



	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2				1					1	1	2	3
CO2	2		2	2								2	1	2
CO3	3		2	2	2							1	1	3
CO4	2	3	1	1								1		2
CO5	1	2		1							1	2		3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Reference Books:
1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools" (Dragon Book), Addison Wesley, 2nd Edition.
2. Kenneth C. Louden, "Compiler Construction: Principles and Practice", Cengage Learning.
3. D.M. Dhamdhare, "Compilers: Principles and Practice", Macmillan India.
4. Andrew W. Appel, "Modern Compiler Implementation in C", Cambridge University Press.
e-Learning Source:
1. https://onlinecourses.nptel.ac.in/noc21_cs07/preview
2. https://nptel.ac.in/courses/106/108/106108052/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	3	3	3	3						3	3		
CO2	2	2	3	2		1							3	2	3	
CO3	1	3	2	3		2							1	2	3	
CO4	3	3	3	3		2							3	3	3	
CO5	3	3	3	3		3			1				2	3	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective Session: 2026-27 (NEP)

Course Code	CS305	Title of the Course	COMPUTER NETWORK	L	T	P	C
Year	III	Semester	VI	4	0	2	5
Pre-Requisite	None	Co-requisite	None				
Course Objectives	1. To inculcate the conceptual & practical knowledge of computer networking right from “Basic” to a “Higher-Level understanding” of the course. 2. Helping to acquire the know-how of designing & organization computer networks, understanding the communication process and use of networking devices. 3. Imparting knowledge of Network Models, its working principles and functioning of various protocols associated thereto. 4. Enabling students to gain the practical knowledge of designing efficient networks, its implementation, monitoring and troubleshooting of computer network						

Course Outcomes	
CO1	Recall and understand communication and networking fundamentals, such as “Network Design, its Types, Transmission Media, Switching Techniques, Networking Devices, and OSI & TCP/IP Models”.
CO2	Understand & Analyze Error Control, Flow Control, & Access Control Mechanisms and Apply Appropriate Methods/Measures to Resolve Relevant Issues for Fast & Efficient Data Link Layer Operations.
CO3	Analyze and Assess Routing Algorithms & IP Addressing mechanisms to Design, Create and Develop networks/sub-network using IP addressing concepts and Implement routing algorithms through modern simulation tools.
CO4	Implement & Evaluate TCP and various congestion control techniques, differentiate connectionless and connection-oriented services, and apply flow control techniques to assess and analyze network performance.
CO5	Recognize and Analyze Factors Influencing Network Performance, Assess Quality of Service, and Resolve Issues Using Various Application Layer Protocols.

THEORY

S. No.	Title of the Units	Content of Unit	Contact Hrs.	Mapped CO
1	Basics of Network & Physical Layer	Computer Network: Basic Communication Model, Data representation, Modes of Communication, Performance Criteria, Topologies, Types of Network, OSI Layered Architecture, TCP/IP protocol suite. Physical Layer: Transmission Media- Guided Media: Twisted Pair Cable, Coaxial Cable, Fiber Optics, Unguided Media: Radio Waves, Microwaves & Infrared Waves. Switching Techniques: Circuit switching, Message Switching, Packet Switching, Network Devices: Repeater, Hub, Switch, Bridge, Router and Gateway.	9	1
2	Data Link Layer	Error Control: Types of Error, Block Coding- Error Detection: Linear Block Codes, Cyclic Codes, Error Correction: Hamming Code. Flow control: Stop & Wait, Sliding Window Protocols: Functioning and Implementation of SW-Protocols- Go-Back-N ARQ, Selective Repeat ARQ. Access Control: Random Access methods- ALOHA, CSMA, CSMA/CD. Channelization- FDMA, TDMA, CDMA. Overview of Fast Ethernet, FDDI.	8	2
3	Network Layer	IP Addressing: Classfull Addressing, net-id, hosted, mask, subnet. Classless addressing, Subnetting using Classless Addressing, IPv4 Addressing, Datagram Formats for IPv4 and IPv6 addresses. Routing: Packet delivery and packet forwarding. Unicast Routing: Distance Vector Routing-RIP and Link State Routing-OSPF, Path Vector Routing-BGP Address Mapping Protocols: ARP and RARP.	9	3
4	Transport Layer	Transport Layer Services: Process To Process Delivery, Connectionless Versus Connection Oriented Services, UDP Services & Frame Format. Transmission Control Protocol: TCP Services & Segment Format, TCP Connection Establishment & Termination Process. Congestion Control Techniques: Open Loop Techniques- Retransmission, , Admission Control, Acknowledgement Policy, Discard Policy & Traffic Shaping. Closed Loop Techniques- Choke Packet, Back Pressure, Implicit & Explicit Signaling.	7	4
5	Quality of Service	Network Criteria: Performance, Reliability, Security, Jitter. Traffic Scheduling: FIFO Technique, Weighted Fair Queuing. Traffic Shaping: Leaky Bucket, Token Bucket. Application Layer: Domain Name System: Name Space, DNS, Distribution of Domain Name Space. E-Mail Protocol: SMTP, IMAP, POP3. File Transfer: FTP. Telnet, WWW Architecture, Client-Server, URL, Cookies, Firewall.	7	5

PRACTICAL

S.No	List of Experiments	Contact Hrs.	Mapped CO
1	Simulation of Basic Router Configuration in cisco packet tracer	2	1
2	Simulation of Router Name and Password in cisco packet tracer	2	1

3	Simulation of Banner mold and login in Cisco packet tracer	2	2
4	Simulation of telnet in Cisco packet tracer	2	2
5	Simulation of DHCP in Cisco packet tracer	2	3
6	Simulation of RIP in cisco packet tracer	2	3
7	Simulation of OSPF in cisco packet tracer	2	4
8	Simulation of crate and add VLAN in cisco packet tracer	2	4
9	Simulation of STP in cisco packet tracer	2	5
10	Simulation of two router communication in cisco packet Tracer	2	5

Reference Books:

1. Forouzan, "Data Communication and Networking", TMH
2. A.S.Tanenbaum, "Computer Networks", 3rd Edition, Prentice Hall India, 1997
3. W. Stallings, "Data and Computer Communication", Macmillan Press, 1989.

e-Learning Resources:

[NPTEL Video Lecture by Dr. Neminath Hubballi \(IIT Indore\)](#) - Advance Computer Network

[NPTEL Video Lecture by Prof. Ajit Pal \(IIT Kharagpur\)](#)

[NPTEL Video Lecture by Prof. Hema A Murthy \(IIT Madras\)](#)

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO /CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1		1						1	2	1	3
CO2	3	2	2	2	2						1	1	3	1
CO3	3	2	3	2	3	1		1			1	3	1	2
CO4	2	1	2	1	2			1			1	1	2	1
CO5	2	1	1		1			1			2	2	1	2

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-27 (NEP)							
Course Code	CS394	Title of the Course	Artificial Intelligence Analyst	L	T	P	C
Year	III	Semester	VI	4	0	2	5
Pre-Requisite	None	Co-requisite	None				
Course Objectives	- To understand the different phases of Artificial Intelligence on cloud platforms. - To learn data exploration and data understanding techniques for working with datasets. - To understand data preparation and data conversion methods for AI applications. - To learn how to use different data visualization charts and understand their characteristics. - To get an introduction to machine learning algorithms and estimators for building models.						

