classification based on concepts from association rule mining, Other Classification Methods, Classification accuracy.	1. Apply candidate-elimination algorithm to obtain most general and most specific hypotheses for the training examples. (C3) 2. Apply the concept of entropy and information gain to find the root node of the decision tree (C3). 3. Design a model using K-means classifier to predict how well products are accepted by the clients (C3).

Unit 5: Stream Computing in Big Data	
Introduction - Streaming Data – Sources – Difference between Streaming Data and Static Data. Overview of Large Scale Stream Processing Engines – Issues in Stream Processing - Phases in Streaming Analytics Architecture - Vital Attributes - High Availability – Low Latency – Horizontal Scalability-Fault Tolerance - Service Configuration and Management - Apache ZooKeeper - Distributed Stream Data Processing: Co-ordination, Partition and Merges, Transactions. Duplication Detection using Bloom Filters - Apache Spark Streaming Examples Choosing a storage system – NoSQL Storage Systems.	1. Understanding issues with stream processing in big data (C3). 2. Describe how big data systems achieve high availability and low latency. (C2) 3. Describe how Spark does in memory processing. (C3)
Unit 6: Security in Big Data	
Privacy – Identification of Anonymous People – Why Big Data Privacy is self-regulating? – Ethics – Ownership – Ethical Guidelines – Big Data Security – Organizational Security - Steps to secure big data – Classifying Data – Protecting – Big Data Compliance - HADOOP SECURITY DESIGN	1. Describe why Big Data Privacy is self-regulating. (C2) 2. Describe the steps to secure big data systems. (C2)
Unit 7: Data Visualization, Characterization – Data Wrangling	
Combining and Merging DataSets – Reshaping and Pivoting – Data Transformation – String Manipulation, Regular Expressions - DATA AGGREGATION, GROUP OPERATIONS ,TIMESERIES - GoupBy Mechanics – Data Aggregation – Groupwise Operations and Transformations – Pivot Tables and Cross Tabulations – Date and Time Date Type tools – Time Series Basics – Data Ranges, Frequencies and Shifting - WEB SCRAPING - Data Acquisition by Scraping web applications –Submitting a form - Fetching web pages – Downloading web pages through form submission – CSS Selectors - Data Visualization Tools	1. Understanding various formats of data. (C1) 2. Design programs to dynamically extract data from web. (C4) 3. Design programs to read data from various data sources. (C4) 4. Create visualization for time series data. (C4) 5. Create visualization for statistical distributions. (C4) 6. Create visualization for maps, Hierarchical data and network data. (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*	*		
Sessional Examination 2			*	*	*
Assignment/Presentation	*	*	*	*	*
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• HADOOP: The definitive Guide, Tom White 4th edition, O Reilly Publication • Python for Data Analysis, Wes Mc Kinney, O Reilly Publication. • Practical Data Science with R, Nina Zumel, John Mount, Manning Publications. • Machine Learning, E. Alpaydin, MIT Press, 2010

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Networks
Course Code: CDC 604	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:** Networking Basics
Synopsis:	This Course provides insight on 1. Basic Networking Concepts. 2. Data centre terminologies. 3. Storage Area Network Concepts. 4. Software Defined Networks.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe cloud networking components and terminologies, different networking types and OSI model
CO 2:	Explain the concept of data centre planning and deployment
CO 3:	Demonstrate the concept of storage area networks
CO 4:	Explain the concept of software defined radios
CO 5:	Explain the concept of content delivery networks

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*		*								
CO 2		*		*							
CO 3	*		*	*							
CO 4		*		*							
CO 5	*		*	*							

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction to Networks	
Understanding the Cloud Network – Terminologies in Cloud – Components involved in cloud networking infrastructure – NaaS – SAN in cloud – DATA Center – Deployment of a Data Center and factors affecting Data Center | Networking: Types of Networking – IEEE standard | Layers of OSI Model – TCP – UDP - IPv4 and IPv6.	At the end of the topic student should be able to: 1. Explain about cloud network terminologies and components (C2) 2. Describe the different layers of OSI model (C2) 3. Explain the different types of Networking in IEEE standards (C2)
Unit 2: Data Center Networking	
Introductions – Data Center Planning and Deployment – Cooling, Power and Air Distribution –Server: Stand-alone, blades, stateless, clustering, scaling, optimization - Infrastructure Protocols - Load Balancing – Disaster Recovery- Inter-Data Center Networking | Introduction to Business Continuity | Local Replication and Remote Replication.	1. Describe about data center planning and deployment. (C2) 2. Write the significance of load balancing and replication in data center. (C3) 3. Describe different data protection policies. (C2)
Unit 3: Storage Area Networks	
Storage Systems - Information Storage – Data Center Environment – DAS | Data Protection: RAID –Implementation – Array Components - Techniques | Intelligent Storage Systems | Fibre Channel Storage - NAS | Backup, Archive and Replications | Securing and Managing the storage Infrastructure |CAS - Content-Addressed Storage| Introduction to SCSI.	1. Describe the architecture of a storage area network. (C2) 2. Explain the operations of NAS. (C4) 3. Explain the concept and operation of CAS. (C4) 4. Explain SCSI. (C2)
Unit 4: Software Defined Radios	
Introduction to SDN – Centralized and Distributed Control and Data Planes –SDN Controllers – SDN Solutions to Data Centre - Network Function Virtualization (NFV) – Use Cases.	1. Describe SDN controllers. (C2) 2. Explain Network function virtualization. (C2)
Unit 5: Content Delivery Networks	
CDN Models – CDN workflow – Publishing – Case Studies.	1. Explain the CDN workflow. (C2) 2. Write the significance of CDN model (C3)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	
Assignment/Presentation	*	*	*	*	*
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Rajkumar Buyya, Caesar Wu, Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center, Elseiver • Thomas D. Nadeau, Ken Gray, SDN Software Defined Networks, O'Reilly Media • William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and CloudWith contributions by: Florence Agboma, British Sky Broadcasting, Sofiene Jelassi, Pearson Publications. • Gilbert Held, A practical guide to content delivery networks, 2nd edition, CRC Press. • Dom Robinson, Content delivery networks: fundamentals, design, and evolution, John Wiley & Sons, 2017.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Security
Course Code: CDC 605	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:** Network security, Networking Basics
Synopsis:	This Course provides insight on 1. Cryptographic fundamentals like CIA triad, encryption standards, Key management techniques, hashing. 2. Security Issues to be considered in cloud architecture. 3. Design principles of cloud security.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Identify fundamentals of cloud computing architectures based on current standards, protocols, and best practices.
CO 2:	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud and evolve appropriate safeguards and countermeasures.
CO 3:	Design Cloud security architectures that assures secure isolation of compute, network and storage infrastructures, comprehensive data protection, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates.
CO 4:	Cloud computing security guidelines set forth by ISO, NIST, ENISA and Cloud Security Alliance (CSA).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*		*		*						
CO 2	*	*								*	
CO 3	*	*	*	*	*					*	
CO 4	*										

