30.1.6

UNIVERSITY SCHOOL
OF
INFORMATION AND COMMUNICATION TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

PROGRAMME STRUCTURE

B.TECH. COMPUTER SCIENCE AND ENGINEERING
SPECIALIZATION IN MACHINE LEARNING
2021-2025

30.1.6
08.09.23

GAUTAM BUDDHA UNIVERSITY
GAUTAM BUDH NAGAR, GREATER NOIDA, UP, INDIA

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Gautam Buddha University
Greater Noida, (U.P.)

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SEMESTER I

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CS101	Fundamentals of Computer Programming	3	1	0	4	CC1 / FC
2	CM101	Fundamental of Machine Learning	2	0	0	2	CC2 / FC
3	MA101	Engineering Mathematics-I	3	1	0	4	GE1
4	PH102	Engineering Physics	3	1	0	4	GE2
5	EC101	Basic Electronics Engineering	3	1	0	4	GE3 / FC
6	EN101	English Proficiency	2	0	0	2	OE1 / AECC
7	CE103	Engineering Graphics Lab	1	0	2	2	GE-L1
8	CS181	Computer Programming Lab	0	0	2	1	CC-L1 / SEC
9	PH104	Engineering Physics Lab	0	0	2	1	GE-L2
10	EC181	Basic Electronics Engineering Lab	0	0	2	1	GE-L3
11	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**17**	**4**	**8**	**25**	

SEMESTER II

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM102	Introduction to Python	2	0	0	2	CC3 / FC
2	CM104	Computer Organistaion and Architecure	3	0	0	3	CC4 / SEC
3	MA102	Engineering Mathematics-II	3	1	0	4	GE4
4	EE102	Basic Electrical Engineering	3	1	0	4	GE5
5	ME101	Engineering Mechanics	3	1	0	4	GE6
6	ES101	Environmental Studies	3	1	0	4	OE2 / AECC
7	CM182	Python Programming Lab	0	0	2	1	CC-L2 / SEC
8	EE104	Basic Electrical Engineering Lab	0	0	2	1	GE-L4
9	ME102	Workshop Practice	1	0	2	2	GE-L5
10	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**16**	**4**	**6**	**25**	

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SEMESTER III

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM201	Internet Technology	3	0	0	3	CC5 / SEC
2	CM203	Operating Systems	3	0	0	3	CC6
3	CM205	Data Structure & Algorithms	3	0	0	3	CC7 / SEC
4	CM207	Computer Vision	3	0	0	3	CC8
5	CM209	Introduction to R Programming	3	0	0	3	CC9
6	MA201	Engineering Mathematics-III	3	1	0	4	GE7
7	CM281	R Programmiing Lab	0	0	3	2	CC-L3
8	CM283	Data Structure & Algorithms Lab	0	0	3	2	CC-L4 / SEC
9	CM285	Internet Technology Lab	0	0	3	2	CC-L5 / SEC
10	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**18**	**1**	**9**	**25**	

SEMESTER IV

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM202	Software Engineering	3	0	0	3	CC10
2	CM204	Database Management System	3	0	0	3	CC11 / SEC
3	CM206	Java Programming	3	0	0	3	CC12
4	CM208	Artificial Intelligence	3	0	0	3	CC13
5	CM210	Theory of Automata	3	0	0	3	CC14
6	CM212	Introduction to MATLAB	3	1	0	4	CC15 / SEC
7	CM282	Database Management System Lab	0	0	3	2	CC-L6 / SEC
8	CM284	Java Programming Lab	0	0	3	2	CC-L7 / SEC
9	CM286	MATLAB Lab	0	0	3	2	CC-L8 / SEC
10	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**18**	**1**	**9**	**25**	