Course Outcomes	
CO1	Define the foundational concepts of Artificial Intelligence.
CO2	Identify the steps involved in preprocessing and analyzing data for AI applications.
CO3	Use popular AI tools and frameworks such as TensorFlow, PyTorch, scikit-learn, and Keras to develop AI solutions.
CO4	Analyze real-world applications of AI across industries such as healthcare, finance, retail, and autonomous systems to understand their use and impact.
CO5	Evaluate the rapid evolution of Artificial Intelligence and develop a mindset of continuous learning and adaptation.

THEORY				
Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction To Artificial Intelligence:	A comprehensive overview of AI concepts and applications, discussing the various types of AI and the need to transition towards its adoption. It explores the historical development and current trends in AI, highlighting IBM's significant contributions throughout its evolution. Students will learn about the different stages of AI history and their implications. Additionally, the unit emphasizes the ethical considerations and societal impacts of AI, showcasing its influence on the real world and examining real-time applications in various industries.	8	1
2	Python for Artificial Intelligence:	It begins with an introduction to Python, covering its features, variables, data types, and syntax. Students will gain a solid understanding of object-oriented programming (OOP) concepts, including functions, classes, and objects. The unit also explores key Python libraries such as Pandas, NumPy, Matplotlib, scikit-learn, and Keras, providing foundational knowledge for AI programming.	8	2
3	Machine Learning and training of AI:	This unit focuses on the relationship between machine learning and AI, explaining the process of transforming a regular machine into a smart machine using machine learning techniques. Students will explore various types of machine learning algorithms, including supervised learning, unsupervised learning, reinforcement learning, and ensemble learning, with hands-on implementation using Python.	8	3
4	Deep Learning and Training of AI:	Deep learning and its distinctions from machine learning and AI. Topics include neural networks and their various types, as well as algorithms such as recurrent neural networks (RNNs) with their implementation in Python. Key concepts like activation functions, bias, weights, backpropagation, and the vanishing gradient problem are also covered. The unit explores long short-term memory (LSTM) networks and convolutional neural networks (CNNs), detailing pooling, padding, fully connected layers (FCLs), and their implementation using Python and Keras.	8	4
5	AI services by IBM tools:	AI-powered tools for text-to-speech and speech-to-text conversions. Additionally, the unit focuses on building virtually powered chatbots integrated with AI assistants. By leveraging IBM Cloud services, students will gain hands-on experience in developing AI-driven solutions, preparing them for industry demands.	8	5

PRACTICAL			
S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	Introduction to IBM cloud services	2	1
2	To study text to speech conversion using Watson AI	2	1
3	To study speech to text conversion using Watson AI	2	1
4	Data preparation and conversion using python (pandas).	2	2
5	To study about different types of visualization graph using data refinery visualization features and EDA in python programming.	2	2
6	To study about different ML algorithms/estimators using sci-kit learn.	2	3
7	Introduction to IBM Watson assistant.	2	3
8	Build a live AI powered chat-bot for websites.	2	4
9	Deploying IBM Watson assistant chat-bot.	2	4
10	Creating prediction models using python and sci-kit learn.	2	5

11	Creating classification models using python and sci-kit learn.	2	5
Reference Books:			
1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education.			
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media.			
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.			
4. Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media.			

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO- PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO														
CO1	3	2	1	1	1	1	1	1	1		2	3	1	1
CO2	3	2	2	1	3	1	1		1	1		3	3	2
CO3	3	3	2	2	3	2	2	1		1	1	3	3	2
CO4	3	3	2	2	3			2		1		3	3	2
CO5	2	2	3	2	3	1	1	1	1		3		3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-27 (NEP)															
Course Code		CS334		Title of the Course		Cloud Computing						L	T	P	C
Year		III		Semester		V						3	0	0	3
Pre-Requisite		None		Co-requisite		None									
Course Objectives		The course aims to provide an in-depth understanding of various paradigms and computing techniques in cloud computing. It explores the key concepts, technologies, strengths, limitations, and potential applications of cloud computing. Students will gain knowledge of the architecture and infrastructure of cloud computing, including models such as SaaS, PaaS, IaaS, and deployment options like public, private, and hybrid clouds. The course focuses on interpreting data, understanding scalability, and leveraging cloud services to achieve efficient database management for cloud storage.													
Course Outcomes															
CO1		Understand and explain the paradigms of cloud computing and different computing techniques.													
CO2		Analyze and articulate the concepts, key technologies, strengths, limitations, and potential applications of cloud computing.													
CO3		Identify and evaluate the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, and deployment models such as public, private, and hybrid clouds.													
CO4		Interpret data, scalability, and various cloud services to optimize database efficiency for cloud storage.													
CO5		Recommend and justify suitable cloud computing solutions for specific applications, considering efficiency and scalability.													
Unit No.	Title of the Unit		Content of Unit									Contact Hrs.	Mapped CO		
1	Introduction:		Historical development, Vision of Cloud Computing, Characteristics of cloud computing as per NIST, Cloud computing reference model, Cloud computing environments, Cloud services requirements, Cloud and dynamic infrastructure. Overview of cloud applications: ECG Analysis in the cloud, Protein structure prediction, Gene Expression Data Analysis, Satellite Image Processing, CRM and ERP, Social networking.									7	1		
2	Cloud Computing Architecture:		Cloud Reference Model, Types of Clouds, Cloud Interoperability & Standards, Scalability and Fault Tolerance; Cloud Solutions: Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management. Cloud Offerings: Cloud Analytics, Virtual Desktop Infrastructure.									7	2		
3	Cloud Management & Virtualization Technology:		Resiliency, Provisioning, Asset management, Concepts of Map reduce, Cloud Governance, High Availability and Disaster Recovery. Virtualization: Fundamental concepts of compute, storage, networking, desktop and application virtualization. Virtualization benefits, server virtualization, Block and file level storage virtualization Hypervisor management software, Infrastructure Requirements, Virtual LAN(VLAN) and Virtual SAN(VSAN) and their benefits.									7	3		
4	Cloud Security:		Cloud Information security fundamentals, Cloud security services, Design principles, Secure Cloud Software Requirements, Policy Implementation, Cloud Computing Security Challenges, Virtualization security Management, Cloud Computing Security Architecture.									6	4		
5	Market Based Management of Clouds, Federated Clouds/Inter Cloud:		Characterization & Definition, Cloud Federation Stack, Third Party Cloud Services. Case study: Google App Engine, Microsoft Azure, Hadoop, Amazon.									6	5		
Reference Books:															
1. Buyya, Selvi ,” Mastering Cloud Computing “,TMH Pub.															
2. Kumar Saurabh, “Cloud Computing” , Wiley Pub.															
3. Krutz , Vines, “Cloud Security “ , Wiley Pub.															
4. Velte, “Cloud Computing- A Practical Approach” ,TMH Pub.															
5. Sosinsky, “Cloud Computing” , Wiley Pub.															
e-Learning Source:															
https://nptel.ac.in/courses/106105196															
PO- PSO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
PO1		2	3	1	1	-	-	-	-	-	-	-	2	-	2
PO2		2	3	1	2	-	-	-	-	-	-	-	2	-	2
PO3		1	2	3	1	-	-	-	-	-	-	-	2	-	2
PO4		1	2	2	1	-	-	-	-	-	-	-	1	-	2
PO5		1	2	2	1	-	-	-	-	-	-	-	2	-	1
PO6		1	2	2	1	-	-	-	-	-	-	-	2	-	1
1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation															