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction to Security	
Need for Security, CIA triad, Services – Mechanisms and Attacks, Classic Encryption Techniques – Substitution cipher – Transposition cipher, Characteristic of Cryptographic Systems- Modern Encryption Techniques, symmetric key, asymmetric key, PKI and Key Management, block cipher, stream cipher, Hashing.	At the end of the topic student should be able to: 1. Recognize the Need for Security, CIA triad, Services. (C2) 2. Practice Cryptographic Algorithms. (C3)
Unit 2: Introduction to Cloud Security	
Model for Network Security, Cloud security challenges, security models in clouds.	1. Define Network Security, Cloud security challenges(C1) 2. Classify security models in clouds(C2).
Unit 3: Security Design and Architecture for Cloud Computing	
Guiding Security design principles for Cloud Computing –Secure Isolation - Comprehensive data protection - End-to-end access control - Monitoring and auditing - CSA, NIST and ENISA guidelines for Cloud Security.	1. Analyze Security principles for cloud computing (C4) 2. Demonstrating End-to-end access control - Monitoring and auditing(C3)
Unit 4: Data Protection for Cloud Infrastructure and Services	
Data Redaction, Tokenization, Obfuscation, Assuring data deletion - Data retention, deletion and archiving procedures for tenant data - Data Protection Strategies.	1. Apply Data Redaction, Tokenization, Obfuscation, Assuring data deletion(C3) 2. Identify Data Protection Strategies(C1)
Unit 5: Enforcing Access Control for Cloud Infrastructure based Services	
Common attack vectors and threats - Enforcing Access Control Strategies - Compute, Network and Storage - Authentication and Authorization - Roles-based Access Control, Multi-factor – authentication - Host, storage and network access control options - OS Hardening and minimization, securing remote - access, Verified and measured boot - Firewalls, IDS, IPS and honeypot.	1. Discuss Common attack vectors and threats and Enforcing Access Control Strategies. (C2) 2. Differentiate Authentication and Authorization (C4) 3. Describe OS Hardening and minimization, securing remote - access, Verified and measured boot. (C1)

Unit 6: Monitoring, Auditing and Management	
Proactive activity monitoring, Incident Response - Monitoring for unauthorized access, malicious traffic, abuse of system - privileges, events and -alerts - Auditing – Record generation, Reporting and Management - Tamper-proofing audit logs - Quality of Services - Secure Management - User management - Identity management - Security Information and Event Management.	1. Outline Proactive activity monitoring, Incident Response Monitoring for unauthorized access, malicious traffic, abuse of system (C1) 2. Distinguish Auditing – Record generation, Reporting and Management (C2)
Unit 7: Cloud Computing Security Design Patterns – I	
Security Patterns for Cloud Computing - Trusted Platform- Geo-tagging - Cloud VM Platform Encryption - Trusted Cloud Resource Pools - Secure Cloud Interfaces - Cloud Resource Access Control - Cloud Data Breach Protection - Permanent Data Loss Protection - In-Transit Cloud Data Encryption.	1. Describe Security Patterns for Cloud Computing -Trusted Platform- Geo-tagging - Cloud VM Platform Encryption. (C1) 2. Employ Trusted Cloud Resource Pools - Secure Cloud Interfaces - Cloud Resource Access Control - Cloud Data Breach Protection (C3)
Unit 8: Cloud Computing Security Design Patterns – II	
Security Patterns for Cloud Computing – Network Security, Identity & Access Management & Trust - Secure On-Premise Internet Access - Secure External Cloud Connection - Cloud Denial-of-Service Protection - Cloud Traffic Hijacking Protection -Automatically Defined Perimeter - Cloud Authentication Gateway - Federated Cloud Authentication - Cloud Key Management - Trust Attestation Service - Collaborative Monitoring and Logging - Independent Cloud Auditing.	1. Classify Security Patterns for Cloud Computing – Network Security, Identity & Access Management & Trust - Secure On-Premise (C2) 2. Paraphrase Cloud Denial-of-Service Protection - Cloud Traffic Hijacking Protection - Automatically Defined Perimeter - Cloud Authentication Gateway - Federated Cloud Authentication (C2)
Unit 9: Policy, Compliance & Risk Management in Cloud Computing	
Introduction to Legal, security, forensics, personal & data - privacy issues within Cloud environment - Cloud security assessment & audit reports - Laws & regulatory mandates - Personal Identifiable Information & Data Privacy - Privacy requirements for Cloud computing (ISO 27018) - Metrics for Service Level Agreements (SLA) - Metrics for Risk	1. Define Legal, security, forensics, personal & data - privacy issues within Cloud environment. (C1) 2. Interpret Cloud security assessment & audit reports - Laws & regulatory mandates .(C3)

Management:ENISA, NIST SP 800 ,PCI DSS, SAS 70 , CSA Security, Trust, and Assurance Registry (STAR)	

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*		
Assignment/Presentation	*	*	*		
End Semester Examination	*	*	*	*	

Feedback Process	• End-Semester Feedback
Reference Material	• Vic (J.R.) Winkler, Securing The Cloud: Cloud Computing Security Techniques and Tactics, Syngress/Elsevier • Thomas Erl, Cloud Computing Design Patterns, Prentice Hall, • Lawrence C. Miller, CISSP, Network Security in Virtualized Data Centers For Dummies, John Wiley & Sons, 2012 • DCIM For Dummies, Nlyte Special Edition, John Wiley & Sons Inc • Raghu YeluriEnrique Castro-Leon, Building the Infrastructure for Cloud Security A Solutions view, Apress, 2014 • Helmut Krcmar,Ralf Reussner,Bernhard Rumpe(Editors), Trusted Cloud Computing , Springer, 2014 • William Stallings, Cryptography and network security: principles and practice, - Prentice Hall – 2003 • Transaction papers, Blogs and White papers

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Database Management
Course Code: CDC 606	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:** Familiarity in developing application using any high level language
Synopsis:	1. This course introduces the student to the concept of data management in the applications developed for cloud technology 2. The course illustrates the evolution of database from file system to RDBMS to NoSQL 3. Course focusses on topics related to design and usage of RDBMS, and No SQL 4. Bring awareness about distributed database system
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Understand the concepts of DBMS, Relational data model, steps involved in design the RDBMS system and No SQL system.
CO 2:	Demonstrate the design concepts and implement the database using the concepts if ER Diagram, logical design, SQL query execution and Query optimization techniques.
CO 3:	Understand the principles of Distributed Databases, concept of No SQL and related classifications and categories

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*									
CO 2					*						
CO 3	*	*									

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Evolution of Database - Introduction to Cloud Database – Data Lake - Database as a Service – Type of Data w.r.t Big Data - Type of Cloud Databases – Introduction to NOSQL – NOSQL vs SQL – Structured, Semi structured, Unstructured data.	At the end of the topic student should be able to: 1. Illustrate the evolution of database systems over the time and also look through the Big Data's perspective (C2)
Unit 2: Introduction to DBMS	
File Systems Organization - Sequential, Pointer, Indexed, Direct - Purpose of Database System- Database System Terminologies-Database characteristics- Data models – Types of data models – Components of DBMS- Relational Algebra. | Logical database design: Relational DBMS - Codd's Rule - Entity-Relationship model - Extended ER Normalization – Functional Dependencies, Anomaly- 1NF to 5NF- Domain Key Normal Form – Denormalization.	1. Learn the basics of DBMS, DBMS based application design steps, ER Diagram(C2) 2. Discuss the demonstrate the concepts of Normalization, Domain Constraints to be used on Logical model of Relational database, and SQL (C2) 3. Introduce Query processing and query optimization techniques(C2,C4) 4. Illustrate the key steps in design and developing the application using Database using decoupled layered approach for the Cloud operations (C4)
Unit 3: SQL & Query Optimization	
SQL Standards - Data types - Database Objects- DDL-DML-DCL-TCL-Embedded SQL-Static Vs Dynamic SQL - Query Optimization: Query Processing and Optimization - Heuristics and Cost Estimates in Query Optimization.	1. Describe and Discuss SQL query processing steps and optimization approaches.(C2)
Unit 4: Transaction Processing and Concurrency Control	
Introduction-Properties of Transaction-Serializability- Concurrency Control – Locking Mechanisms- Two Phase Commit Protocol-Dead lock.	1. Illustrate the necessity of Transaction management(C2). 2. Define the locking mechanism used in concurrency control (C2)
Unit 5: Cloud Databases	
Types of NOSQL Databases - CAP Theorem - Key-value stores - Document stores - Column stores – Graph	1. Discuss the Types of No SQL databases, CAP theorem and different categories on No SQL databases (C2) 2. Design and Develop an application using the No SQL DB (C4)