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SEMESTER V

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM301	Compiler Design	3	0	0	3	CC16 / AECC
2	CM303	Soft Computing Techniques	3	0	0	3	CC17
3	CM305	Analysis and Design of Algorithms	3	0	0	3	CC18
4	CM307	Big Data Analytics	3	0	0	3	CC19
5	CM309	Machine Learning	3	1	0	4	CC20 / SEC
6		Elective 1	3	0	0	3	E1 / DSE
7	CM381	Analysis and Design of Algorithms Lab	0	0	3	2	CC-L9 / SEC
8	CM383	Big Data Analytics Lab	0	0	3	2	CC-L10 / SEC
9	CM385	Machine Learning Lab using Python	0	0	3	2	CC-L11 / SEC
10	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**18**	**1**	**9**	**25**	

SEMESTER VI

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM302	Machine Learning Operations	3	0	0	3	CC21
2	CM304	Deep Learning	3	0	0	3	CC22
3	CM306	Reinforcement Learning	3	1	0	4	CC23
4	CM308	Human Machine Interaction	3	0	0	3	CC24
5	CM310	Cloud Computing	3	0	0	3	CC25 / SEC
6		Elective 2	3	0	0	3	E2 / DSE
7	CM382	Machine Learning Operations Lab	0	0	3	2	CC-L12
8	CM384	Deep Learning Lab using Python	0	0	3	2	CC-L13
9	CM386	Reinforcement Learning Lab using Python	0	0	3	2	CC-L14
10	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**18**	**1**	**9**	**25**	

Industrial Training will be done by candidate individually after third year during the summer break and it will be of minimum 4 weeks. It will be evaluated as per University Examination in VII semester.

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SEMESTER VII

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM401	Parallel Processing and CUDA Programming	3	1	0	4	CC26
2	CM403	Data Visualization	3	0	0	3	CC27
3	CM405	Applied Machine Learning	2	0	0	2	CC28 / SEC
4		Elective 3	3	0	0	3	E3 / DSE
5		Elective 4	3	0	0	3	E4 / DSE
6	CM481	Applied Machine Learning Lab	0	0	3	2	CC-L15
7	CM491	Minor Project	0	0	10	5	MP1 / E
8	CM493	Industrial Traning	0	0	6	3	IT1 / E
9	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**14**	**1**	**19**	**25**	

SEMESTER VIII

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM490	Seminar	0	0	3	2	S / E
2	CM492	Major Project	0	0	16	8	MP2 / E
3	CM494	Intenship	0	0	30	15	I / E
4	GP	General Proficiency	Non Credit				
		Total Hours and Credits	**0**	**0**	**49**	**25**	

GRAND TOTAL OF CREDITS = 200

In the **Seminar**, student need to study and present individually, on latest research paper of their specialized area and It will be evaluated as per University Examination Rules.

The **Internship** in Industry will be done by candidate individually during the 8th semester and it will be for a minimum of 4 (-6) months. It will be evaluated as per University Examination Rules.

Minor and Major Project will be in a group and It will be evaluated as per University Examination Rules.

USICT will provide a mentor/supervisor for industrial training, seminar, internship, minor and major projects.

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ELECTIVES FROM DCSE

S.No.	Course Code	Course Name	L	T	P	Credits	Types
1	CM311	Computational Intelligence	3	0	0	3	E1
2	CM313	Stochastic Processes	3	0	0	3	E1
3	CM315	Data Mining	3	0	0	3	E1
4	CM317	Decision Thinking and Algorith Design	3	0	0	3	E1
5	CM319	Statistical Machine Learning	3	0	0	3	E1
6	CM312	Artificial Neural Networks	3	0	0	3	E2
7	CM314	Knowledge Engineering	3	0	0	3	E2
8	CM316	Graph Theory	3	0	0	3	E2
9	CM318	Expert Systems	3	0	0	3	E2
10	CM320	Fuzzy logic	3	0	0	3	E2
11	CM407	Computational Neuroscience	3	0	0	3	E3
12	CM409	Intelligent Machining	3	0	0	3	E3
13	CM411	Introduction to Brain and Neuroscience	3	0	0	3	E3
14	CM413	Digital Fabrication	3	0	0	3	E3
15	CM415	Internet of Things	3	0	0	3	E3
16	CM417	Digital Image Processing	3	0	0	3	E4
17	CM419	Ensemble learning	3	0	0	3	E4
18	CM421	Predictive Analysis	3	0	0	3	E4
19	CM423	Embedded Systems	3	0	0	3	E4
20	CM425	Machine Intelligence for Medical Image Analysis	3	0	0	3	E4

CM Computer Science & Engineering / Machine Learning for Course Code
CC Core Course from USICT for course type
GE General Elective from related discipline of other Deptt./School
GE L General Elective Lab from related discipline of other Deptt./School
OE Open Elective from other discipline of other Deptt./School
AECC Ability Enhancement Compulsary Course
DSE Discipline Specific Course
SEC Skill Enhancement Course
E Elective from USICT
CC-L Core Course Lab from USICT
IT1 Industrial Training
MP Minor / Major Project
S Seminar
I Internship

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COMPUTER VISION			
Course Code:	CM207	Course Credits:	3
Course Category:	CC	Course (U / P)	U
Course Year (U / P):	2U	Course Semester (U / P):	3U
No. of Lectures + Tutorials (Hrs./Week):	03 + 00	Mid Sem. Exam Hours:	1.5
Total No. of Lectures (L + T):	45 + 00	End Sem. Exam Hours:	3

COURSE OBJECTIVES

- To introduce students the major ideas.
- To Understand basic concepts of CV
- To develop an appreciation for various issues in the design of computer vision and object recognition system.
- Find and select appropriate data that can be used to create a visualization that answers a particular research question.
- For each individual statistical test students should be able to understand how it works

COURSE OUTCOMES

At the end of the course the students should be able to:

- identifybasicconcepts,terminology,theories,modelsandmethodsinthefieldofcomputer vision
- describe known principles of human visual system
- describebasicmethodsofcomputervisionrelatedtomulti-scalerepresentation,edgedetection anddetectionofotherprimitives,stereo,motionandobjectrecognition,
- suggest a design of a computer visions system for a specific problem

UNIT I Introduction to Computer Vision.

General introduction, History of CV, Required component, Useful application, Image acquisition using a camera, Different types of cameras for different domain- Stills, Video, DSLR, Bodycam, Drone, Color spaces: RGB, CMYK, HSV, Camera specifications: Pinhole, CMOS, CCD, Image specifications: Pixel (Picture element), Aspect ratio, HD, Interlacing, Type of digital images: Binary, Grayscale, Color, Conversion techniques.

UNIT II Image processing and Edge Detection

Noise Removal, salt and pepper noise, Pixel Neighborhood, Types of Filter: mean or Box filtering, median Filter, Generic properties of smoothing, Gaussian separability, Introduction to edges and gradient, Intensity difference, 1D versus 2D edge detection, Edge detection in mammals, 1D signals and 2D signals, Image Gradient, Image noise: Gaussian noise, Smoothing + Edge detection.

UNIT III Image Segmentation and features.

Image Segmentation and features, Thresholding based on histogram, formulation, Advancements, and effectiveness, Thresholding based on different metrics, covariance-based, Different types of background subtraction, mean, Euclidean, Mahalanobis, Clustering to Image Segmentation, Transform to color space.

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1.(CSE) Specialization: Machine Learning

UNIT IV Shape of Objects and Motion.

Medial axis, Boundary coding, Chain Coding, Shape Numbering, Bounding box, Principal Component Analysis, Eigen Values and Vectors, Finding Eigen sets, Simple motion, Image differentiation, Single constant threshold, Weighted aggregate, Hierarchical Motion Estimation, 3D motion of a point, Matrix operations for different motion in objects, 2D matrix motion, Translation Motion, Affine Motion, Spatial Pattern of where motion occurred.

UNIT V Feature Extraction and Camera Projection:

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT, Ambiguity in single, Geometry for simple stereo system View, depth and Calibration, Epipolar Geometry: Baseline, Epipole, Epipolar Line, Epipolar Plane.

Text and Reference Books:

[1] Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

[2] Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.\

[3] Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.

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INTRODUCTION TO MATLAB			
Course Code:	CM 212	Course Credits:	3
Course Category:	CC	Course (U / P)	U
Course Year (U / P):	2U	Course Semester (U / P):	4U
No. of Lectures + Tutorials (Hrs/Week):	03 + 00	Mid Sem. Exam Hours:	1
Total No. of Lectures (L + T):	45 + 00	End Sem. Exam Hours:	3
COURSE OBJECTIVES			
1. Create and troubleshoot basic m scripts.			
2. Create publishable, reproducible analysis reports.			
3. Confidently develop MATLAB M-files and save results of computations from a MATLAB session.			
4. . Use MATLAB to perform complex arithmetic			
5.Generate and plot signals and complex valued functions			
COURSE OUTCOMES			
At the end of the course the students should be able to:			
1. Utilize a methodical approach to identify, formulate, and solve computational problems.			
2. Comprehend MATLAB basics, branching and looping.			
3. Apply MATLAB in solving algebra calculus problems.			
4. Apply various techniques to solve and visualize engineering-related computational problems using MATLAB.			
5. Sketching of discrete and continuous time signals			

UNIT I: Introduction and Basics.
Importance of MATLAB, MATLAB environment, various toolboxes, using MATLAB as a calculator, Variables and arrays, operations on variables and arrays, matrix operations, displaying output data, introduction to plotting, data files, built-in MATLAB functions, user-defined function.

UNIT 2: Branching and Loops and 2D/3D Plots.
Relational and logic operators, branches, WHILE loops FOR loops, SWITCH, BREAK, CONTINUE, vectorization, MATLAB profiler, 2D plots, 3D plots, data distribution plots, polar plots, contour plots, surface plots .

UNIT 3: Numerical Methods and Structures.
Linear algebra and vector analysis, newton and bisection methods, numerical solution to ordinary differential equations, curve fitting, interpolation, least squares regression , Cell Arrays, structure arrays, string, sorting & searching, importing data into MATLAB, file Input / Output functions, working with the spreadsheet and low- level data file.

UNIT 4: Advanced Features
Graphical User Interfaces and GUIDE, application development, Simulink, MATLAB with cross language platforms

UNIT 5: Applications.
Optimization methods, Signal processing, image processing, machine learning, system-level modeling.

Text Books:

1. Matlab for Beginners: A Gentle Approach Peter I. Kattan 2008
2. Matlab for Newbies: The bare essentials,September 9,2015,by Siddharth Verma.
3. MATLAB Handbook with Applications to Mathematics, Science, Engineering, and Finance Jose Miguel David Baez-Lopez, David Alfredo

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MATLAB			
Course Code:	CM286	Course Credits:	2
Course Category:	CC	Course (U / P)	U
Course Year (U / P):	2U	Course Semester (U / P):	4U
No. of Lectures + Tutorials (Hrs/Week):	03+ 00	Mid Sem. Exam Hours:	
Total No. of Lectures (L + T):	10+ 00	End Sem. Exam Hours:	3

COURSE OBJECTIVES
1 To Impart the Knowledge to the students with MATLAB software.
2 To provide a working introduction to the Matlab technical computing environment..
3 To introduce students the use of a high-level programming language, Matlab..
4 Being able to do simple calculations using MATLAB.
5 Being able to carry out simple numerical computations and analyses using MATLAB.

COURSE OUTCOMES
At the end of the course the students should be able to:
1 Understand the basics of Matlab.
2 Break a complex task up into smaller, simpler tasks.
3. Manipulate vectors and matrices, use matrix indexing, and determine matrix dimensions
4 Write simple programs in MATLAB to solve scientific and mathematical problems.
5 Use the MATLAB GUI effectively.

LIST OF EXPERIMENTS:

1. Introduction to SDK of MATLAB.
2. Basic Syntax and scalar arithmetic operations and calculations.
3. Working with formulas.
4. Arithmetic operations in matrix data
5. Matrix operations (Inverse, Transpose)
6. Reading an image file
7. Reading from and writing to a text file
8. Introduction to toolboxes
9. Data visualization and plotting
10. Relational operators in data
11. Logical operation in data
12. Loops in MATLAB
13. Computing Eigen value for a matrix
14. Random number generation – Montecarlo methods

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MLOPS			
Course Code:	CM302	**Course Credits:**	3
Course Category:	CC	**Course (U/P)**	U
Course Year (U/P):	3U	**Course Semester (U/P):**	6U
No. of Lectures + Tutorials (Hrs/Week)	03+00	**Mid Sem. Exam Hours:**	1
Total No. Of Lectures (L+T):	45+00	**End Sem. Exam Hours:**	3

COURSE OBJECTIVES

1. Understanding fundamentals of MLOps and its importance
2. Analyzing the process of deployment and production of a model
3. Understanding how a model is monitored after deployment
4. Describing the way of governance of the model, once deployed and evaluated
5. Furnishing understanding of MLOps through studying its use cases

COURSE OUTCOMES

At the end of the course, the students should be able to:

1. Learn about the principles of MLOps, challenges and the uses of it in the enterprise.
2. Deploy and evaluate a model and have a good understanding about Runtime environments, ensuring end-to-security and resolving any issues.
3. Test a model and use CI/CD pipelines appropriately for monitoring after the model is deployed.
4. Allot rights to the appropriate authority to govern the model after testing and be able to understand the entire process of governance of the life cyle of a machine learning model.
5. Implement MLOps practically in the real-world, following the use cases in the course.

UNIT 1: MLOPS: WHAT AND WHY

Defining MLOps and Its Challenges, MLOps to Mitigate and Assess Risk, MLOps for Responsible AI, MLOps for Scale, Model Development, Establishing Business Objectives, Data Sources and Exploratory Data Analysis, Feature Engineering and Selection, Training and Evaluation, Reproducibility, Responsible AI, Productionalization, Model Deployment Types and Contents, Model Deployment Requirements, Monitoring, DevOps Concerns, Data Scientist Concerns, Business Concerns, Iteration and Life Cycle, Feedback Loop, Data and Process Governance

UNIT 2: MODEL DEVELOPMENT AND PRODUCTION

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Experimentation, Evaluating and Comparing Models, Choosing Evaluation Metrics, Cross-Checking Model Behavior, Impact of Responsible AI on Modeling, Version Management and Reproducibility, Runtime Environments, Adaptation from Development to Production Environments, Data Access Before Validation and Launch to Production, Model Risk Evaluation, Purpose of Model Validation, Quality Assurance for Machine Learning, Key Testing Considerations, Reproducibility and Auditability, Machine Learning Security, Adversarial Attacks, Other Vulnerabilities, Model Risk Mitigation, Changing Environments, Interactions Between Models, Model Misbehavior

UNIT 3: DEPLOYING AND MONITORING

CI/CD Pipelines, Building ML Artifacts, Testing Pipeline, Deployment Strategies, Categories of Model Deployment, Considerations When Sending Models to Production, Maintenance in Production, Containerization, Scaling Deployments, Requirements and Challenges, Model Degradation, Ground Truth Evaluation, Drift Detection in Practice, Example Causes of Data Drift, Input Drift Detection Techniques, Feedback Loop, Logging, Model Evaluation

UNIT 4: MODEL GOVERNANCE

Who decides the Governance Organization needs, Matching Governance with Risk Level, Current Regulations Driving MLOps Governance, Financial Model Risk Management Regulation, GDPR and CCPA Data Privacy Regulations, The New Wave of AI-Specific Regulations, Emergence of Responsible AI, Key Elements of Responsible AI (Data, Bias, Inclusiveness, Model Management at Scale, Governance), Template for MLOps Governance

UNIT 5: MLOPS: REAL-WORLD EXAMPLES

MLOps in Practice: Consumer Credit Risk Management

Background: The Business Use Case, Model Development, Model Bias Considerations, Prepare for Production, Deploy to Production

MLOps in Practice: Consumption Forecast.

Power Systems, Data Collection, Problem Definition, Spatial and Temporal Resolution, Implementation, Modeling, Deployment, Monitoring

MLOps in Practice: Marketing Recommendation Engines.

The Rise of Recommendation Engines, Data Preparation, Design and Manage Experiments, Model Training and Deployment, Pipeline Structure and Deployment Strategy, Monitoring and Feedback

Text Book:

1. Introducing MLOps: How to Scale Machine Learning in the Enterprise, Mark Treveil, O'reilly Publications
2. MLOps Engineering at Scale, Carl Osipov
3. MLOps with Azure, Mark Tabladillo

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MLOPS LAB			
Course Code:	CM382	**Course Credits:**	2
Course Category:	CC-P	**Course (U/P)**	U
Course Year (U/P):	3U	**Course Semester (U/P):**	6U
No. of Lectures (Hrs/Week)	02 (3 hrs)		
Total No. Of Labs (L+T):	10	**End Sem. Exam Hours:**	3

COURSE OBJECTIVES

1. Understanding concepts, principles, and significance of MLOps in modern machine learning workflows
2. Being familiarized with Azure DevOps, including its core components and how it can be used for version control, continuous integration and continuous deployment
3. Being rained in best practices for testing and validating machine learning models, ensuring model quality and reliability
4. Getting insights into managing ML environment dependencies, provisioning environments, and tracking configurations using Azure DevOps
5. Implementing model monitoring solutions and A/B testing to evaluate model performance in real-world scenarios

COURSE OUTCOMES

At the end of the course, the students should be able to:

1. Apply testing and validation techniques to ensure the quality and reliability of machine learning models.
2. Set up model monitoring and conducting A/B testing to continuously improve model performance.
3. Handle complex ML workflows and advanced CI/CD strategies for large-scale ML projects.
4. Manage ML environment dependencies and configurations efficiently.

List of Experiments

1. Making ID on Azure DevOps and applying for Parallelization.
2. Creating and managing Git repositories, branching and merging strategies.
3. Integrating Git with Azure DevOps.
4. Setting up a CI pipeline in Azure DevOps.
5. Building and packaging ML models as part of CI.
6. Setting up a CD pipeline in Azure DevOps.
7. Deploying and monitoring ML models in Azure.

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8. Strategies for model testing and validation.
9. Implementing automated testing for ML models.
10. Incorporating validation checks in CI/CD pipelines.
11. Handling complex ML workflows.
12. Managing multiple models and pipelines and implementing advanced CI/CD strategies.

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CLOUD COMPUTING			
Course Code:	**CM310**	**Course Credits:**	**3**
Course Category:	**CC**	**Course (U / P)**	**U**
Course Year (U / P):	**3U**	**Course Semester (U / P):**	**6U**
No. of Lectures + Tutorials (Hrs/Week):	**03 + 00**	**Mid Sem. Exam Hours:**	**1**
Total No. of Lectures (L + T):	**45 + 00**	**End Sem. Exam Hours:**	**3**

COURSE OBJECTIVES
1. Comprehensive and in-depth knowledge of Cloud Computing concepts,
2. Understand the technologies, architecture and applications
3. Cloud Computing fundamental issues, technologies, applications and implementations.
4. Another objective is to expose the students to frontier areas of Cloud Computing andinformation systems, while providing sufficient foundations to enable further study and research.

COURSE OUTCOMES
1. At the end of the course the students should be able to:
2. Understand the fundamental principles of distributed computing
3. Understand the importance of virtualization in distributed computing and how this hasenabled the development of Cloud Computing
4. Analyze the performance of Cloud Computing.
5. Understand the concept of Cloud Security.
6. Learn the Concept of Cloud Infrastructure Model.

UNIT 1: INTRODUCTION TO CLOUD COMPUTING: Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering& Monitoring cloud services, benefits and limitations, Deploy application over cloud, Comparison among SAAS, PAAS, IAAS Cloud computing platforms: Infrastructure as service: Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.

UNIT 2: INTRODUCTION TO CLOUD TECHNOLOGIES: Study of Hypervisors Compare SOAP and REST Web Services, AJAX and mashups-Web services: SOAP and REST, SOAP versus REST, AJAX: asynchronous 'rich' interfaces, Mashups: user interface services Virtualization Technology: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization Multi Tenant software: Multi-entity support, Multi-schema approach, Multi-tenancy using cloud data stores, Data access control for enterprise applications

UNIT 3: DATA IN THE CLOUD: Relational databases, Cloud file systems: GFS and HDFS, Big Table, HBase and Dynamo. Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce, Introduction to cloud development, Example/Application of Mapreduce, Features and comparisons among GFS,HDFS etc, Map-Reduce model Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud Cloud computing security architecture:Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control- Identity management, Access control, Security. Autonomic

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fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud Cloud computing security architecture:Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control- Identity management, Access control, Autonomic Security.

Cloud computing security challenges: Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud

UNIT 4: Issues in cloud computing, Implementing real time application over cloud platform Issues in Intercloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment. Cloud Middleware. Mobile Cloud Computing. Inter Cloud issues. A grid of clouds, Sky computing, load balancing, resource optimization, resource dynamic reconfiguration, Monitoring in Cloud

UNIT 5: Cloud computing platforms, Installing cloud platforms and performance evaluation Features and functions of cloud platforms: Xen Cloud Platform, Eucalyptus, OpenNebula, Nimbus, TPlatform, Apache Virtual Computing Lab (VCL), Enomaly Elastic Computing Platform

Text Books:

1. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, Cloud Computing for Dummies by (WileyIndia Edition)
2. Gautam Shroff, Enterprise Cloud Computing by, Cambridge
3. Ronald Krutz and Russell Dean Vines, Cloud Security by, Wiley-India

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Parallel Processing and CUDA Programming			
Course Code:	**CM 401**	**Course Credits:**	**4**
Course Category:CC	**CC**	**Course (U / P)**	
Course Year (U / P):U	**4U**	**Course Semester (U / P):**	**7U**
No. of Lectures + Tutorials H rs/Week):	**3+ 01**	**id Sem. Exam Hours:**	**1**
Total No. of Lectures (L + T):30	**45+ 15**	**End Sem. Exam Hours:**	**3**
COURSE OBJECTIVES			
1. Define terminology commonly used in parallel computing, such as efficiency and speedup.			
2. Describe common GPU architectures and programming models			
3. Implement efficient algorithms for common application kernels, such as matrix multiplication			
4. Given a problem, develop an efficient parallel algorithm to solve it.			
5. Given a problem, implement an efficient and correct code to solve it, analyze its performance, and gi onvincing written and oral presentations explaining the achievements			
COURSE OUTCOMES			
At the end of the course the students should be able to:			
1.Understand the distributed and parallel computing systems			
2. Familiar with parallel and distributed languages MPI, Pthread, OpenMP, and CUDA			
3. Design parallel and distributed algorithms using these parallel languages			
4. Writing Parallel Programs.			
5 Able to meaure performance metrics			

Unit-1 Introduction

Introduction to Parallel Computers ,Message-Passing Computing and Programming, Multithread Programming , Parallel Programming Paradigms, Parallel Architecture, Parallel Architecture (case studies)

Unit-2

CUDA Programming , OpenMP Programming , Embarrassingly Parallel Computation, GPU-Compute Architecture, CUDA, Memory organization in CUDA Multi- CoreCPU programming, MPI, PVM, Performance evaluation and scalability

Unit-3

Partitioning and Divide-and-Conquer Strategies , Pipelined Computation ,Synchronous Computations, Pipelining and Throughput Latency and Latency hiding

Unit-4

Synchronous Computations,Load Balancing and Termination Detection,Distributed Shard Memory, Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU

Unit-5

Sorting Algorithms, Min/Max, Sum Searching, Merging, Sorting, Prefix operationsN- body problems, Matrix operations

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REFERENCE BOOKS:

1. David Kirk and Wen-mei Hwu, Programming Massively Parallel Processors: A Hands-On Approach, 2nd Edition, Publisher: Morgan Kaufman, 2012, ISBN: 9780124159921.
2. Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, Morgan Kaufman; 2012 (ISBN: 978-0124159334
3. An Introduction to Parallel Algorithms by Joseph Jaja (Addison-Wesley Professional)

4. Introduction to Parallel Computing by Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta (Pearson)

1. Parallel Programaming in C with MPI and openMP by Michael J Quinn (McGraw H

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