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-27 (NEP)															
Course Code		CS341		Title of the Course		Introduction to Internet of Things						L	T	P	C
Year		III		Semester		VI						3	0	0	3
Pre-Requisite		None		Co-requisite		None									
Course Objectives		To introduce the fundamental concepts, architecture, and design principles of the Internet of Things (IoT). To impart knowledge of IoT communication models, protocols, and access technologies. To enable students to understand IoT system management, M2M communication, and virtualization techniques. To provide practical exposure to IoT devices such as Arduino and Raspberry Pi, focusing on interfacing and programming. To develop skills in cloud integration, data analytics, and IoT security for real-world applications.													
Course Outcomes															
CO1		Recall and explain the fundamental concepts of IoT including its definition, characteristics, physical and logical design, architectures, functional blocks, communication models, APIs, and challenges.													
CO2		Identify and analyze IoT communication protocols, wireless medium access issues, routing protocols, sensors, actuators, smart objects, and IoT access technologies to evaluate their role in IoT networks.													
CO3		Apply and assess IoT system management concepts including SDN, NFV, NETCONF, YANG, and SNMP to differentiate approaches and implement basic IoT management solutions.													
CO4		Design and implement IoT applications using Arduino and Raspberry Pi by programming interfaces (serial, SPI, I2C), integrating external gadgets, controlling outputs, and reading inputs.													
CO5		Evaluate and develop IoT solutions using cloud storage models, web servers, communication APIs, data analytics tools, and security mechanisms to address advanced IoT challenges.													
Unit No.	Title of the Unit		Content of Unit									Contact Hrs.		Mapped CO	
1	Introduction to IoT		Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Comparing IoT Architectures , Functional blocks of IoT, Communication models & APIs, IoT Challenges.									6		1	
2	Communication Protocols		Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensors, Actuators and Smart Objects, Sensor Networks, Connecting Smart Objects, IoT Access Technologies.									7		2	
3	IoT and M2M		Software defined networks, network function virtualization, difference between SDN and NFV for IoT, Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER									7		3	
4	IoT Physical Devices and Endpoints		Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI focusing on interfacing external gadgets, controlling output, reading input from pins.									7		4	
5	IoT Physical Servers and Advanced Topics		Introduction to Cloud Storage models and communication APIs, Web server – Web server for IoT, Cloud for IoT, An Introduction to Data Analytics for IoT, Big Data Analytics Tools and Technology, Securing IoT, Common Challenges in IoT Security									6		5	
Reference Books:															
1- Raj Kamal, “Internet of Things: Architecture and Design Principles”, Standard Edition, McGraw Hill Education, 2022.															
2- Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.															
3- David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT, 20217															
Program Articulation Matrix (PAM)															
PO- PSO	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
	CO1	3	2	2	-	2	-	-	-	-	-	-	3	2	-
	CO2	2	3	2	2	2	-	-	-	-	-	-	2	3	-
	CO3	3	2	3	2	2	-	-	-	-	-	-	3	3	2
		2	3	2	3	2	-	2	-	-	-	-	2	2	2
	CO5	3	2	3	2	3	-	-	2	-	-	2	3	3	2
1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation															

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2026-27(NEP)							
Course Code	CS345	Title of the Course	Advance Computer Architecture	L	T	P	C
Year	III	Semester	VI	3	0	0	3
Pre-Requisite	None	Co-requisite	None				
Course Objectives	1. Understand the evolution of computer architecture and the impact of parallel processing on performance. 2. Analyze the principles of pipelining, instruction-level parallelism, and scheduling mechanisms in modern processors. 3. Apply various processor architectures, including superscalar, vector, and VLIW architectures, to optimize computational efficiency. 4. Evaluate the role of synchronous parallel processing in SIMD Architectures and their applications in high-performance computing. 5. Demonstrate knowledge of interconnection networks and their significance in multi-processor communication and data transfer.						
Course Outcomes							
CO1	Explain fundamental concepts of computer architecture, including performance evaluation, parallel processing, and classification schemes.						
CO2	Analyze pipeline processing, instruction-level parallelism, and hazard detection mechanisms to improve execution efficiency.						
CO3	Apply different processor architectures (Superscalar, Vector, VLIW) and memory technologies for optimized computing.						
CO4	Evaluate SIMD architecture, parallel algorithm design, and data mapping techniques in high-performance systems.						
CO5	Design and assess interconnection networks, including crossbar and shuffle-exchange networks, for efficient communication in multi-processor environments.						
THEORY							
Unit No.	Title of the Unit	Content of Unit			Contact Hrs.	Mapped CO	
1	Introduction	Introduction to Computer Architecture, Evolution of Computer Architecture, Parallel Computing, Parallel Architectural Classification Schemes: Flynn’s, Shores, Feng’s Classification; Performance of Parallel Processors: Speedup Performance Laws, Amdahl Law, and Gustafson Law, Performance metrics and measures.			7	1	
2	Pipeline Processing:	Pipeline Processing: Introduction to Pipeline Processing, Arithmetic Pipelines, Pipelined Instruction Processing, Instruction Level Parallelism, Interlocks, Hazards, and Hazards Detention & Resolution, Scheduling of Pipelines.			6	2	
3	Processor Architectures	Processor Architectures: Superscalar Architecture, Vector Architecture and VLIW Architecture, Super pipeline design, Memory Technology: Cache Architecture; Cache Coherence and Synchronization Mechanisms, Shared-Memory Organizations.			7	3	
4	Synchronous parallel processing	Synchronous parallel processing, SIMD Architecture, and programming principles, SIMD parallel algorithm, Data mapping and memory in Array Processor			6	4	
5	Interconnection Network	Interconnection Network, introduction to permutations, group of mapping, decomposition of a permutation into cycles, elementary permutation used in interconnection network, complete non-blocking network, cross-bar network, clos network, Bens’s network, shuffle exchange network.			7	5	
Reference Books:							
1. Peterson & Heresy, “Quantitative Approach to computer Architecture”							
2. Kai Hwang, “Advance Computer Architecture”, McGraw Hill International							
3. Morris Mano, “Computer System Architecture”							
4. Bhujde, “Parallel Computing”, New Age International							
e-Learning Source:							