Unit 6: Distributed Database System	
Introduction to Distributed Database Systems – Concurrency – Implementation - Performance and security issues.	1. Outline Distributed Database Systems (C1) 2. Summarize the performance and security issues of distributed systems (C2)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2		*	*		
Assignment/Presentation					
End Semester Examination	*	*	*		

Feedback Process	• End-Semester Feedback
Reference Material	• Abraham Silberschatz, Henry F. Korth and S. Sudharshan, Database System Concepts, Sixth Edition, Tata Mc Graw Hill, 2011. • C.J.Date, A.Kannan and S.Swamynathan, An Introduction to Database Systems, Eighth, Edition, Pearson Education, 2006. • Atul Kahate, Introduction to Database Management Systems, Pearson Education, New Delhi, 2006. • Alexis Leon and Mathews Leon, Database Management Systems, Vikas Publishing House Private Limited, New Delhi, 2003. • Raghu Ramakrishnan, Database Management Systems, Fourth Edition, Tata Mc Graw Hill, 2010. • G.K.Gupta, Database Management Systems, Tata Mc Graw Hill, 2011. • Rob Cornell, Database Systems Design and Implementation, Cengage Learning, 2011. • John W. Rittinghouse, James F. Ransome, Cloud Computing: Implementation, Management, and Security, CRC Press, 2009 • Lee Chao, Cloud Database Development and Management, Auerbach Publications, 2013 • Pramod J Sadalage and Martin Fowler, NoSQL Distilled, Addison-Wesley Publisher, 2012. • Ian Robinson , Jim Webber , Emil Elfrem, "Graph Databases",O'reilly Media, • Articles, White papers and Transaction Papers

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Big Data and Data Visualization Lab
Course Code: BDA-614L	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First year, Semester 2
No of Credits: 1	**Prerequisites:** Programming in Python or Java
Synopsis:	1. Students learn to handle big data in distributed computing architecture. 2. Installation and working on Hadoop and ecosystem 3. Build machine learning Models 4. Processing of data stream 5. Choose proper data visualization techniques
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Handle big data using Hadoop and its ecosystems.
CO 2:	Building machine learning algorithm using Spark.
CO 3:	Data Cleaning and Data Visualization.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*	*		*	*					
CO 2	*	*	*	*	*	*			*	*	
CO 3	*	*	*	*	*	*		*			

Course content and outcomes:	
Content	***Competencies***
Unit 1: Big Data	
Introduction to Hadoop. Data Analysis using Hadoop ecosystems	At the end of the topic student should be able to: 1. Installation of Hadoop and Spark distributed systems. (C4) 2. Reading and writing data into HDFS (C2). 3. Develop scripts to transfer structured data from SQL database to HDFS. (C3) 4. Develop script to query the data from HDFS using Hive. (C4)
Unit 2: Machine Learning	
Machine Learning in Big Data. Stream processing in Big Data.	1. Design a model using K-means classifier to predict how well products are accepted by the clients (C4). 2. Develop applications using Stream processing in big data (C4).
Unit 3: Data Visualization	
Video encoding and processing techniques.	1. Design programs to dynamically extract data from web. (C4) 2. Develop visualization application for time series data. (C4) 3. Develop visualization application for statistical distributions. (C4) 4. Develop visualization application for maps, Hierarchical data and network data. (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*	*	
Sessional Examination 2		*	*
Assignment/Presentation	*	*	*
Laboratory Examination	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• T. Hastie, R. Tibshirani and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer, 2nd Edition, 2009 • Machine Learning for Big Data, Jason Bell, Wiley Big Data Series • Big Data: Principles and best practices of scalable real-time data systems - Nathan Marz and James Warren. Manning Publisher. • Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale – Tom White, O'Reilly Publication 4th Edition. • Spark: The Definitive Guide: Big Data Processing Made Simple – Bill Chambers, Matei Zaharia, O'Reilly Publication 1st Edition

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Networks Lab
Course Code: CDC-604L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 1	**Prerequisites:** Basic understanding of Network concepts
Synopsis:	This Course provides insight on 1. The basic understanding of cloud network concepts. 2. The basic knowledge about cloud data centre networking. 3. The understanding of Storage Area Networks. 4. The concept of Software defined Radios. 5. The knowledge about the content delivery networks.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Illustrate cloud networking components, different networking types.
CO 2:	Demonstrate the concept of storage area networks.
CO 3:	Demonstrate the concept of software defined radios and content delivery networks.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*			*						
CO 2	*		*								
CO 3	*				*						

Course content and outcomes:	
Content	***Competencies***
Unit 1:	
Introduction to Networks	At the end of the topic student should be able to: 1. Illustrate cloud network terminologies and components (C2) 2. Explain the different types of Networking in IEEE standards (C2)
Unit 2:	
Storage Area Networks	1. Illustrate NAS architecture (C2) 2. Model Data protection policies (C2)
Unit 3:	
Software Defined Radios and Content delivery network	1. Illustrate simple SDN architecture (C2)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs				
Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination 1	*	*		
Sessional Examination 2			*	*
Assignment/Presentation		*		*
Laboratory Examination	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Rajkumar Buyya, Caesar Wu, Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center, Elseiver • Thomas D. Nadeau, Ken Gray, SDN Software Defined Networks, O'Reilly Media • William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud With contributions by: Florence Agboma, British Sky Broadcasting, Sofiene Jelassi, Pearson Publications. • Gilbert Held, A practical guide to content delivery networks, 2nd edition, CRC Press. • Dom Robinson, Content delivery networks: fundamentals, design, and evolution, John Wiley & Sons, 2017.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Security Lab
Course Code: CDC-605L	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits:1	**Prerequisites:** Network security, Networking Basics, Programming Basics
Synopsis:	This Course provides insight on 1. Cryptographic fundamentals like CIA triad, encryption standards, Key management techniques, hashing. 2. Security Issues to be considered in cloud architecture. 3. Design principles of cloud security.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Identify fundamentals of cloud computing architectures based on current standards, protocols, and best practices.
CO 2:	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud and evolve appropriate safeguards and countermeasures.
CO 3:	Design Cloud security architectures that assures secure isolation of compute, network and storage infrastructures, comprehensive data protection, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates.
CO 4:	Cloud computing security guidelines set forth by ISO, NIST, ENISA and Cloud Security Alliance (CSA)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*		*		*						
CO 2	*		*		*						
CO 3	*		*		*						
CO 4	*		*		*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: Monoalphabetic substitution cipher	
Implementation of Monoalphabetic substitution cipher in Java/Python/C	At the end of the topic student should be able to: 1. Practice the Implementation of Monoalphabetic substitution cipher. (C3)
Unit 2: Caesurae cipher/Additive substitution cipher	
Implementation of Caesurae cipher/Additive substitution cipher in Java/Python/C	1. Practice the Implementation of Caesurae cipher/Additive substitution cipher. (C3)
Unit 3: Brute Force Crypt Analysis of Caesurae Cipher	
Implementation of Brute Force Crypt Analysis of Caesurae Cipher in Java/Python/C	1. Practice the Implementation of Brute Force Crypt Analysis. (C3)
Unit 4: Play fair cipher	
Implementation of Play fair cipher in Java/Python/C	1. Practice the Play fair cipher. (C3)
Unit 5: Vernam cipher	
Implementation of Vernam cipher in Java/Python/C	1. Practice the Implementation of Vernam cipher. (C3)
Unit 6: Hill cipher	
Implementation of Hill cipher in Java/Python/C	1. Practice the Implementation of Hill cipher. (C3)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs				
Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination 1	*	*		
Sessional Examination 2			*	
Assignment	*	*	*	
Laboratory examination	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	References: • Vic (J.R.) Winkler, Securing The Cloud: Cloud Computing Security Techniques and Tactics, Syngress/Elsevier • Thomas Erl, Cloud Computing Design Patterns, Prentice Hall, • Lawrence C. Miller, CISSP, Network Security in Virtualized Data Centers For Dummies, John Wiley & Sons, 2012 • DCIM For Dummies, Nlyte Special Edition, John Wiley & Sons Inc • Raghu YeluriEnrique Castro-Leon, Building the Infrastructure for Cloud Security A Solutions view, Apress, 2014 • Helmut Krcmar,Ralf Reussner,Bernhard Rumpe(Editors), Trusted Cloud Computing , Springer, 2014 • William Stallings, Cryptography and network security: principles and practice, - Prentice Hall – 2003 • Transaction papers, Blogs and White papers