Program Articulation Matrix (PAM)														
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	1	2	1	2	3	1	1
CO2	3	3	2	3	2	1	1	1	2	2	2	3	2	2
CO3	2	3	3	3	3	1	1	1	2	3	2	3	3	3
CO4	3	3	3	3	3	2	1	2	2	3	2	3	3	3
CO5	3	3	3	3	3	2	1	2	3	3	2	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Program Articulation Matrix (PAM)														
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1		1					2	2	2	2	3	2
CO2	3	3	3	3	3						2	2	3	2
CO3	3	3			3				2		3	3	3	
CO4	3	3	3		2						3	3	2	2
CO5	3	3			1				2		3	2		2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-2027 (NEP)

Course Code	CS312	Title of the Course	Digital Image Processing	L	T	P	C
Year	III	Semester	V	3	0	0	3
Pre-Requisite	None	Co-requisite	None				

Course Objectives	- To introduce the fundamentals of image processing, including motivation, applications, visual perception, image models, and basic operations such as sampling and quantization. - To explore various image enhancement techniques, including spatial domain filtering, histogram processing, arithmetic operations, and color transformations - To study image registration and feature extraction methods, covering geometric transformations, stereo imaging, topological and geometric attributes. - To introduce advanced image processing algorithms for face detection and recognition
--------------------------	---

Course Outcomes:

CO1	Describe fundamental concepts of image processing, including enhancement, segmentation, and morphological operations.
CO2	Apply image processing techniques such as filtering, edge detection, and color transformations to solve computational problems.
CO3	Analyze and evaluate image registration, feature extraction, and segmentation algorithms for effective image representation.
CO4	Implement object recognition techniques using classification, clustering, and syntactic recognition methods.
CO5	Design and develop real-world applications utilizing existing image processing algorithms and tools.

THEORY

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction and Fundamentals	Motivation and Perspective, Applications, Components of Image Processing System, Element of Visual Perception, A Simple Image Model, Sampling and Quantization.	6	1
2	Image Enhancement in Spatial Domain	Introduction; Basic Gray Level Functions – Piecewise-Linear Transformation Functions: Contrast Stretching; Histogram Specification; Histogram Equalization; Local Enhancement; Enhancement using Arithmetic/ Logic Operations – Image Subtraction, Image Averaging; Basics of Spatial Filtering; Smoothing - Mean filter, Ordered Statistic Filter; Sharpening – The Laplacian.	7	2
3	Color Image Processing	Color Fundamentals, Color Models, Converting Colors to different models, Color Transformation, Smoothing and Sharpening, Color Segmentation. Morphological Image Processing: Introduction, Logic Operations involving Binary Images, Dilation and Erosion, Opening and Closing, Morphological Algorithms – Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening.	8	3
4	Registration	Introduction, Geometric Transformation – Plane to Plane transformation, Mapping, Stereo Imaging – Algorithms to Establish Correspondence, Algorithms to Recover Depth Segmentation Introduction, Region Extraction, Pixel-Based Approach, Multi-level Thresholding, Local Thresholding, Region-based Approach, Edge and Line Detection: Edge Detection, Edge Operators, Pattern Fitting Approach, Edge Linking and Edge Following, Edge Elements Extraction by Thresholding, Edge Detector Performance, Line Detection, Corner Detection.	8	4
5	Feature Extraction	Representation, Topological Attributes, Geometric Attributes. Description Boundary-based Description, Region based Description, Relationship. Object Recognition: Deterministic Methods, Clustering, Statistical Classification, Syntactic Recognition, Tree Search, Graph Matching	8	5

Reference Books:

1. Digital Image Processing 2nd Edition, Rafael C. Gonzalez and Richard E. Woods. Published by: Pearson Education.
2. Digital Image Processing and Computer Vision, R.J. Schalkoff. Published by: John Wiley and Sons, NY.
1. Fundamentals of Digital Image Processing, A.K. Jain. Published by Prentice Hall, Upper Saddle River, NJ.

e-Learning Source:

<https://nptel.ac.in/courses/106106131>

Program Articulation Matrix														
PO- PS O CO	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	2	1	3	1	1	3	1	2	1	1	2	3	2	
CO 2	3	2	3	2	1	1			2		2	1	3	
CO 3	2	2	1	1	2	2	3		1		3			3
CO 4	3	2	2	2	3	3					2			3
CO5	3	1	1	1	1	2	1				2			3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:2026-27 (NEP)							
Course Code	CS346	Title of the Course	Concepts in Advanced Database System	L	T	P	C
Year	III	Semester	VI	3	0	0	3
Pre-Requisite	DBMS	Co-requisite	None				
Course Objectives	- To enhance students' knowledge of advanced SQL queries and query optimization techniques. - To understand distributed databases, their architecture, query processing, and recovery mechanisms. - To explore database tuning techniques, performance optimization, and benchmarking strategies. - To gain knowledge of database security, access control, and encryption techniques. - To introduce emerging database technologies such as temporal, spatial, multimedia, and data mining databases.						
Course Outcomes							
CO1	Apply query processing and optimization techniques for efficient database operations.						
CO2	Analyze object-oriented databases, database tuning, and performance benchmarking.						
CO3	Design and manage distributed databases, including concurrency control and recovery mechanisms.						
CO4	Implement database security techniques, encryption, and access control mechanisms.						
CO5	Explore and apply concepts of advanced databases such as temporal, spatial, multimedia, and data mining databases.						
THEORY							
Unit No.	Title of the Unit	Content of Unit			Contact Hrs.	Mapped CO	
1	Query Processing and Optimization	Clustering & Indexing Techniques, Query Processing Steps and Cost Estimation, Algorithms for Selection, Join, and Projection Operations, Query Optimization: Heuristic Optimization, Cost-Based Optimization, Query Evaluation Plans Pipelined Query Processing, System Catalog in RDBMS			6	1	
2	Object-Oriented and Extended Relational Databases	Database Tuning: Workloads, Tuning Decisions, and DBMS Benchmarks, Multiple Attribute Search Keys and Optimization Strategies, Object-Oriented Database Systems (OODBMS): Requirements, Properties, and Benefits, Structured Types, Object Identity, Containment, Class Hierarchy, Logic-Based Data Model and Nested Relational Model			7	2	
3	Distributed Databases	Architecture, Data Fragmentation, Replication, Query Processing, Semi-Join, Parallel Joins, Concurrency Control, Recovery, Deadlock Handling, Commit Protocols			6	3	
4	Database Security and Privacy	Database Security Threats and Challenges Access Control Mechanisms: Role-Based Access Control (RBAC), Discretionary and Mandatory Access Control (DAC & MAC) SQL Security: Grant & Revoke, Views, Integrity Constraints Data Encryption Techniques in Databases (AES, RSA, Hashing), Statistical Database Security and Anonymization Techniques Role of Database Administrator (DBA) in Security Management			7	4	
5	Advanced and Emerging Databases	Temporal & Spatial Databases (Time-series Data, Spatial Indexing, GIS Systems), Multimedia Databases (Audio, Video, Image Processing), Data Mining & Knowledge Discovery (Clustering, Association Rules, Decision Trees), Active & Deductive Databases, NoSQL Databases (MongoDB, Cassandra, Hadoop, CAP Theorem, BASE vs. ACID Models)			7	5	
Reference Books:							
1-Majumdar&Bhattacharya,“DatabaseManagementSystem”,TMH.							
2-Korth,Silberchatz,Sudarshan,“DatabaseConcepts”,AddisonWesley							
3-Elmastri,Navathe,“FundamentalsofDatabaseSystems”,AddisonWesley							
4-DateC.J.,“AnIntroductiontoDatabaseSystem”,AddisonWesley.							

Program Articulation Matrix (PAM)

PO- PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PSO 1	PSO 2	PSO 3
CO														
CO1	3	3	2	2	3	2	2	3		2	2	3	3	3
CO2	3	3	3	3	3	2	2	3		1	2	3	3	3
CO3	3	3	3	3	2	2	2	2		2	2	3	1	3
CO4	3	3	2	3	3	2	2	2		2	2	3	3	1
CO5	3	2	3	3	2	2	2	3		1	2	1	3	3

1- LowCorrelation;2-ModerateCorrelation;3-SubstantialCorrelation



<https://nptel.ac.in/courses/106105166>

Program Articulation Matrix														
PO- PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO														
C01	3	3	2	2	2							3	2	2
C02	2	2	2	2	2							2	2	1
C03	2	2	1	1	2							3	2	1
C04	3	2	1	2	1	2	1					3	2	1
C05	2	2	3	2	2	1	1	1				3	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective Session: 2026-27 (NEP)							
Course Code	CS412	Title of the Course	Cryptography and Network Security	L	T	P	C
Year	III	Semester	VI	4	0	0	4
Pre-Requisite	None	Co-requisite	None				
Course Objectives	Understand the theory and applications of cryptography and network security.						
	The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis.						
	This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms.						
	Aim is to develop a workable knowledge of the mathematics used in cryptology in this course. Reveal different types of cipher generation method to solve engineering and other problems.						
Course Outcomes							
CO1	To understand both classical and modern encryption techniques, as well as the ability to analyze cryptographic systems and evaluate their effectiveness in securing data.						
CO2	Apply your knowledge of block cipher modes to achieve secure communication and analyze the role of random numbers in cryptographic algorithms.						
CO3	Apply, analyze and compare various public key cryptography techniques						
CO4	To design, implement, and analyze secure authentication and digital signature systems in real-world scenarios.						
CO5	Able to analyze appropriate secure communication protocols based on security requirements and implement basic network security measures using firewalls.						
Unit No.	Title of the Unit	Content of Unit			Contact Hrs.	Mapped CO	
1	Introduction to OSI Security Architecture:	Security Attacks, Services and Mechanisms, Introduction to Cryptology. Conventional Encryption: Conventional Encryption Model, Classical Encryption Techniques–Substitution Ciphers: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One-Time Pad; Transpositions Ciphers: Rail Fence Technique; Rotor Machines, Cryptanalysis, Steganography. Modern Block Ciphers- Block Ciphers Principles: Stream & Block Ciphers, Fiestal Cipher, Shannon’s Theory of Confusion and Diffusion, S-DES, Data Encryption Standards (DES): DES Encryption and Decryption, Strength of DES.			8	1	
2	Block Cipher Modes of Operation:	ECB, CBC, CFB, OFB, CTR, Triple DES: Double DES, TDES with Two Keys, TDES with Three Keys. Symmetric Key Distribution using KDC, Random Number Generation: Use of Random Numbers, Pseudo Random Number Generators, Cryptographically Generated Random Numbers, Blum BlumShub Generator. Introduction to Graph, Ring and Field, Prime and Relative Prime Numbers, Modular Arithmetic, Fermat’s & Euler’s Theorem, Primality Testing, Euclid’s Algorithm.			8	2	
3	Principles of Public Key Cryptosystems:	Introduction, Application & Requirement; RSA Algorithm: Computational Aspects, Security of RSA; Diffie-Heilman Key Exchange Algorithm, Introductory Idea of Elliptic Curve Cryptography. Message Authentication & Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes (MAC), Hash Functions: Requirement for a Hash Function, Simple Hash Functions, Security of Hash Function & MAC, MD5 Message Digest Algorithm, Secure Hash Algorithm (SHA-1).			8	3	
4	Digital Signatures:	Requirements, Direct & Arbitrated Digital Signature, Protocols: Mutual & One way Authentication; Digital Signature Standard (DSS): DSS Approach, Digital Signature Algorithm. Authentication Applications: Kerberos Version 4 & Difference between Kerberos v4 & v5, Kerberos Realms; X.509 Authentication Service: Authentication Procedures, Directory Authentication Service; Electronic Mail Security – Pretty Good Privacy (PGP): Operational Description, Cryptographic Keys, Key Rings, Public Key Management.			8	4	
5	IP Security:	Architecture, Authentication Header, Encapsulating Security Payloads, Combining Security Associations, Key Management; Web Security: Secure Socket Layer & Transport Layer Security, Secure Electronic Transaction (SET). System Security: Intruders, Viruses and Related Threats: Malicious Programs, The Nature of Viruses, Types of Viruses, Macro Viruses, Email Viruses; Firewall: Firewall Design Principles, Trusted Systems.			8	5	
Reference Books:							
1. William Stallings, “Cryptography and Network Security: Principles and Practice” Prentice Hall, New Jersey.							
2. Johannes. A. Buchmann, “Introduction to cryptography”, Springer Verlag. Bruce Schiener, “Applied Cryptography”.							
e-Learning Source:							
https://nptel.ac.in/courses/106105031							

Program Articulation Matrix (PAM)														
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1		2						3	3	2
CO2	3	3	3	3								3	3	2
CO3	3	3	1	2								3		3
CO4	3	3	3	3		1	2	2	2		3	3	3	3
CO5	3	3	3	3	3			1			3	3	3	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2016-17						
Course Code	CS-412	Title of the Course	Cryptography and Network Security	L	T	P
Year	IV	Semester	VII	3	1	0
Pre-Requisite	None	Co-requisite	None			
Course Objectives	Understand the theory and applications of cryptography and network security. The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis. This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms. Aim is to develop a workable knowledge of the mathematics used in cryptology in this course. Reveal different types of cipher generation method to solve engineering and other problems.					