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Cloud Database Management Lab
Course Code: CDC-606L	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits: 1	**Prerequisites:** Familiarity in developing application using any high level language

Synopsis:	1. This course introduces the student to the concept of data management in the applications developed for cloud technology 2. The course illustrates the evolution of database from file system to RDBMS to NoSQL 3. Course focusses on topics related to design and usage of RDBMS, and No SQL 4. Bring awareness about distributed database system
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Demonstrate the concepts of DBMS, Relational data model, steps involved in design the RDBMS system and No SQL system.
CO 2:	Demonstrate the design concepts and implement the database using the concepts if ER Diagram, logical design, SQL query execution and Query optimization techniques.
CO 3:	Illustrate the concept of No SQL and related classifications and categories and Demonstrate the usage of knowledge through Application development using database.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1			*		*						
CO 2			*	*							
CO 3				*					*		

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction	
Evolution of Database - Introduction to Cloud Database – Data Lake - Database as a Service – Type of Data w.r.t Big Data - Type of Cloud Databases – Introduction to NOSQL – NOSQL vs SQL – Structured, Semi structured, Unstructured data.	At the end of the topic student should be able to: 1. Set up DB and set database tables. (C3).
Unit 2: Introduction to DBMS	
File Systems Organization - Sequential, Pointer, Indexed, Direct - Purpose of Database System- Database System Terminologies -Database characteristics- Data models – Types of data models – Components of DBMS - Relational Algebra. Logical database design: Relational DBMS - Codd's Rule - Entity-Relationship model - Extended ER Normalization – Functional Dependencies, Anomaly- 1NF to 5NF- Domain Key Normal Form – Denormalization.	1. Design the application involving database and try JDBC (tool used for Java or equivalent technique for other language) to connect to database through application (C4)
Unit 3: SQL & Query Optimization	
SQL Standards - Data types - Database Objects- DDL-DML-DCL-TCL-Embedded SQL-Static Vs Dynamic SQL - Query Optimization: Query Processing and Optimization - Heuristics and Cost Estimates in Query Optimization.	1. Execute basic queries and optimized queries (C3) 2. Develop the team with different modules / layer assigned to each member – namely control layer, business layer, data layer and assign appropriate tasks – to develop the loosely coupled application for cloud (C4)
Unit 4: Transaction Processing and Concurrency Control	
Introduction-Properties of Transaction- Serializability- Concurrency Control – Locking Mechanisms- Two Phase Commit Protocol-Dead lock.	1. Review the execution plan provided by the DB client for the SQL query execution (C4)
Unit 5: Cloud Databases	
Types of NOSQL Databases - CAP Theorem - Key-value stores - Document stores - Column stores – Graph	1. Setup and install the No SQL - (MongoDB)(C3) 2. Practice basic queries to interact with No SQL DB

Unit 6: Distributed Database Systems	
Introduction to Distributed Database Systems – Concurrency – Implementation - Performance and security issues.	1. Explore switch between RDBMS and MongoDB (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*		
Sessional Examination 2		*	*
Assignment/Presentation			
Laboratory examination	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Abraham Silberschatz, Henry F. Korth and S. Sudharshan, Database System Concepts, Sixth Edition, Tata Mc Graw Hill, 2011. • C.J.Date, A.Kannan and S.Swamynathan, An Introduction to Database Systems, Eighth, Edition, Pearson Education, 2006. • Atul Kahate, Introduction to Database Management Systems, Pearson Education, New Delhi, 2006. • Alexis Leon and Mathews Leon, Database Management Systems, Vikas Publishing House Private Limited, New Delhi, 2003. • Raghu Ramakrishnan, Database Management Systems, Fourth Edition, Tata Mc Graw Hill, 2010. • G.K.Gupta, Database Management Systems, Tata Mc Graw Hill, 2011. • Rob Cornell, Database Systems Design and Implementation, Cengage Learning, 2011. • John W. Rittinghouse, James F. Ransome, Cloud Computing: Implementation, Management, and Security, CRC Press, 2009 • Lee Chao, Cloud Database Development and Management, Auerbach Publications, 2013 • Pramod J Sadalage and Martin Fowler, NoSQL Distilled, Addison-Wesley Publisher, 2012. • Ian Robinson , Jim Webber , Emil Elfrem, "Graph Databases", O'reilly Media, • Articles, White papers and Transaction Papers

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Machine Learning for Big Data
Course Code: BDA 605	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:** Programming with Python and Data Visualization
Synopsis:	This Course provides insight on 1. This course provide the concept of neurons and biological motivation, activation functions and threshold units, supervised and unsupervised learning, perceptron network models in Artificial Neural Networks. 2. This course provide the knowledge about learning from unclassified data using clustering techniques. 3. This course provide the concept of Support Vector Machines for linear and non-linear classification. 4. This course provide the concept of Deep Learning and design of convolutional neural network for Deep Learning. 5. This course provide the knowledge about the applications and design of Reinforcement Learning algorithms.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe activation functions, weights and threshold units used in artificial neural networks, supervised and unsupervised learning, gradient descent approach, types of perceptron models, overfitting
CO 2:	Explain the concept of hierarchical clustering and non-hierarchical clustering, support vector machine, deep neural networks and reinforcement learning
CO 3:	Demonstrate artificial neural network models, clustering models, support vector classifier models, Deep learning models and reinforcement learning models
CO 4:	Compare and contrast single layer, multilayer and deep neural networks in terms of accuracy in classification
CO 5:	Design back propagation neural network, K-means and agglomerative clustering, deep neural network, reinforcement learning models and selection of a machine learning algorithm for the given data analysis.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2		*									
CO 3			*								
CO 4				*							
CO 5				*							