Course Outcomes	
CO1	To understand both classical and modern encryption techniques, as well as the ability to analyze cryptographic systems and evaluate their effectiveness in securing data.
CO2	Apply your knowledge of block cipher modes to achieve secure communication and analyze the role of random numbers in cryptographic algorithms.
CO3	Apply, analyze and compare various public key cryptography techniques
CO4	To design, implement, and analyze secure authentication and digital signature systems in real-world scenarios.
CO5	Able to analyze appropriate secure communication protocols based on security requirements and implement basic network security measures using firewalls.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to OSI Security Architecture:	Security Attacks, Services and Mechanisms, Introduction to Cryptology. Conventional Encryption: Conventional Encryption Model, Classical Encryption Techniques Substitution Ciphers: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One-Time Pad; Transpositions Ciphers: Rail Fence Technique; Rotor Machines, Cryptanalysis, Steganography. Modern Block Ciphers- Block Ciphers Principles: Stream & Block Ciphers, Fiestal Cipher, Shannon's Theory of Confusion and Diffusion, S-DES, Data Encryption Standards (DES): DES Encryption and Decryption, Strength of DES.	8	1
2	Block Cipher Modes of Operation:	ECB, CBC, CFB, OFB, CTR, Triple DES: Double DES, TDES with Two Keys, TDES with Three Keys. Symmetric Key Distribution using KDC, Random Number Generation: Use of Random Numbers, Pseudo Random Number Generators, Cryptographically Generated Random Numbers, Blum BlumShub Generator. Introduction to Graph, Ring and Field, Prime and Relative Prime Numbers, Modular Arithmetic, Fermat's & Euler's Theorem, Primality Testing, Euclid's Algorithm.	8	2
3	Principles of Public Key Cryptosystems:	Introduction, Application & Requirement; RSA Algorithm: Computational Aspects, Security of RSA; Diffie-Heilman Key Exchange Algorithm, Introductory Idea of Elliptic Curve Cryptography. Message Authentication & Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes (MAC), Hash Functions: Requirement for a Hash Function, Simple Hash Functions, Security of Hash Function & MAC, MD5 Message Digest Algorithm, Secure Hash Algorithm (SHA-1).	8	3
4	Digital Signatures:	Requirements, Direct & Arbitrated Digital Signature, Protocols: Mutual & One way Authentication; Digital Signature Standard (DSS): DSS Approach, Digital Signature Algorithm. Authentication Applications: Kerberos Version 4 & Difference between Kerberos v4 & v5, Kerberos Realms; X.509 Authentication Service: Authentication Procedures, Directory Authentication Service; Electronic Mail Security – Pretty Good Privacy (PGP): Operational Description, Cryptographic Keys, Key Rings, Public Key Management.	8	4
5	IP Security:	Architecture, Authentication Header, Encapsulating Security Payloads, Combining Security Associations, Key Management; Web Security: Secure Socket Layer & Transport Layer Security, Secure Electronic Transaction (SET). System Security: Intruders, Viruses and Related Threats: Malicious Programs, The Nature of Viruses, Types of Viruses, Macro Viruses, Email Viruses; Firewall: Firewall Design Principles, Trusted Systems.	8	5

Reference Books:

1. William Stallings, "Cryptography and Network Security: Principles and Practice" Prentice Hall, New Jersey.
2. Johannes. A. Buchmann, "Introduction to cryptography", Springer Verlag. Bruce Schiener, "Applied Cryptography".

e-Learning Source:

<https://nptel.ac.in/courses/106105031>

PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1		2							3	3		2
CO2	3	3	3	3									3	3		2
CO3	3	3	1	2									3		3	2
CO4	3	3	3	3		1	1	2	2	2		3	3	3	3	3
CO5	3	3	3	3	3				1			3	3	3	3	2

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Course Code	CS292	Title of the Course	Theory of Computation	L	T	P	C
Year	III	Semester	VI	4	0	0	4
Pre-Requisite	Discrete Mathematics	Co-requisite	None				
Course Objectives	The primary objective of this course is to introduce students to the foundations of computability theory. Other objectives include the application of mathematical techniques and logical reasoning to important problems, and to develop a strong background in reasoning about finite state automata and formal languages.						

CO1	Demonstrate computational mathematical models for problem solving and describe how they relate to formal languages.
CO2	Understand and analyze the relationship among language classes and Grammars with the help of Chomsky Hierarchy.
CO3	Identify and apply rigorous formal mathematical models for proving different properties of Grammar, languages and Automata.
CO4	Recall mathematical foundations and algorithmic principles, understand their role in system design, apply to models, analyze effectiveness, and evaluate its real-world utility.
CO5	Examine the applicability of theoretical concepts to practical engineering problems, such as compiler design.

S. No.	Title of the Units	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to Automata	Finite state machine, definitions, Finite automaton model, acceptance of strings and languages Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA	9	1
2	Regular Expression & Languages	Chomsky Hierarchy, Regular Grammars, Unrestricted Grammars, Context Sensitive Language, Regular expression (RE); Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleene's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non-Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages	8	2
3	Context free Grammar and Context Free Languages	Context free grammar (CFG) and Context Free Languages (CFL): Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure properties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.	9	3
4	Push Down Automata (PDA):	Push Down Automata (PDA): Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two stacks PDA, Non-Deterministic Push Down Automata.	7	4
5	Turing Machines (TM):	Turing machines (TM): Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and Recursively Enumerable languages, Halting problem, Introduction to Undecidability, Undecidable problems about TMs. Post correspondence problem (PCP), Modified PCP, Introduction to recursive function theory	7	5

1.	Hopcroft and Ullman, "Introduction to Automata Theory Languages and Computation", Addison Wesley.
2.	Mishra & Chandrasekhar, "Theory of Computer Sciences", PHI.
3.	Peter Linz, "An Introduction to Formal Languages and Automata", Jones & Bartlett Learning. Recommended Prerequisite – CS206Co-requisite - None

<https://nptel.ac.in/courses/106105196>

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO /CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2						1	1	1		3
CO2	3	2	3	2	2	1						2		3
CO3	3	3	3	2		2						2		3
CO4	3	2	2	2	3	3		2		1	1	2		
CO5	3	2	1	1		2				2			1	2

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-27 (NEP)							
Course Code	CS395	Title of the Course	Predictive Analytics	L	T	P	C
Year	III	Semester	V	4	0	0	4
Pre-Requisite	None	Co-requisite	None				
Course Objectives	- To provide an overview of an exciting field of Predictive Analytics. - To introduce the tools required For Predictive Analytics. - Review and explore data to look at data distributions and to identify data problems, including missing values. - To enable students to have skills that will help them to solve complex real-world problems for decision support. - To study, understand and implement each unit according to National Education Policy and Bloom's Taxonomy.						