Course content and outcomes:	
Content	***Competencies***
Unit 1: Artificial Neural Networks	
Neurons and biological motivation, Activation functions and threshold units, Supervised and unsupervised learning, Perceptron Model: representational limitation and gradient descent training, Multilayer networks and back propagation, Overfitting	At the end of the topic student should be able to: 1. Relate biological neurons with artificial neurons and the motivation for ANN development. (C1) 2. Distinguish Supervised and unsupervised learning (C2). 3. Describe about error reduction techniques in used Artificial Neural Networks based learning (C2) 4. Write the usability of different activation functions for ANN learning system. (C3) 5. Describe the architecture of various perceptron networks. (C2)
Unit 2: Clustering	
Learning from unclassified data, Clustering. Hierarchical Agglomerative Clustering, Non- Hierarchical Clustering - k-means partitional clustering, Expectation maximization (EM) for soft clustering, Semi-supervised learning with EM using labelled and unlabelled data.	1. Write the different methods of learning from unclassified data (C3). 2. Explain the operations of various clustering models in machine learning (C5) 3. Describe the methods used for measuring dissimilarity between two clusters. (C2) 4. Apply clustering techniques for data analysis. (C3)
Unit 3: Kernel Methods	
Dual Representations, Design of Kernels.	1. Describe Dual Representations. (C2) 2. Explain the Kernel trick for learning non-linear functions (C5)

Unit 4: Support Vector Machines (SMV)	
Maximum margin linear separators, Quadratic programming solution to finding maximum margin separators, Kernels for learning non-linear functions, Varying length pattern classification using SVM	1. Describe about Maximum Margin and Support 2. Vector Machine. (C2) 3. Examine the advantages of maximum margin linear separators technique in SVM (C4) 4. Explain the Kernel trick for learning non-linear functions (C5) 5. Show the relation between two forms of representation of a hyperplane (C3)
Unit 5: Deep Learning	
Introduction to Deep Learning, Introduction to convolutional Neural Network (CNN), CNN Architecture and layers, Building simple CNN model for classification, Training and Testing the CNN model	1. Define Deep Learning. (C1) 2. Describe the applications of deep learning. (C2) 3. Explain the architecture of Deep Neural Network and CNN (C5) 4. Design a classifier for the image classification system. (C5)
Unit 6: Reinforcement Learning	
Characteristics, N-arm Bandit Problem, Calculating the Value Function, Associative Learning – Adding States, The Markov Property & Markov Decision Process	1. Explain the concept of Multi-Armed Bandit Problem (MABP). (C2) 2. Write the functions of Upper Confidence Bound (UCB) algorithm. (C3) 3. Outline the learning process and characteristics of reinforcement learning. (C4) 4. Explain about Markov decision process. (C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*	*		*
Sessional Examination 2	*	*	*	*	*
Assignment/Presentation	*	*	*	*	*
End Semester Examination	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• T. Mitchell, "Machine Learning", McGraw-Hill, 1997. • E. Alpaydin, "Machine Learning", MIT Press, 2010. • C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006. • R. Duda, E. Hart, and D. Stork, "Pattern Classification", Wiley Interscience, 2000. • Satish Kumar, "Neural Networks - A Class Room Approach", Second Edition, Tata McGraw-Hill, 2013. 1. T. Hastie, R. Tibshirani and J. Friedman," The Elements of Statistical Learning: Data Mining", Inference and Prediction, Springer, 2nd Edition, 2009. 2. Jason Bell, "Machine Learning for Big Data", Wiley Big Data Series, 2016. 3. J. Shawe-Taylor and N. Cristianini, "Kernel Methods for Pattern Analysis", Cambridge University Press, 2004. 4. S. Haykin, "Neural Networks and Learning Machines", Prentice Hall of India, 2010. 5. Rama Murthy G, "Multidimensional Neural Networks Unified Theory", New Age International, 2008. 11. F. Camastra and A. Vinciarelli, "Machine Learning for Audio, Image and Video Analysis – Theory and Applications", Springer, 2008.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Entrepreneurship
Course Code: ENP 601	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:**
Synopsis:	This course introduces students to the theory of entrepreneurship and its practical implementation. It focuses on different stages related to the entrepreneurial process, including business model innovation, monetization, small business management as well as strategies that improve performance of new business ventures. Cantered on a mixture of theoretical exploration as well as case studies of real-world examples and guest lectures, students will develop an understanding of successes, opportunities and risks of entrepreneurship. This course has an interdisciplinary approach and is therefore open to students from other Majors.
Course Outcomes (COs):	On successful completion of this course, students will be able to:
CO 1:	To impart knowledge on the basics of entrepreneurial skills and competencies to provide the participants with necessary inputs for creation of new ventures.
CO 2:	To familiarize the participants with the concept and overview of entrepreneurship with a view to enhance entrepreneurial talent
CO 3:	To appraise the entrepreneurial process starting with pre-venture stage
CO 4:	To Create and exploit innovative business ideas and market opportunities
CO 5:	To Build a mind-set focusing on developing novel and unique approaches to market opportunities
CO 6:	To explore new vistas of entrepreneurship in 21st century environment to generate innovative business ideas through case studies.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2				*							
CO 3			*								
CO 4						*					
CO 5								*			
CO 6										*	

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction to Entrepreneurship	
Meaning and Definition of Entrepreneurship-Employment vs Entrepreneurship, Theories of Entrepreneurship, approach to entrepreneurship, Entrepreneurs VS Manager	At the end of the topic student should be able to: 1. Explain the meaning of Entrepreneurship (C1) 2. Discuss the theories of Entrepreneurship (C1) 3. Discuss the approaches to Entrepreneurship (C1)
Unit 2: Entrepreneurial Traits	
Personality of an entrepreneur, Types of Entrepreneurs	1. Discuss the Personality traits of entrepreneurs. (C2)
Unit 3: Process of Entrepreneurship	
Factors affecting Entrepreneurship process	1. Identify the fundamentals and responsibilities of entrepreneurship (C2) 2. Exemplify one's capabilities in relation to the rigors of successful ventures (C3) 3. Identify and differentiates the different characteristics and competencies of an entrepreneurs (C2)
Unit 4: Business Start-up Process	
Idea Generation, Scanning the Environment, Macro and Micro analysis	1. Explain the Process of Business start up (C1) 2. Develop creativity and critical thinking in identifying opportunities (C5) 3. Apply innovative approaches in envisioning ones entrepreneurial career (C3)
Unit 5: Business Plan writing	
Points to be considered, Model Business plan	1. Identify different business models (C3) 2. Describe different parts of a business plan(C2)
Unit 6: Case studies	
Indian and International Entrepreneurship	1. Perform self-assessment and analyse entrepreneurial personal traits and competencies (C4) 2. Evaluate oneself and plan courses of action to help develop one's entrepreneurial characteristics and competencies. (C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	C0 6
Sessional Examination 1	*	*				
Sessional Examination 2			*	*		
Assignment/Presentation					*	*
End Semester Examination	*	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• NVR Naidu and T. Krishna Rao, “Management and Entrepreneurship”, IK International Publishing House Pvt. Ltd 2008. • Mohanthy Sangram Keshari, “Fundamentals of Entrepreneurship”, PHI Publications, 2005 • Butler, D. (2006). Enterprise planning and development. USA: Elsevier Ltd. Gerber, M.E. (2008) Awakening the entrepreneur within. NY: Harper Collins.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	IT Project Management
Course Code: CSE 631	**Course Instructor:**
Academic Year: 2020 – 2021	**Semester:** First Year, Semester 2
No of Credits: 3	**Prerequisites:** Familiarity in developing application using any high level language
Synopsis:	This Course provides insight on 1. The concept of software development process and project management 2. Illustrates the difference between a lab assignment and group project 3. Help the students to understand the finer points of Project management 4. Bring awareness about the processes, tools and techniques involved in the field of IT project management
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Illustrate the importance of project planning.
CO 2:	Discuss and demonstrate various tools applicable for different phases of the software project.
CO 3:	Illustrate the importance of Change management.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*	*									
CO 2		*	*								
CO 3	*		*								

Course content and outcomes:	
Content	***Competencies***
Unit 1: Software Project Planning	
Understand the Project Needs, Create the Project Plan, Diagnosing Project Planning Problems	At the end of the topic student should be able to: 1. Understand the project needs, necessity of plan, Define the Project Plan, Diagnosing Project Planning Problems (C1)
Unit 2: Estimation	
Elements of a Successful Estimate, Wideband Delphi Estimation, Other Estimation Techniques, Diagnosing Estimation Problems.	1. List the importance of estimation and describe different estimation techniques (C2) 2. Discuss the significance of Reviews and different review techniques (C2)
Unit 3: Project Schedules	
Building the Project Schedule, Managing Multiple Projects, Use the Schedule to Manage Commitments, Diagnosing Scheduling Problems.	1. Outline the steps in building project schedule.(C1) 2. Indicate mechanism of managing multiple projects. (C2)
Unit 4: Reviews	
Inspections, Deskchecks, Walkthroughs, Code Reviews, Pair Programming, Use Inspections to Manage Commitments, Diagnosing Review Problems.	1. Discuss the significance of Reviews and different review techniques (C2)
Unit 5: Software Requirements	
Requirements Elicitation, Use Cases, Software Requirements Specification, Change Control, Introduce Software Requirements Carefully, Diagnosing Software Requirements Problems	1. Introduce to requirement elicitation techniques, design and demonstrate the requirement documentation by field visits(C2)
Unit 6: Design and Programming	
Review the Design, Version Control with Subversion, Refactoring, Unit Testing, Use Automation, Be Careful with Existing Projects, Diagnosing Design and Programming Problems	1. Illustrate the key steps in design and programming phase. Version control and unit testing significance (C3)
Unit 7: Software Testing	
Test Plans and Test Cases, Test Execution, Defect Tracking and Triage, Test Environment and Performance Testing, Smoke Tests, Test Automation, Postmortem Reports, Using Software	1. Define the test plans, significance of test phase and the test case characteristics. Introduce different types testing and significance of type of testing.(C2)

Testing Effectively, Diagnosing Software Testing Problems	
Unit 8: Understanding Change	
Why Change Fails, How to Make Change Succeed	1. Illustrate the necessity of Change management system – developing impact analysis document and its importance (C3).
Unit 9: Management and Leadership	
Take Responsibility, Do Everything Out in the Open, Manage the Organization, Manage Your Team	1. Understand the role of management in motivating the team, finer points of managing the team (C2)
Unit 10: Managing an Outsourced Project	
Prevent Major Sources of Project Failure, Management Issues in Outsourced Projects, Collaborate with the Vendor	1. Describe the differences of managing the outsourced project, typical point of conflicts(C2) 2. Review of the project management process (C2)
Unit 10: Process Improvement	
Life Without a Software Process, Software Process Improvement, Moving Forward	1. Analyse the projects without process and continuous process improvements initiatives needed for success of the project (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	30	60
Quiz	02	04
Small Group Discussion (SGD)	02	02
Self-directed learning (SDL)	-	04
Problem Based Learning (PBL)	02	04
Case Based Learning (CBL)	-	-
Revision	02	-
Assessment	06	-
TOTAL	**44**	**74**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2	*		*		
Assignment/Presentation	*	*			
End Semester Examination	*	*	*		

Feedback Process	• End-Semester Feedback
Reference Material	• "Applied Software Project Management" By Jennifer Greene, Andrew Stellman (O'Reilly Publications) 2005. • "The Art of Project Management" By Scott Berkun (O'Reilly Publications) 2005.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Machine Learning for Big Data Lab
Course Code: BDA-605L	**Course Instructor:**
Academic Year: 2020-2021	**Semester:** First Year, Semester 2
No of Credits: 1	**Prerequisites:** Programming with Python and Data Visualization

Synopsis:	This Course provides insight on
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Demonstrate activation functions, weights and threshold units in artificial neural networks
CO 2:	Demonstrate Artificial Neural Network, Clustering, Support Vector Machine, Deep Neural Network and Reinforcement Learning models
CO 3:	Analyse Artificial Neural Network, Clustering, Support Vector Machine, Deep Neural Network and Reinforcement Learning models
CO 4:	Compare and contrast single layer, multilayer and deep neural networks in terms of accuracy in classification
CO 5:	Design different types of artificial neural network models, clustering models, deep neural network models, reinforcement learning models

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*										
CO 2		*									
CO 3			*								
CO 4				*							
CO 5				*							

Course content and outcomes:	
Content	***Competencies***
Unit 1: Artificial Neural Networks	
Neurons and biological motivation. Activation functions and threshold units. Supervised and unsupervised learning Perceptron Model: representational limitation and gradient descent training. Multilayer networks and back propagation. Overfitting.	At the end of the topic student should be able to: 1. Demonstrate activation functions, weights and threshold units in artificial neural networks (C3) 2. Demonstrate ANN models (C3) 3. Design of ANN models for classification (C5) 4. Analyse the performance issues (C4)
Unit 2: Clustering	
Learning from unclassified data Clustering. Hierarchical Aglomerative Clustering. Non-Hierarchical Clustering- k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data.	1. Demonstrate various clustering models in machine learning (C3) 2. Design different types of clusters (C5) 3. Analyse the performance of clustering techniques on different data (C4) 4. Apply clustering techniques for data analysis. (C3)
Unit 3: Kernel Methods	
Dual Representations . Design of Kernels	1. Design of different kernel techniques (C5)
Unit 4: Support Vector Machines (SMV)	
Maximum margin linear separators. Quadractic programming solution to finding maximum margin separators. Kernels for learning non-linear functions. Varying length pattern classification using SVM	1. Demonstrate Maximum margin linear separators. (C3) 2. Design SVM classifiers (C5) 3. Analyse the performance of SVM (C4)
Unit 5: Deep Learning	
Introduction to Deep Learning Introduction to convolutional Neural Network (CNN) CNN Architecture and layers Building simple CNN model for classification Training and Testing the CNN model	1. Develop Deep Neural Network/ CNN (C5) 2. Design a classifier for the image classification system. (C5) 3. Compare performance of CNN and ANN for image classification (C4)
Unit 6: Reinforcement Learning	
Characteristics, N-arm Bandit Problem Calculating the Value Function Associative Learning – Adding States The Markov Property & Markov Decision Process	1. Apply reinforcement learning model using different principles (C3) 2. Analyse various reinforcement learning techniques (C4) 3. Design of reinforcement learning models (C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test - yes	Sessional examination
Theory Assignments	End semester examination - yes
Lab Assignment & Viva - yes	Viva

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination 1	*	*			
Sessional Examination 2			*	*	
Assignment/Presentation			*	*	*
Laboratory examination			*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Machine Learning, T. Mitchell, McGraw-Hill, 1997 • Machine Learning, E. Alpaydin, MIT Press, 2010 • Pattern Recognition and Machine Learning, C. Bishop, Springer, 2006 • Pattern Classification, R. Duda, E. Hart, and D. Stork, Wiley-Interscience, 2000 • Neural Networks - A Class Room Approach, Satish Kumar, Second Edition, Tata McGraw-Hill, 2013 • The Elements of Statistical Learning: Data Mining, Inference and Prediction, T. Hastie, R. Tibshirani and J. Friedman, Springer, 2nd Edition, 2009 • Machine Learning for Big Data, Jason Bell, Wiley Big Data Series • Kernel Methods for Pattern Analysis, J. Shawe-Taylor and N. Cristianini, Cambridge University Press, 2004 • Neural Networks and Learning Machines, S. Haykin, Prentice Hall of India, 2010 • Multidimensional Neural Networks Unified Theory, Rama Murthy G • F.Camastra and A.Vinciarelli, Machine Learning for Audio, Image and Video Analysis – Theory and Applications, Springer, 2008

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Entrepreneurship Lab
Course Code: ENP-601L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 1	**Prerequisites:** -
Synopsis:	1. This course introduces students to the theory of entrepreneurship and its practical implementation. 2. It focuses on different stages related to the entrepreneurial process, including business model innovation, monetization, small business management as well as strategies that improve performance of new business ventures. 3. Cantered on a mixture of theoretical exploration as well as case studies of real-world examples and guest lectures, students will develop an understanding of successes, opportunities and risks of entrepreneurship. 4. This course has an interdisciplinary approach and is therefore open to students from other Majors.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Understand the concept of entrepreneurship
CO 2:	To appraise the entrepreneurial process starting with pre-venture stage through group discussion
CO 3:	To Build a mind-set focusing on developing novel and unique approaches to market opportunities by considering case studies and understand the complete flow of entrepreneurship

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*					*		*			
CO 2						*					
CO 3								*		*	

Course content and outcomes:	
Content	***Competencies***
Unit 1: Introduction to Entrepreneurship	
Meaning and Definition of Entrepreneurship-Employment vs Entrepreneurship, Theories of Entrepreneurship, approach to entrepreneurship, Entrepreneurs VS Manager	At the end of the topic student should be able to: 1. Discuss the theories of Entrepreneurship (C1) 2. Discuss the approaches to Entrepreneurship (C1)
Unit 2: Process of Entrepreneurship	
Factors affecting Entrepreneurship process	1. Exemplify one's capabilities in relation to the rigors of successful ventures (C3) 2. Identify and differentiates the different characteristics and competencies of an entrepreneurs (C2)
Unit 3: Business Plan writing	
Points to be considered, Model Business plan	1. Identify different business models (C3) 2. Describe different parts of a business plan(C2)
Unit 4: Case studies	
Indian and International Entrepreneurship	1. Perform self-assessment and analyse entrepreneurial personal traits and competencies (C4) 2. Evaluate oneself and plan courses of action to help develop one's entrepreneurial characteristics and competencies. (C5)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with Cos			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*	*	
Sessional Examination 2			*
Assignment/Presentation		*	*
Laboratory Examination	*	*	*

Feedback Process	• Mid-Semester feedback • End-Semester Feedback
Reference Material	1. NVR Naidu and T. Krishna Rao, "Management and Entrepreneurship", IK International Publishing House Pvt. Ltd 2008. *2.* Mohanthy Sangram Keshari, "Fundamentals of Entrepreneurship", PHI Publications, 2005 *3.* Butler, D. (2006). Enterprise planning and development. USA: Elsevier Ltd. Gerber, M.E. (2008) Awakening the entrepreneur within. NY: Harper Collins.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	IT Project Management Lab
Course Code: CSE-631L	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 1	**Prerequisites:** Familiarity in developing application using any high level language
Synopsis:	This Course provides insight on 1. The concept of software development process and project management 2. Illustrates the difference between a lab assignment and group project 3. Help the students to understand the finer points of Project management 4. Bring awareness about the processes, tools and techniques involved in the field of IT project management.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Practice the project development through project planning.
CO 2:	Understand the finer points of Project management.
CO 3:	Bring awareness about the processes, tools and techniques involved in the field of IT project management.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1			*	*							
CO 2					*				*		
CO 3			*		*						

Course content and outcomes:	
Content	***Competencies***
Unit 1: Software Project Planning	
Understand the Project Needs, Create the Project Plan, Diagnosing Project Planning Problems.	At the end of the topic student should be able to: 1. Discussion on tools needed for project management (C3)
Unit 2: Estimation	
Elements of a Successful Estimate, Wideband Delphi Estimation, Other Estimation Techniques, Diagnosing Estimation Problems.	1. Download and demonstrate the tools typically used for UML design. (C3)
Unit 3: Project Schedules	
Building the Project Schedule, Managing Multiple Projects, Use the Schedule to Manage Commitments, Diagnosing Scheduling Problems.	1. Design the application through the UML tool practiced (C4) 2. Develop the team with different roles assigned to each member – namely project manager, developer, tester and assign appropriate tasks (C4)
Unit 4: Reviews	
Inspections, Deskchecks , Walkthroughs, Code Reviews, Pair Programming, Use Inspections to Manage Commitments, Diagnosing Review Problems.	1. Develop basic set of programs and to illustrate the unit tests (C2)
Unit 5: Software Requirements	
Requirements Elicitation, Use Cases, Software Requirements Specification, Change Control, Introduce Software Requirements Carefully, Diagnosing Software Requirements Problems	1. Field visit to develop and practice the requirement elicitation (C3)
Unit 6: Design and Programming	
Review the Design, Version Control with Subversion, Refactoring, Unit Testing, Use Automation, Be Careful with Existing Projects, Diagnosing Design and Programming Problems	2. Illustrate the key steps in design and programming phase. Version control and unit testing significance (C3) 3. Review of various artefacts generated by project and revise the project management methodology to the team (C5)
Unit 7: Software Testing	
Test Plans and Test Cases, Test Execution, Defect Tracking and Triage, Test Environment and Performance Testing, Smoke Tests, Test Automation,	1. Inter team testing set up based on requirement document(C5)

Postmortem Reports, Using Software Testing Effectively, Diagnosing Software Testing Problems	
Unit 8: Understanding Change	
Why Change Fails, How to Make Change Succeed	1. Illustrate the necessity of Change management system – SVN hands on (C3).
Unit 9: Management and Leadership	
Take Responsibility, Do Everything Out in the Open, Manage the Organization, Manage Your Team	2. Discussion on the topic with the help of case study (C3)
Unit 10: Managing an Outsourced Project	
Prevent Major Sources of Project Failure, Management Issues in Outsourced Projects, Collaborate with the Vendor	1. Discussion on the topic with the help of case study (C3)
Unit 11: Process Improvement	
Life Without a Software Process, Software Process Improvement, Moving Forward	1. Post-mortem report generation of respective project by each team – review of the report and suggest areas of improvement (C4)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	12	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	03	-
Clinic	-	-
Practical	24	-
Revision	03	-
Assessment	06	-
TOTAL	**48**	**-**

Assessment Methods:	
Formative:	**Summative:**
Internal practical Test	Sessional examination
Theory Assignments	End semester examination
Lab Assignment & Viva	Viva

Mapping of assessment with COs			
Nature of assessment	CO 1	CO 2	CO 3
Sessional Examination 1	*	*	
Sessional Examination 2			*
Assignment/Presentation	*		
Laboratory Examination	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• "Applied Software Project Management" By Jennifer Greene, Andrew Stellman (O'Reilly Publications) 2005. • "The Art of Project Management" By Scott Berkun (O'Reilly Publications) 2005.

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Mini Project - 2
Course Code: CDC 696	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 4	**Prerequisites:** Any programming language and circuit basics
Synopsis:	Students are expected to select a problem in the area of their interest and the area of their specialization that would require an implementation in hardware / software or both in a semester
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Apply the objectives of the project work and provide an adequate background with a detailed literature survey
CO 2:	Breakdown the project into sub blocks with sufficient details to allow the work to be reproduced by an independent researcher
CO 3:	Compose hardware/software design, algorithms, flowchart, methodology, and block diagram
CO 4:	Evaluate the results
CO 5:	Summarize the work carried out

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1				*							
CO 2					*			*			
CO 3							*			*	
CO 4						*					*
CO 5							*				

Course content and outcomes:	
Content	***Competencies***
Phase 1	
Problem identification, synopsis submission, status submission, mid evaluation.	At the end of the topic student should be able to: 1. Identify the problem/specification (C1) 2. Discuss the project (C2) 3. Prepare the outline (C3) 4. Describe the status of the project (C2) 5. Prepare a mid-term project presentation report (C3) 6. Prepare and present mid-term project presentation slides (C3, C5) 7. Develop project implementation in hardware/software or both in chosen platform (C5)
Phase 2	
Status submission, final evaluation.	1. Prepare the progress report (C3) 2. Prepare the final project presentation report (C3) 3. Prepare and present final project presentation slides (C3, C5) 4. Modify and Develop implementation in hardware/software or both in chosen platform (C3, C5) 5. Justify the methods used and obtained results (C6)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	48	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	03	-
TOTAL	**51**	**09**

Assessment Methods:	
Formative:	**Summative:**
Project Problem Selection	Mid-Term Presentation
Synopsys review	Second status review
First status review	Demo & Final Presentation

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Mid Presentation	*	*			
Presentation	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Particular to the chosen project

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Seminar - 2
Course Code: CDC 698	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** First Year, Semester 2
No of Credits: 1	**Prerequisites:** Communication Skill
Synopsis:	1. To select, search and learn technical literature. 2. To identify a current and relevant research topic. 3. To prepare a topic and deliver a presentation. 4. To develop the skill to write a technical report. 5. Develop ability to work in groups to review and modify technical content.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Show competence in identifying relevant information, defining and explaining topics under discussion.
CO 2:	Show competence in working with a methodology, structuring their oral work, and synthesizing information.
CO 3:	Use appropriate registers and vocabulary, and will demonstrate command of voice modulation, voice projection, and pacing.
CO 4:	Demonstrate that they have paid close attention to what others say and can respond constructively.
CO 5:	Develop persuasive speech, present information in a compelling, well-structured, and logical sequence, respond respectfully to opposing ideas, show depth of knowledge of complex subjects, and develop their ability to synthesize, evaluate and reflect on information.

Mapping of COs to POs											
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1	*							*	*		*
CO 2	*							*	*		*
CO 3	*							*	*		*
CO 4	*							*	*		*
CO 5	*							*	*		*

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	14	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
TOTAL	**14**	**-**

Assessment Methods:	
Formative:	**Summative:**
Seminar Topic Selection	
Synopsys review	
PPT Review	

Mapping of assessment with Cos					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Presentation	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Particular to the chosen Seminar

Name of the Program:	Master of Engineering - ME (Cloud Computing)
Course Title:	Project Work
Course Code: CDC 799	**Course Instructor:**
Academic Year: 2020 - 2021	**Semester:** Second Year, Semester 3, 4
No of Credits: 25	**Prerequisites:** SDLC, Communication Skills, technical skills.

Synopsis:	1. The project work aims to challenge analytical, creative ability and to allow students to synthesize, apply the expertise and insight learned in the core discipline. 2. Students build self-confidence, demonstrate independence, and develop professionalism on successfully completion of the project.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	To be acquainted with working environment and processes that in place at the relevant Industries.
CO 2:	To familiarize the challenges as relevant professionals.
CO 3:	Review the literature and develop solutions for real time on-board projects.
CO 4:	Write technical report and deliver presentation.
CO 5:	Apply engineering and management principles to achieve project goal.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*
CO 1						*	*	*	*	*	*
CO 2					*						
CO 3	*	*	*	*	*						
CO 4	*	*	*	*							
CO 5						*	*	*	*	*	*

Course content and outcomes:	
Content	***Competencies***
Phase 1:	
Problem identification, synopsis submission, status submission, mid evaluation.	At the end of the topic student should be able to: 1. Identify the problem/specification (C1) 2. Discuss the project (C2) 3. Prepare the outline (C3) 4. Prepare a mid-term project presentation report (C3) 5. Prepare and present mid-term project presentation slides (C3, C5) 6. Develop project implementation in hardware/software or both in chosen platform (C5)
Phase 2	
Status submission, final evaluation.	1. Prepare the progress report (C3) 2. Prepare the final project presentation report (C3) 3. Prepare and present final project presentation slides (C3, C5) 4. Modify and Develop implementation in hardware/software or both in chosen platform (C3, C5) 5. Justify the methods used and obtained results (C6)

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	-	-
Quiz	-	-
Small Group Discussion (SGD)	14	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
TOTAL	**14**	**-**

Assessment Methods:	
Formative:	**Summative:**
Project Problem Selection	Mid-Term Presentation
Synopsys review	Second status review
First status review	Demo & Final Presentation

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Mid Presentation	*	*			
Presentation	*	*	*	*	*

Feedback Process	• End-Semester Feedback
Reference Material	• Particular to the chosen project

PROGRAM OUTCOMES (POS) AND COURSE OUTCOMES (COS) MAPPING

Sl.No.	Course Code	Course Name	Credits	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	CSE 601	Data Structures and Algorithms	3	*	*		*		*					
2	CSE 602	Real Time Operating Systems	3	*	*	*	*							
3	CDC 602	Cloud Architecture and Management	3	*	*	*		*	*	*	*	*	*	*
4	ESD 603	Cloud Application Development with Java	3	*	*	*		*						
5	CSE-628	Client Side Internet Technology	3	*	*			*						
6	BDA-601	Fundamentals of Machine Learning	3	*	*	*	*							
7	CDC-607	DevOps for Cloud	3	*	*	*		*						
8	CSE 601L	Data Structures and Algorithms Lab	1		*	*	*	*						
9	CSE 602L	Real Time Operating Systems Lab	1		*	*	*	*						
10	CDC 602L	Cloud Architecture and Management Lab	1		*	*	*	*						
11	CDC 603L	Cloud Application Development with Java Lab	1		*	*	*	*						
12	CSE-628L	Client Side Internet Technology Lab	1	*	*			*						
13	BDA-601L	Fundamentals of Machine Learning Lab	1	*	*	*	*							
14	CDC-607L	DevOps for Cloud Lab	1	*	*	*		*						
15	ESD 695	Mini Project - 1	4				*	*	*	*	*		*	*
16	ESD 697	Seminar - 1	1											
17	BDA 614	Big Data and Data Visualization	3	*	*	*	*			*				
18	CDC 604	Cloud Networks	3	*	*	*	*							

19	CDC 605	Cloud Security	3	*	*	*	*	*					*	
20	CDC 606	Cloud Database Management	3	*	*			*						
21	CSE-629	Server Side Internet Technology	3											
22	CSE-630	Data Warehousing and Data Mining	3											
23	BDA-605	Machine Learning for Big Data	3	*	*	*	*							
24	ENP-601	Entrepreneurship	3	*		*	*		*		*		*	
25	CSE-631	IT Project Management	3	*	*	*								
26	BDA 614L	Big Data and Data Visualization Lab	1		*	*	*	*						
27	CDC 604L	Cloud Networks Lab	1		*	*	*	*						
28	CDC 605L	Cloud Security Lab	1	*	*	*		*						
29	CDC 606L	Cloud Database Management Lab	1		*	*	*	*						
30	CSE-629L	Server Side Internet Technology Lab	1											
31	CSE-630L	Data Warehousing and Data Mining Lab	1											
32	BDA-605L	Machine Learning for Big Data Lab	1	*	*	*	*							
33	ENP-601L	Entrepreneurship Lab	1	*					*		*			
34	CSE-631L	IT Project Management Lab	1			*	*	*				*		
35	CDC 696	Mini Project - 2	4				*	*	*	*	*		*	*
34	CDC 698	Seminar - 2	1	*							*	*		*
35	CDC 799	Project Work	25	*	*	*	*	*	*	*	*	*	*	*