Course Outcomes	
CO1	Define Predictive Analytics and recall its key concepts as an emerging field.
CO2	Explain the purpose and use of tools required for Predictive Analytics.
CO3	Apply data exploration techniques to review datasets, examine distributions, and detect issues such as missing values.
CO4	Analyze complex real-world problems using acquired skills to support effective decision-making.
CO5	Evaluate and apply IBM Watson Studio and its tools to develop and assess end-to-end machine learning solutions.

THEORY				
Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	ANALYTICS OVERVIEW	Definition of business Analytics with real time examples, role of analytics in decision-making, data-driven business strategies, How Predictive analytics: Transforming data into future insights, case studies on business forecasting, Analytics trends: Past, Present & Future, Towards a Predictive enterprise.	8	1
2	IBM SPSS MODELER & DATA MINING	Introduction to data mining, real-world applications Strategy for data mining: CRISP-DM, Identify nodes and streams, The framework of a Data – mining project, Brief the unit of analysis, types of dialog box, case studies in business and healthcare. Concepts of Unit of analysis (Distinct, Aggregate, SetToFlag), Integrate data, CLEM Expression, Role of Relationship between two fields, Identifying the modeling objective.	8	2
3	IBM SPSS MODELER & DATA MINING	Concepts of Unit of analysis (Distinct, Aggregate, SetToFlag), Integrate data, CLEM Expression, Role of Relationship between two fields, Identifying the modeling objective.	8	3
4	ADVANCED DATA PREPARATION WITH IBM SPSS MODELER	Functions to enrich data, Method to transform data, Cross-record functions, Sampling, Partitioning and sampling data, Improving Efficiency.	8	4
5	PREDICTIVE ANALYTICS WITH IBM WATSON STUDIO	IBM Watson Studio, Watson studio Components, Data preparation, Watson Machine learning, Data Refinery, Watson Studio Neural Network Modeler, IBM Watson Studio jobs, Use case with AutoAI.	8	5
Reference Books:				
1. IBM Courseware				
2. Predictive Analytics Mesmerizing & fascinating by ERIC SIEGEL				
3. IBM SPSS Predictive Analytics: Optimizing Decisions at the Point of Impact				
4. An Introduction to Secondary Data Analysis with IBM SPSS Statistics				

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	2		2	2		1	1	1	1	2		2
CO2	2	3		1	3	3	1	1		2		2		3
CO3	2	1	3	3	1	3	1	2	3	3	3	3	3	1
CO4	2	2	3	3	1	3		2	1	3	3	3	3	3
CO5	2	2	3	3	2	3	2	3	2	3	3	3	3	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective Session: 2026-27 (NEP)															
Course Code		CS338		Title of the Course			Mobile App Development Lab					L	T	P	C
Year		III		Semester			V					0	0	2	1
Pre-Requisite		None		Co-requisite			None								
Course Objectives		The Mobile App Development Lab aims to empower students with the practical skills and knowledge required to conceive, develop, and deploy innovative mobile applications that address real-world challenges and user needs.													
Course Outcomes															
CO1	Understand the industry-standard development environments, integrated development environments (IDEs), and software development kits (SDKs) for mobile platforms.														
CO2	Apprehend the fundamental concepts of mobile app development, using user-interface design, data management, and application lifecycle.														
CO3	Implement essential concepts and features in mobile apps development														
CO4	Debug and troubleshoot common issues in mobile app development, employing debugging tools and techniques effectively.														
CO5	Build and Develop Mobile Apps using the fundamental concepts of mobile app development approaches and strategies.														
S. No.	List of Experiments										Contact Hrs.		Mapped CO		
1	Develop an application that uses GUI components, Font, and Colors.										2		1		
2	Develop an application that uses Layout Managers and event listeners.										2		1		
3	Write an application that draws basic graphical primitives on the screen.										2		2		
4	Develop an application that makes use of databases.										2		2		
5	Develop an application that makes use of Notification Manager.										2		3		
6	Implement an application that uses multi-threading.										2		3		
7	Develop a native application that uses GPS location information.										2		4		
8	Develop a mobile application to send an email.										2		4		
9	Implement an application that writes data to the SD card.										2		5		
10	Develop a Mobile application for simple needs (Mini Project).										2		5		
e-Learning Source:															
Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO- PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	
CO															
CO1	1	3	3	1	3		1	1		1	1	1	3	3	
CO2	2	2	3	3	1		2	1		1	2	2	2	1	
CO3	1	1	1	2	3		2	2		2	1		3	2	
CO4	2	2	1	2	2		1	3		3		2	1	1	
CO5	1	2	1	3	1	3		2	3	2	1	1	2	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-27 (NEP)							
Course Code	CS391	Title of the Course	Hadoop	L	T	P	C
Year	III	Semester	V	4	0	2	5
Pre-Requisite	None	Co-requisite	None				
Course Objectives	1. To provide an overview of an exciting field of big data analytics and Hadoop. 2. Develop an understanding of the complete open-source Hadoop ecosystem and its near-term future direction. 3. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL MapReduce 4. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability. 5. To enable students to have skills that will help them to solve complex real-world problems in decision support						

Course Outcomes	
CO1	Understand the fundamental concepts of Big Data, Hadoop ecosystem, types of data, and the evolution of Hadoop architecture along with its role in modern data processing.
CO2	Demonstrate the architecture and application of HDFS and its components such as NameNode, Secondary NameNode, and Zookeeper.
CO3	Apply Hadoop commands and APIs to manage distributed storage and processing, including implementing file operations in HDFS and executing MapReduce programs.
CO4	Implement big data processing solutions using MapReduce and related ecosystem tools such as Hive, Pig, Flume, Hbase and Ambari for handling large-scale datasets.
CO5	Analyze and compare big data tools and technologies such as Hadoop, RDBMS, Hive, and Pig, and evaluate their suitability for different data storage and processing scenarios.

THEORY				
Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Big Data	Develop an understanding of the complete open-source Hadoop ecosystem and its near-term future directions, compare and evaluate the major Hadoop distributions and their ecosystem components both their strengths and their limitations, and hands-on experience with key components of various big data ecosystem components and roles in building a complete big data, Future of Big Data. Knowledge of data, How to use Big insight.	8	1
2	Hadoop	Why Hadoop? What is Hadoop? Hadoop vs RDBMS, Hadoop vs Big Data, Types of Data, Brief history of Hadoop, Problems with traditional large-scale systems, Requirements for a new approach, Anatomy of a Hadoop cluster. , the overall architecture of Ambari and Ambari' relation to other services and components of a Hadoop cluster, the functions of the main components of Ambari, initiating start and stop services from Ambari Web Console.	8	1,5
3	HDFS	Concepts & Architecture, Data Flow (File Read, File Write), Fault Tolerance, Shell Commands, Java Base API, Data Flow Archives, Coherency, Data Integrity, Role of Secondary Name Node, Zookeeper.	8	2,3
4	MapReduce	Theory, Data Flow (Map – Shuffle - Reduce), Map Red vs MapReduce APIs, Programming Mapper, Reducer, Combiner, Partitioner, Implementation of Mahout, R, Sqoop, Yarn, what is flume Flume, the architecture of Flume, Flume Modes. Introduction to Spark and Kafka.	8	3,4
5	Hive and Pig	List the characteristics of representative data file formats including flat/text files CSV XML JSON and YAML, Architecture, Installation, Configuration, Hive vs RDBMS, Tables, DDL & DML, Partitioning & Bucketing, Hive Web Interface, Why Pig, Use case of Pig, Pig Components, Data Model, Pig Latin.	8	4,5

PRACTICAL			
S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	Perform setting up and installing Hadoop in its three operating modes: Standalone, Pseudo Distributed, Fully Distributed from scratch.	2	1
2	Install and Setup Hadoop cluster on Ambari console using Virtual box.	2	1
3	Implement the following file management tasks in Hadoop: - Adding files and directories - Retrieving files - Deleting files - Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command line utilities.	2	3
4	Install and Run Hive then use Hive to create, load, alter, and drop databases, tables.	2	4
5	Implement Hive Partitioning with data set.	2	4
6	Implement Hive bucketing with data set.	2	4
7	Run a basic Word Count Map Reduce program to understand Map Reduce paradigm with data set.	2	4

8	Implement Matrix Multiplication with Hadoop MapReduce.	2	4
9	Implement Hbase commands with data set.	2	4
10	Install and Run Pig then write Pig Latin scripts to sort, group, join and filter your data.	2	4
11	Explore Zookeeper.	2	2

Reference Books:

1. Kumar, Nitin. Big Data Using Hadoop and Hive, Berlin, Boston: Mercury Learning and Information, 2021.
<https://doi.org/10.1515/9781683926443>
2. T. Deshpande, Hadoop Real-World Solutions Cookbook (Packt Publishing, 2016) 290 p
3. Machine Learning for Big Data: Hands-On for Developers and Technical Professionals” by Jason Bell. Bell, 2nd ed. Wiley, 2020. Web. 15 Oct. 2022.
4. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data” by EMC Education Services

e-Learning Source:

<https://www.linkedin.com/learning/topics/hadoop-2>

<https://www.coursera.org/learn/data-engineering-pipelines-etl-hadoop>

PO- PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO														
CO1	3	2		1	2						1	3	1	1
CO2	3	2	1		2						1	3	2	1
CO3	3			1	3						1	3	2	2
CO4	3	1	2	2	2						1	3	3	2
CO5	3	3		1	2						1	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



Integral University, Lucknow

Effective from Session: 2026-27 (NEP)							
Course Code	CS392	Title of the Course	Data Science and Use Cases	L	T	P	C
Year	III	Semester	V	4	0	0	4
Pre-Requisite	None	Co-requisite	None				
Course Objectives	• How Statistical Modeling relates to Machine Learning and do a comparison of each. • Real-life examples of Machine learning and how it affects society in ways you may not have guessed! In the labs: • Use Python libraries for Machine Learning, such as scikit-learn. • To enable students to know real world implementation on Popular algorithms: Regression, Classification, and Clustering. • To enable students about Recommender Systems: Content-Based and Collaborative Filtering.						

Course Outcomes	
CO1	Define how statistical modeling relates to machine learning and list key comparisons between them.
CO2	Explain real-life applications of machine learning and describe how it influences society in both expected and unexpected ways.
CO3	Use Python libraries like scikit-learn to implement machine learning techniques in lab exercises.
CO4	Analyze real-world implementations of popular algorithms like Regression, Classification, and Clustering to evaluate their differences and use cases.
CO5	Design and develop recommender systems using approaches such as Content-Based Filtering and Collaborative Filtering to solve real-world problems.

THEORY				
Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	INTRODUCTION TO MACHINE LEARNING	• Definition & Importance of ML • Applications of Machine Learning (Healthcare, Finance, Robotics, NLP) • Types of ML: Supervised, Unsupervised, Reinforcement Learning • Machine Learning lifecycle (data collection, preprocessing, deployment) • Python libraries suitable for Machine Learning • Feature Engineering & Data Preprocessing	8	1
2	REGRESSION	• Linear Regression: Least Squares Method, Gradient Descent • Non-linear Regression • Evaluation Metrics: MSE, RMSE, R-squared • Regularization techniques (Lasso, Ridge, Elastic Net) • Implement Regression models using Scikit-learn	8	2
3	CLASSIFICATION	• Binary & Multi-class Classification • K-Nearest Neighbour • Decision Trees & Random Forests • Logistic Regression • Support Vector Machines • Model Evaluation	8	3
4	UNSUPERVISED LEARNING	• K-Means Clustering • Hierarchical Clustering • Density-Based Clustering • Dimensionality Reduction: PCA • Anomaly Detection & Outlier Analysis • Reinforcement Learning Basics	8	4
5	RECOMMENDER SYSTEMS	• Content-based recommender systems • Collaborative Filtering • Case study: Netflix/Amazon recommendation engines • Introduction to reinforcement learning	8	5

Reference Books:	
1.	Machine Learning by Tom M. Mitchell
2.	Python Machine Learning by Sebastian Raschka and Vahid Mirjalili
3.	Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts and Technique to Build Intelligent Systems by Aurélien Géron
4.	Understanding Machine Learning by Shai Shalev-Shwartz and Shai Ben-David La

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO- PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO														
CO1	3	2	2	1	2	1		1	1	1	3	3	2	3
CO2	2	3	2	2	2	3	1	2	1	1	2	1	2	3
CO3	2	2	3	3	3			1		1			3	2
CO4	3	3	3	3	2	1	1	1	2	1	2	3	1	3
CO5	2	2	3	2	2	1	1	1	2	2	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation