Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS301**	**Title of the Course**	**Design and Analysis of Algorithm**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	To analyze the problem and design an efficient algorithm to solve it by using & modifying classical design techniques or creating a new solution technique						

Course Outcomes	
CO1	Would be able to analyze the problem and design an efficient algorithm to solve it by using & modifying classical design techniques or creating a new solution technique.
CO2	For an algorithm given all the required parameters, would be able to analyze the algorithm and evaluate its utility in the given situation, able to apply the approach where problem can be solved by smaller input then apply for larger perspective.
CO3	Given more than one solutions for the problem, would be able to evaluate and compare those using standard mathematical techniques and select the best solution.
CO4	For a design problem given, would be able to compare and evaluate different Data Structures available and modify or create new them for the same.
CO5	For given different problems, would be able to categorize the different kind of complexities and develop non deterministic solution to problems having large complexities.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction:**	Introduction: Algorithms, Analysis of Algorithms, Growth of Functions: Asymptotic Notations, Standard Notations and Common Functions; Recurrence Methods: Substitution Method, Iteration Method, Recursion Tree Method, Master's Method.	8	1
2	**Designing of Algorithms and Advanced Data Structure**	Divide & Conquer: Heap Sort, Quick Sort, Sorting in Linear Time, Medians and Order Statistics. Red-Black Trees, Augmenting Data Structure, Binomial Heaps, Fibonacci Heaps.	8	2
3	**Advanced Design and Analysis Techniques**	Greedy Algorithms: Knapsack Problem, Travelling Salesperson Problem, Minimum Cost Spanning Trees: Kruskal's Algorithm, Prim's Algorithm. Dynamic Programming: Longest Common Subsequence, Matrix Chain Multiplication, 0/1 Knapsack Problem, Single Source Shortest Path: Dijkstra's Algorithm, Bellman Ford Algorithm.	8	3
4	**Amortized Analysis, Back Tracking: and Branch & Bound**	Accounting Method, Aggregate Method, Potential Method, Introduction, Subset Sum Problem, n-Queens problem and Introduction, 0/1 Knapsack, 15 Puzzle problem.	8	4
5	**String Matching and Complexity Theory**	Algorithm, The Rabin-Karp Algorithm, The Knuth-MorrisPratt Algorithm. Class P and NP, NP-hard Problems, NP-Complete Problems, Polynomial Reduction, Approximation Algorithm	8	5

Reference Books:

1. Coremen, Rivest, Lisserson, "Algorithms", PHI.
2. Horwitz & Sahani, Fundamental of Computer Algorithm, Galgotia.
3. Michael T. Goodrich and Roberto Tamassia, Algorithm Design: Foundation, Analysis and Internet Examples, John Wiley Publications.

e-Learning Source:

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

	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
CO1	1	3	3	1	3		3	1	1			1	1	3	
CO2	2	2	3	3	1	1	2	2	1			2	2	2	1
CO3	1	1	1	2	3	1		2	2			1		3	1
CO4	2	2	1	2	2	1	2	1	3		1		2	1	1
CO5	1	2	1	3	1		1		2	3	1	1	1	2	3

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CS302	**Title of the Course**	Design and Analysis of Algorithm Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	0	0	2	1
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	● To learn the detail about DAA and about of Recursive binary and linear search. ● To learn basic concepts of divide and conquer techniques and the Optimal Spanning tree. ● To learn Greedy approach through various problem. ● Study on sorting Network and NP complete theory. ● Learning backtracking and Spanning tree.						

Course Outcomes	
CO1	Able to understand about DAA and implementation of Recursive Binary and linear search.
CO2	Able to implement divide and conquer techniques and optimal spanning tree. .
CO3	Able to analyze Greedy solution and implementation.
CO4	Able to implement Backtracking problem and shortest path.
CO5	Study on Sorting network and NP-Complete theory.

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Introduction	2	1
2	Implement Recursive Binary & Linear Search.	2	1
3	Implement Quick Sort (Divide & Conquer)	2	2
4	Find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.	2	2
5	Implement Knapsack Problem (GREEDY ALGO.	2	3
6	Implement of Directed and Undirected Graph.	2	3
7	Implement Shortest Path by Dijkstra's Algorithm.	2	4
8	Implement 8-Queen Problem (Backtracking).	2	4
9	Study of Sorting Network.	2	5
10	Study of NP-Complete Theory.	2	5

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

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS303**	**Title of the Course**	**Principles of Operating System**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	To introduce students with basic concepts of Operating System, its functions and services. To critique how memory management is implemented by the operating system, including concepts of paging, segmentation, paged segmentation etc. To introduce the concepts of Processes in Operating System and various algorithms to schedule these processes. To provide the knowledge of basic concepts towards process synchronization, deadlock and related issues. To gain insight on file management, disk management etc and to become familiar with the protection and security mechanisms taken by operating system.						

Course Outcomes	
CO1	The basic concepts of Operating System, its functions and services.
CO2	Design and effective memory management scheme for the operating system where there is less wastage and the response time is quick.
CO3	The basic concepts of Processes in Operating System and the application of various CPU scheduling algorithms.
CO4	Analyse the basic concepts of process synchronization, deadlock and related issues.
CO5	The basic components of file management, disk management etc and will become familiar with the protection and security mechanisms taken by operating system.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Desktop OS and Mobile OS**	Importance of Operating Systems; Basic Concepts and Terminology; Evolution of Operating Systems: Batch, Interactive, Time Sharing & Real Time Systems. Operating System Structure: Simple Structure, Layered Approach; System Calls; Kernels: overview, objectives of kernel, types of kernels. Architecture, Android OS, iOS, Virtual OS, Cloud OS and their design.	8	1
2	**Process, Threads, CPU Scheduling and Real Time Scheduling**	Introduction, Process Model, Process State, Process Control Block. Overview, benefits of threads, types of threads. Basic Concepts, Scheduling Criteria, And Types of Scheduling, Scheduling Algorithms: FCFS, SJF, Round Robin, Priority Scheduling, Multilevel Queue Scheduling, Multilevel, Feedback Scheduling. Introduction, Uniprocessor scheduling, Multiprocessor Scheduling.	8	2
3	**Process Synchronization and Deadlock**	Principles of Concurrency, Race Condition, Critical Section, Critical Section Problem, Synchronization Mechanism, Semaphores and Classical Problems of Synchronization: Bounded Buffer Problem, Readers Writers Problem.Principles, System Model, Deadlock Characterization, Methods of Deadlock Handling: Prevention, Avoidance, Detection & Recovery from Deadlock	8	3
4	**Memory Management and Virtual Memory Management**	Introduction, logical vs. physical address space, swapping, contiguous memoryallocation, paging, segmentation, segmentation with paging. Introduction, demand paging, performance, page replacement, page replacement algorithms (FCFS, LRU, Optimal), allocation of frames, thrashing.Other Memory Management Schemes: Swapping, Overlays.	8	4
5	**Device Management, Disk Scheduling and Protection & Security**	Introduction, types of devices, FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK Scheduling File Systems: file concept, Access Mechanism, directory structure, file system structure, allocation methods (Contiguous, linked, indexed), free-space management (bit vector, linked list, grouping), Directory implementation (linear list, hash table), efficiency & performance.	8	5

Reference Books:

1. Galvin, Silberchatz “Operating Systems Principles”, Addision Wesley.
2. Milenekovie, “Operating System Concept”, McGraw Hill.
3. Dietal, “An Introduction to Operating System”, Addion Wesley.
4. Tannenbaum, “Operating System Design And Implementation”, PHI.
5. Galvin, Silberchatz “Operating Systems Principles”, Addision Wesley.

e-Learning Source:

https://nptel.ac.in/courses/106105214

	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	3	3	1		3			1	2	1		1	3	3		
CO2	2	3	3	2				1	2	1	2	2	2	2	1	2
CO3	2	2	1	3	2		1	2	2	2	3	3	1	2	3	1
CO4	3	3	1	2			1			3	2	2	3	2	2	
CO5	3	1	1	1	2			1	1	2		2	2	3		1

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CS-391	**Title of the Course**	Hadoop	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course provides an overview of the dynamic field of big data analytics and Hadoop, focusing on the complete open-source Hadoop ecosystem and its anticipated advancements. It introduces essential tools for managing and analyzing big data, such as Hadoop, NoSQL, and MapReduce, while teaching fundamental techniques and principles for achieving scalable and streaming-capable big data analytics. The course equips students with the skills needed to address complex real-world problems and make informed decisions in a data-driven environment.						

Course Outcomes	
CO1	Understand the core concepts of big data analytics and the Hadoop ecosystem to analyze its significance and future potential.
CO2	Develop expertise in using tools like Hadoop, NoSQL, and MapReduce to manage and process large datasets effectively.
CO3	Apply fundamental techniques and principles of big data analytics to ensure scalability and streaming capabilities.
CO4	Analyze and evaluate big data frameworks and their application in solving complex real-world decision-support problems.
CO5	Design and implement innovative solutions to address challenges in big data management and analytics.

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	9	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.	8	2
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	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, 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	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	5

Reference Books:

1. Gelman, Andrew, and Jennifer Hill. Data Analysis Using Regression and Multilevel/Hierarchical Models. 1st ed. Cambridge, UK: Cambridge University Press, 2006. ISBN:9780521867061.
2. Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin. Bayesian Data Analysis. 2nd ed. New York, NY: Chapman & Hall, 2003. ISBN:9781584883883
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data" by EMC Education Services
4. Analytics: Data Science, Data Analysis and Predictive Analytics for Business" by Daniel Covington.

	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		2				3	2					2	2			3
CO2		2	3	2				1			2			3		
CO3	3	2	3	2	2				3		2		3	3	1	
CO4		2	3	3	3				2		3	3	2	2		1
CO5	1	2	3	3	2	1	2		2		3	2	3	3		

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CS-392	**Title of the Course**	Data Science and Use Cases	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	3	1	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	Recall the fundamental concepts of Statistical Modeling and Machine Learning and explain their relationships and differences.
CO2	Analyze real-life examples of Machine Learning to evaluate its societal impacts and implications.
CO3	Apply Python libraries, such as scikit-learn, to implement and experiment with Machine Learning techniques in a lab setting.
CO4	Apply Python libraries like scikit-learn to implement Machine Learning algorithms such as Regression, Classification, and Clustering
CO5	Design and develop real-world solutions using Machine Learning models, including Recommender Systems based on Content-Based and Collaborative Filtering.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**INTRODUCTION TO MACHINE LEARNING**	• Applications of Machine Learning • Supervised vs Unsupervised Learning • Python libraries suitable for Machine Learning	9	1
2	**REGRESSION**	• Linear Regression • Non-linear Regression • Model evaluation methods	8	2
3	**CLASSIFICATION**	• K-Nearest Neighbour • Decision Trees • Logistic Regression • Support Vector Machines • Model Evaluation	8	3
4	**UNSUPERVISED LEARNING**	• K-Means Clustering • Hierarchical Clustering • Density-Based Clustering	8	4
5	**RECOMMENDER SYSTEMS**	• Content-based recommender systems • Collaborative Filtering	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, Tools, and Technique to Build Intelligent Systems by Aurélien Géron

4. Understanding Machine Learning by Shai Shalev-Shwartz and Shai Ben-David La
5. Machine Learning by Tom M. Mitchell
6. F. Rosenblatt. The perceptron, a perceiving and recognizing automaton Project Para. Cornell Aeronautical Laboratory, 1957.
7. http://arxiv.org/abs/1702.08608
8. Zeiler, Matthew D., and Rob Fergus. "Visualizing and understanding convolutional networks." European conference on computer vision. Springer, Cham, 2014.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO 3**	**PSO 4**
CO1		2	2	3		3						2		1	2	
CO2		2	3	2	2			1			2		1		2	
CO3	3	2	3	2	2	2			3		2			2	2	1
CO4		2	3	3	3				2		3	3		2	1	
CO5		2	3	3	3		2		2		2	2			3	2

1-Low Correlation; 2- Moderate Correlation, 3-SubstantialCorrelation

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	**CS393**	**Title of the Course**	**Hadoop Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**0**	**0**	**2**	**1**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	**The course provides an overview of the dynamic field of big data analytics and Hadoop, focusing on the complete open-source Hadoop ecosystem and its anticipated advancements. It introduces essential tools for managing and analyzing big data, such as Hadoop, NoSQL, and MapReduce, while teaching fundamental techniques and principles for achieving scalable and streaming-capable big data analytics. The course equips students with the skills needed to address complex real-world problems and make informed decisions in a data-driven environment.**						

	Course Outcomes
CO1	**Understand the core concepts of big data analytics and the Hadoop ecosystem to analyze its significance and future potential.**
CO2	**Develop expertise in using tools like Hadoop, NoSQL, and MapReduce to manage and process large datasets effectively.**
CO3	**Apply fundamental techniques and principles of big data analytics to ensure scalability and streaming capabilities.**
CO4	**Analyze and evaluate big data frameworks and their application in solving complex real-world decision-support problems.**
CO5	**Design and implement innovative solutions to address challenges in big data management and analytics.**

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	**Implement the following file management tasks in Hadoop:**	**2**	**1**
2	• **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**	**1**
3	**Install and Run Hive then use Hive to create, load, alter, and drop databases, tables.**	**2**	**2**
4	**Implement Hive Partitioning with data set**	**2**	**2**
5	**Implement Hive bucketing with data set.**	**2**	**3**
6	**Implement sqoop commands**	**2**	**3**
7	**Run a basic Word Count Map Reduce program to understand Map Reduce paradigm with data set.**	**2**	**4**
8	**Implement Hbase commands with data set**	**2**	**4**
9	**Install and Run Pig then write Pig Latin scripts to sort, group, join and filter your data**	**2**	**5**
10	**Explore Zookeeper**	**2**	**5**
11	**Explore Ambari**	**2**	**5**
Reference Books:			
	• **IBM Courseware**		
	• **Predictive Analytics Mesmerizing & fascinating by ERIC SIEGEL**		

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	3	3	2									2	2			3
CO2		2	3	2				1						3		
CO3	3	2	3	2	2								3	3	1	
CO4		2	3	3	3							3	2	2		1
CO5		2	3	3	2	1	2		2		3	2	3	3		2

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CS304	**Title of the Course**	Theory of Automata & Formal Languages	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	None	**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.						

Course Outcomes	
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 model for proving different properties of grammars, languages and automata.
CO4	Recall mathematical foundations and algorithmic principles, understand their role in system design, apply to modeling, analyze effectiveness, and evaluate real-world utility.
CO5	Examine the applicability of theoretical concepts to practical engineering problems, such as compiler design.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	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.	8	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, Kleen'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 (CFG) and Context Free Languages (CFL):**	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.	8	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.	8	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	8	5

Reference Books:

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

e-Learning Source:

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

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

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	2	2	2	2		1				1		2	1		3	
CO2	3	2	3	2	2	1						2		3		
CO3	3	3	3	2		2						2	2		3	
CO4	3	2	2	2	3	3		2		1	1	2	2			
CO5	3	2	1	1		2				2		2		1	2	

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	**CS-340**	**Title of the Course**	**Software Engineering**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	1. Explain the basic understanding of software, its characteristics, and importance of following engineering principles to develop software. 2. Assess the applicability, strengths, and weaknesses of the different development life cycle models to provide real world software solutions. 3. To understand various processes of each phase of SDLC and make the students capable to prepare quality documentation for software development. 4. To develop effort estimation and risk management skills for developing software. 5. Study of CASE tools, Quality Assurance activities etc. for focusing on quality issues of software.						

Course Outcomes	
CO1	Identify and understand the most suitable SDLC model based on user requirements.
CO2	Analyze and estimate the total effort required while evaluating and managing potential risks during software development.
CO3	Design a high-quality SRS with cohesive and loosely coupled software using structured techniques.
CO4	Apply standard coding guidelines and create effective test cases to evaluate and uncover errors.

CO5	Identify, understand, apply, and evaluate modern CASE tools and international quality standards to develop high-quality software.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Software Engineering**	Types of Software, Software Characteristics, Quality of a Good Software, Software Myths, Software Components, Software Crisis, Software Engineering: Definition, Challenges, Software Engineering Processes, Similarity and Differences from Conventional Engineering Processes. Software Development Life Cycle Models: Build and Fix Models, Waterfall Model, Prototyping Model, RAD Model Iterative Enhancement Model, Evolutionary Development Model and Spiral Model, WINWIN Spiral Model, Fourth Generation Techniques.	8	1
2	**Planning a Software**	Process Planning, Effort Estimation: Uncertainities in Effort Estimation, Building Effort Estimation Models, A Bottom-Up Estimation Approach, COCOMO Model, Project Scheduling & Staffing: Overall Scheduling, Detailed Scheduling, Team Structure, Software Configuration Management(SCM): - Baselines, Version Control, Change Control & Configuration Audit, Risk Management: Reactive and Proactive Risk Strategies, Software Risks, Risk Analysis, Identification, Projection, Assessment, Monitoring and Managing the Risk, RMMM Plan.	8	2
3	**Software Requirements Analysis and Specification**	Software Requirements: Need for SRS, Requirement Process, Problem Analysis: Informal & formal Approaches, Data Flow Modeling, Object Oriented Modeling, Prototyping, Requirements Specifications: Characteristics of an SRS, Components of SRS, Specification Language, Structure of Requirement Document: IEEE Standards for SRS, Validation, Metrics. **Designing and Coding:** Designing: Function Oriented Design: Design Principles: Problem Partitioning and Hierarchy, Abstraction, Modularity, Top Down and Bottom-Up Strategies, Module Level Concepts: Coupling, Cohesion; Structure Design Methodology, Verification, Introduction to Object Oriented Design & User Interface Design, Software Measurement Metrics: Various Size Oriented Measures- Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs.	8	3
4	**Coding &**	**Coding:** Programming Principles and Guidelines: Common Coding Errors, Structured Programming, Information Hiding, Programming Practices, Coding Standards, Coding Process, Refactoring, Verification: Code Inspection, Static Analysis, Proving Correctness, Combining Different Techniques, Metrics. **Testing:** **Testing Fundamentals:** Error Fault and Failure, Test Oracles, Test Cases and Test	8	4

	Testing	Criteria, Test Case Execution and Analysis, Unit Testing, Integration Testing: : Top Down and Bottom up, Acceptance Testing: Alpha and Beta Testing., Regression Testing, functional and non-functional testing. Testing Techniques: White Box: Logic Coverage, Path Coverage, Loop Coverage, Data Flow Testing. Black Box Testing: Boundary Value Analysis, Equivalence Class Testing, state Table Based Testing, Decision Table Based Testing.		
5	**Computer Aided Software Engineering (CASE)**	CASE Tools, Scope, Benefits of CASE Tool, support in Software Life Cycle, Architecture of CASE Environment, Types of CASE Tools, Software Reliability and Quality Management: -Software Quality Management: Quality Concepts, Software Quality Assurance, Software Reviews, Formal Technical Reviews, and Statistical Quality Assurance. Software Reliability, ISO 9000 Quality Standards, CMM Levels.	8	5
Reference Books:				
1. Software Engineering: A Practitioner's Approach by Roger S. Pressman, McGraw-Hill International edition.				
2. An Integrated Approach to Software Engineering, by Pankaj Jalote, Narosa Publishing House.				
3. Software Engineering by K.K. Agarwal.				
4. Software Engineering by Ian Sommerville, Addison-Wesley.				

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

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS310**	**Title of the Course**	**OPEN SOURCE SOFTWARE TECHNOLOGIES LAB**	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**2**	
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To motivate students to use open-source operating systems. To teach students to set up their own Linux server. To teach students to set up their web server and commands To learn using MySql as an open source database system. To learn PHP as an open-source development programming language.						

Course Outcomes	
CO 1	Explain open-source licenses, project structure, and setup.
CO 2	Demonstrate Linux proficiency by installing packages, scheduling tasks, and executing administrative commands.
CO 3	Understand web servers, protocol-based intercommunication, and web page delivery processes.
CO 4	Analyze database schema designs, apply normalization, and formulate complex MySQL queries.
CO 5	Design and develop client-server applications and GUI-based solutions using open-source scripting languages.

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Overview of FOSS & Basic Command Interface on Linux	2	1
2	Usage of Basic Linux Commands, File and Folder Management Commands	2	1
3	Learning network-related Command and Administrative Commands	2	2
4	Learning Vi Editor & its Modes And GUI Tools	2	2
5	Learning Shell Script, A Shell Script to demonstrate various control Constructs	2	3
6	A Script to check for a file and directory existence in the file system	2	3
7	A Script to execute different commands to demonstrate Switch cases statement	2	4
8	A Script to handle command line arguments and other Special symbols	2	4
9	Learn how to Compile, Debug & Execute C, C++ & Java Programming Codes without IDEs.	2	5
10	Learning about LAMP STACK its Installation And Configuration on Linux (Ubuntu) and Performing Post Installation Exercises	2	5

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

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

Integral University, Lucknow

Effective from Session:							
Course Code	CS-394	**Title of the Course**	Artificial Intelligence Analyst	**L**	**T**	**P**	**C**
Year	**3**	**Semester**	6	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Use AI to identify and respond to security threats in real-time. • Apply machine learning to predict and assess risks and vulnerabilities. • Implement AI to automate and enhance incident response processes. • Leverage AI tools for gathering and analyzing threat intelligence. • Address ethical issues and ensure compliance in AI security deployments.						

Course Outcomes	
CO1	Understand the vision of AI from a global context.
CO2	To understand and apply IBM Watson Services in Market perspective of Big Data
CO3	Applying and analyzing architecture and APIs with use of WKS and Watson Assistant
CO4	To evaluate the application of AI and ML in Industrial and Commercial sectors.
CO5	Building and creating the service instances using IBM services and using APIs. Creating projects and research activities based on different principles of AI

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Artificial Intelligence Overview	Eras of Computing, types & main focus of AI, ML & its types, Neural Networks, NLP and processes, Use Cases, Computer Vision tools and use cases, Cognitive Computing, Setting up of IBM Bluemix Account.	9	CO1
2	Artificial Intelligence Foundation	IBM Watson and real-world problems, Deep QA Architecture, Commercialization of Watson, Watson Services – capabilities of each Watson service, Watson Knowledge Studio, Usage of Watson API explorer.	9	CO2
3	NLP and NLC	NLP – Processes, Tools and services of NLP, NLP Use cases, Different components of NLP, Challenges with NLU, NLP Pipeline. Capabilities of IBM Watson NLC, NLU and its capabilities, Watson Tone Analyzer, Watson Discovery Service, Using Discovery API	9	CO3
4	Chatbots	Chatbot and its applications, growing popularity of chatbots, tools and services for chatbots, Workspace, Intent, entity and dialogue nodes. Nodes in a dialogue, Advanced Features of a chatbot, Creation of Watson Assistant Instance, Add Intents and test in slack	9	CO4
5	Computer Vision	CV – history and advancement with AI, CU Use Cases, Pipeline within a CV application, Feature Extraction, image classification and recognition, IBM Visual Recognition Service.	9	CO5

Reference Books:

Elaine A Rich, “Artificial Intelligence”, Tata McGraw-Hill Publishing Company Limited.

Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, Shroff Publishers & Distributors Pvt. Ltd.

“Artificial Intelligence: A Modern Approach” by Stuart Russell and Peter Norvig. • “Artificial Intelligence: A New Synthesis” by Nils J Nilsson.

“Artificial Intelligence: A Modern Approach” by Stuart Russell and Peter Norvig. • “Artificial Intelligence: A New Synthesis” by Nils J Nilsson.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	2	1	-	1	3	1	2	3	2	1	3	2
CO2	2	3	1	3	2	2	-	2	2	1	3	2	1	2	3	1
CO3	1	2	1	2	2	3	-	1	2	2	3	1	2	1	2	2
CO4	3	2	2	3	1	2	1	2	1	2	3	2	3	1	3	1
CO5	3	1	3	2	3	2	2	3	3	3	3	3	3	3	3	2

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

Integral University, Lucknow

Effective from Session:							
Course Code	CS-396	**Title of the Course**	AI Analyst Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• Implement AI-based intrusion detection systems. • Develop models to spot unusual network and user behaviors. • Create workflows for AI-driven incident response. • Use AI to foresee potential security breaches. • Complete projects with AI tools like TensorFlow and PyTorch to enhance security.						

Course Outcomes	
CO1	Recall and explain the significance of Artificial Intelligence in addressing real-world challenges.
CO2	Demonstrate proficiency in utilizing industry-standard AI tools to meet professional requirements.
CO3	Apply AI concepts and tools to analyze and solve complex real-world problems effectively.
CO4	Explore and implement innovative problem-solving techniques using AI and Python programming.
CO5	Design and develop services for converting text to speech and speech to text, showcasing AI applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to IBM Watson	1.To create an IBM cloud account and understand different IBM Watson Services. 2.To create an AI virtual assistant.		CO1
2	Creating ML models in Watson	1.To understand different modules used in python for data analysis. 2.To understand and implement Linear Regression algorithm.		CO2
3	Creating Node Red Applications	1.To Classifying images using Node-Red Guide. 2.Building your own translator with AI guide		CO3
4	Real Life Scenario	1.Gaining insights from AIRBNB reviews guide. 2.Creating a Machine Learning model with Knowledge Studio		CO4
5	IBM Other Services	1.Predict Fraud using AUTO AI guide 2.To understand and implement Text to Speech and Speech to Text Service using IBM Watson		CO5

Reference Books:

IBM Reference Books

"Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig. • "Artificial Intelligence: A New Synthesis" by Nils J Nilsson.

"Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig. • "Artificial Intelligence: A New Synthesis" by Nils J Nilsson.

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CS305	**Title of the Course**	COMPUTER NETWORK	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To inculcate the conceptual & practical knowledge of computer networking right from "Basic" to a "Higher-Level understanding" of the course. • Helping to acquire the know-how of designing & organization computer networks, understanding the communication process and use of networking devices. • Imparting knowledge of Network Models, its working principles and functioning of various protocols associated thereto. • Enabling students to gain the practical knowledge of designing efficient networks, its implementation, monitoring and troubleshooting of computer network						

Course Outcomes	
CO1	Students will grasp communication and networking fundamentals, demonstrating recognition of transmission media, switching techniques, network components, and the ability to differentiate OSI and TCP/IP models.
CO2	Demonstrate proficiency in utilizing error handling techniques, analyzing flow control methods at the Data Link layer, and applying access control mechanisms for secure and efficient network operations
CO3	Demonstrate understanding of routing mechanisms, apply IP addressing for network design, and implement routing algorithms using simulation tools.
CO4	Proficient in TCP understanding, congestion control, distinguishing connectionless/connection-oriented services, and applying flow and congestion control techniques to evaluate network performance
CO5	Students will be able to recognize and evaluate factors affecting network performance, analyze Quality of Service, understand application layer protocols, and resolve networking issues.

S. No.	**Title of the Units**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basics of Network & Physical Layer**	Data communication, Components, Data representation, Data flow. Performance criteria, topologies, category: LAN. MAN & WAN. OSI layered architecture, TCP/IP protocol suite. Physical Layer: Transmission Media Guided media, Twisted pair, coaxial cable, fiber optics. Unguided media: radio waves, microwaves & infrared waves. Circuit switching network, Packet Network & Virtual Circuit. Connecting Devices: Repeater, Hub, Switch, Bridge, Router and Gateway.	8	1
2	**Data Link Layer**	**Error Handling**: types of error, Block Coding, Hamming distance, Linear Block Codes, Cyclic Codes. Flow control: Stop & wait, **Sliding Window Protocols**: Designing and functioning of Go-Back-N, Selective Repeat method. **Random Access Protocol**: ALOHA, CSMA, CSMA/CD. Channelization: Frequency Division Multiple Access, Time Division Multiple Access, Code Division Multiple Access. Overview of Fast Ethernet: FDDI.	7	2
3	**Network Layer**	IPv4 Addressing, Classfull addressing, net-id, hosted, mask, subnet. Classless addressing, subnetting using classless addressing. Datagram formats for IPv4 and IPv6 addresses. **Address mapping protocols**: ARP and RARP. Packet delivery and packet forwarding. Unicast routing: Distance vector routing-RIP and Link state routing-OSPF. Path vector routing-BGP	10	3
4	**Transport Layer**	Process to process delivery, Connectionless versus connection oriented services. User data gram protocol(UDP) , frame format of datagram. **Transmission Control Protocol**: TCP services, TCP features, Segment format. Congestion Control: Open loop techniques (Retransmission, window and acknowledgement policies.), Closed loop techniques (Back pressure and choke packet).	8	4
5	**Quality of Service**	**Flow characteristics:** Reliability, Delay, Jitter and bandwidth. **Traffic Scheduling**: FIFO technique, Weighted fair queuing. Traffic shaping: Leaky bucket and token bucket. **Application Layer:** Domain name System: Name space, Domain Name space, Distribution of domain name space. DNS in internet, Resolution. Electronic Mail: SMTP, IMAP, POP3. File Transfer: FTP. Telnet, WWW: architecture, Client, URL, Cookies.	8	5

Reference Books:	
1	Forouzen, **"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:	
1	**https://nptel.ac.in/courses/106105080** by Prof. Ajit Pal (**IIT Kharagpur**)
2	**https://nptel.ac.in/courses/106106091** by Prof. Hema A Murthy **(IIT Madras**)
3	**https://nptel.ac.in/courses/106106243** (Video lectures) by **IIT Indore (** Advance Computer Network)

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CS306	**Title of the Course**	Computer Networks Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	0	0	2	1
Pre-Requisite	None	**Co-requisite**	Computer Networks				
Course Objectives	Resource sharing in a Computer network is the main objective of this Lab. The objective of this lab course is to get practical knowledge of working principles of various communication protocols. Analyze structure and formats of TCP/IP layer protocols using network tools such as Cisco packet Tracer.						

Course Outcomes	
CO1	Understand the installation and basic functionalities of Cisco packet tracer.
CO2	Understand network layers, structure/format and role of each network layer.
CO3	Able to design and implement various network application such as data transmission between client and server, file transfer, VLAN.
CO4	Understand the various Routing Protocols/Algorithms and Internetworking.
CO5	Understand the structure and organization of computer networks; including wired and wireless communication.

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Simulation of Basic Router Configuration and its security in cisco packet tracer	2	1
2	To analyze the performance of various configurations and protocols in LAN.	2	1
3	To construct a Wireless LAN and make the PCs communicate wirelessly.	2	5
4	To construct simple LAN and understand the concept and operation of Address Resolution Protocol (ARP)	2	3
5	Simulation of telnet in Cisco packet tracer	2	3
6	Simulation of DHCP in Cisco packet tracer	2	3,4
7	Simulation of RIP in cisco packet tracer	2	3
8	Simulation of OSPF in cisco packet tracer	2	2
9	Simulation of crate and add VLAN in cisco packet tracer	2	3
10	Simulation of STP in cisco packet tracer	2	5
11	Simulation of two router communication in cisco packet Tracer	2	2
12	To understand the operation of SSH by accessing the routers remotely by PCs	2	1,4

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

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS311**	**Title of the Course**	**Software Project & Quality Management**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	1. Explain the basic understanding of software, its characteristics, and importance of following engineering principles to develop software. 2. Assess the applicability, strengths, and weaknesses of the different development life cycle models to provide real world software solutions. 3. To understand various processes of each phase of SDLC and make the students capable to prepare quality documentation for software development.						

Course Outcomes	
CO1	Analyze the systematically stepwise project planning.
CO2	Have knowledge of strategic program management, analysis of technical assessment of projects and study and analysis of different Cost-Benefit Evaluation Techniques.
CO3	Apply, analyze and compare effort estimation and different network planning models.
CO4	Evaluation and analysis of different resources and Critical Path, monitoring and control, Prioritizing monitoring and change control.
CO5	Compare and analyze modern project management, contract management, ISO Standards, CMM, Six Sigma Approach.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Project Planning**	Overview of Software Project Planning Software Project, Categorization of Software Project, Introduction to Stepwise Project Planning: Identify Project Scope and objectives, Identify Project Infrastructure, Project Products and Activities, Activity risks, Resource Allocation, Project Plan Execution	8	1
2	**Project Evaluation**	Project Evaluation: Strategic Program Management, Technical Assessment, Cost Benefit Analysis, Cash Flow Forecasting, Cost-Benefit Evaluation Techniques: Net profit, Payback Period, Return on Investment, Net Present Value, Internal Rate of Return, Risk Evaluation, Selection of Technologies, overview of software development models.	8	2
3	**Activity Planning and Risk Management**	Software Effort Estimation an Overview, Project Schedules, Network Planning Models, Activity Duration Estimation, and Risk Management: Identification, Analysis and Abatement of Risk	8	3
4	**Project Monitoring**	Resource Allocation: Nature of resources, Identifying Resource Requirements, Scheduling Resources, Creating Critical Path, Counting the Cost, Cost Schedules. Monitoring and Control: Visualizing progress, Cost Monitoring, Prioritizing Monitoring, Getting Project Back to Target, Change Control	8	4
5	**Software Quality Assurance**	Contract Management, Human Resource Management, Software Quality Definition, Software Quality Assurance, Quality Assurance Plan, Quality Matrices, ISO Standards, CMM, Six Sigma Approach	8	5

Reference Books:

1. Software Project Management by Bob Hughes and Mike Cotterell, Third Edition, TMH.
2. Information Technology Project Management by Kathy Schwalbe, International Student Edition, THOMSON Course Technology, 2003.
3. Software Quality by Mordechai Ben-Menachem/Garry S Marliss. Thomson Learning Publication
4. Software Project Management A Unified Framework by Walker Royce. Pearson Education.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	2	1		2			1	1			3	1		
CO 2	3	3		1		2	2		2	1	2		3	2		
CO 3	2	3	3	2	2	1				2	1		3	3	1	1
CO 4	3	3	2	2	1	3	2		1	2	3	3		3	1	2
CO 5	3		2	2	3	2	1			2	2	2	3			2

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS313**	**Title of the Course**	**Microprocessor and its Applications**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**VI**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	This course deals with the systematic study of the Architecture and programming issues of 8 bit 8085-microprocessor and interfacing with other peripheral ICs and co-processor. In addition, a 16-bit microprocessors and other chips (8255, 8251, 8253 and 8257) are introduced. The aim of this course is to give the students basic knowledge of the microprocessors (8085 and 8086) needed to develop the systems using it.						

Course Outcomes	
CO1	Understand the basic architecture of 8085 and 8086.
CO2	Impart the knowledge about the instruction set of Microprocessor and assembly language Programming
CO3	Understand the basic idea about the data transfer schemes and its applications
CO4	Know about the concepts of Microprocessor interfacing
CO5	Understand advance microprocessor, microcontroller and Embedded System.

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CS314	**Title of the Course**	Microprocessor Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	0	0	2	1
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To expose students to the operation of typical microprocessor (8086) trainer kit. • To prepare the students to be able to solve different problems by developing different programs. • To develop the quality of assessing and analyzing the obtained data.						

Course Outcomes	
CO1	Understanding the working of 8086 practice training kit and simulator and Introduction to ARDUINO
CO2	Set up programming strategies and select proper mnemonics and run their program on their training boards.
CO3	Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.
CO4	Develop testing and experimental procedures on Microprocessor and Microcontroller analyze their operation under different cases.
CO5	Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word processing tools.

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Write a program to two add 16-bit Hexadecimal numbers with and without carry	2	1
2	Write a program to multiply two 16-bit numbers result should be greater than 16 bit.	2	1
3	Write a program to find the greatest number from an array of 10 numbers	2	2
4	Write a program to multiply two 8-bit signed - numbers.	2	2
5	Write a program to input 5 numbers and arrange them in descending order.	2	3
6	Write a program to convert the string data it's Two's complement form	2	3
7	Write a program to read 8-bit data from Port B. Complement this data & send it back to Port A.	2	4
8	Write a program to move a block of data from one memory location to another.	2	4
9	Write a program to run the stepper motor for any number of steps and to stop it.	2	5
10	Practice basic programs on IoT kit such as raspberry and ARDUINO	2	5

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

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**CS315**	**Title of the Course**	**Compiler Design**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**VI**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	The course curriculum helps to understand the concepts of compiler and phases, various translation schemes, the complexity of the input program, machine dependent code and machine independent code, optimization theory, syntax directed translation scheme of the input jobs, role and responsibility of pre-processor in compiler designing and compiling of the input jobs.						

Course Outcomes	
CO1	Know about the concepts of a preprocessor, translation rule, cross compiler, assembler loader and linker.
CO2	To know about the basic principles of the compiler, and its constituent parts, algorithms, and data structures required to be used in the compiler.
CO3	Know about the concepts of the function and complexity of modern compilers.
CO4	Know about the concepts of code generation algorithms to get the machine code for the optimized code.
CO5	Know about the concept flow graph, machine-dependent, and machine-independent optimization, intermediate code .

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	
1	**Introduction:**	Introduction to Compiler, Phases and Passes, Bootstrapping, Finite State Machines and Regular Expressions and their Applications to Lexical Analysis, Implementation of Lexical Analysers, Lexical analyser Generator, LEX-compiler, Formal Grammars and their Application to Syntax Analysis, BNF Notation, Ambiguity, YACC.	8	
2	**Context Free Grammars**	The Syntactic Specification of Programming Languages: Context Free Grammars, Derivation and Parse Trees, Capabilities of CFG. Basic Parsing Techniques: Parsers, Top Down Parsing, Predictive Parsers, LL(1), Shift Reduce Parsing, Operator Precedence Parsing, Elimination of left recursion	8	
3	**Parsing**	Automatic Construction of Efficient Parsers: LR Parsers, the Canonical Collection of LR(O) Items, Constructing SLR Parsing Tables, Constructing Canonical LR Parsing Tables, Constructing LALR Parsing Tables, using Ambiguous Grammars, an Automatic Parser Generator, Implementation of LR Parsing Tables, Constructing LALR Sets of Items.	8	
4	**Syntax-Directed Translation**	Syntax-Directed Translation: Syntax-Directed Translation Schemes, Implementation of Syntax-Directed Translators, Intermediate Code, Postfix Notation, Parse Trees & Syntax Trees, Three Address Code, Quadruple & Triples, Translation of Assignment Statements, Boolean Expressions, Statements that Alter the Flow of Control, Postfix Translation, Translation with a Top Down Parser. More About Translation: Array References in Arithmetic Expressions, Procedures Call, Declarations, Case Statements.	8	
5	**Symbol Tables**	Symbol Tables: Data Structure for Symbols Tables, Representing Scope Information. RunTime Administration: Implementation of Simple Stack Allocation Scheme, Storage Allocation in Block Structured Language. Introduction to Code Optimization: Loop Optimization, the DAG Representation of Basic Blocks, Value Numbers and Algebraic Laws, Global Data-Flow Analysis. Introduction to Code Generation.	8	

Reference Books:

1- Aho, Sethi & Ullman, “Compiler Design”, Addison Wesley.

e-Learning Source:

1. https://onlinecourses.nptel.ac.in/noc21_cs07/preview

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	2	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 from Session: 2021-22							
Course Code	**CS347**	**Title of the Course**	**Green Computing**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**VI**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	To reduce the environmental impact of computing through sustainable practices and technologies.						

Course Outcomes	
CO1	Understand Green IT fundamentals, enabling them to develop and implement strategies for reducing environmental impact in IT operations.
CO2	Learn the life cycle of green devices and evaluating software impact on platform power.
CO3	Develop expertise in implementing sustainable practices across various assets and apply best practices for green PCs.
CO4	Acquire the knowledge of Socio-cultural dimensions of Green IT and Understand the concept of Green Compliance.
CO5	Develop the ability to apply green IT strategies and understanding of the regulatory environment impacting IT.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Green IT Fundamentals: Business, IT, and the Environment –Environmental Impacts of IT, Green IT, Holistic Approach to Greening IT, Greening IT, Applying IT for enhancing. Environmental sustainability, Green IT Standards and Eco-Labelling of IT, Enterprise Green, IT strategy, Green IT: Burden or Opportunity?	8	1
2	**Green Devices and Hardware with Green Software**	Green Devices Hardware/Software: Introduction, Life Cycle of a device or hardware, Reuse, Recycle and Dispose, Energy-saving software techniques, Evaluating and measuring software Impact to platform power	8	2
3	**Green Assets and Modeling and Grid Framework**	Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration –Green Information Systems: Design and Development Models. Virtualization of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework	8	3
4	**Green Compliance and Social Aspects**	Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies and Future. Introduction, Strategizing Green Initiatives, Implementation of Green IT, Information Assurance, Communication and Social media	8	4
5	**Regulating the Green IT and CASE STUDIES**	Introduction, The regulatory environment and IT manufacturers, Non regulatory government initiatives, Industry associations and standards bodies, Green building standards, Green data centers, Social movements and Greenpeace. Case Studies – Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector.	8	5

Reference Books:

1- BhuvanUnhelkar, ―Green IT Strategies and Applications-Using Environmental Intelligence‖, CRC Press, June 2014.

2- Woody Leonhard, Katherine Murray, ―Green Home computing for dummies‖, August 2012.

3- Harnessing Green IT Principles and Practices , San Murugesan, G.R. Gangadharan, Wiley Publication, ISBN:9788126539680

e-Learning Source:

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

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

Integral University, Lucknow

Effective from Session: 2021-22							
Course Code	**CS348**	**Title of the Course**	**Human Computer Interaction**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**VI**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	To give the knowledge of TCP/IP protocol. To give the knowledge of packet switching and message switching. To give the knowledge of sliding window protocol. To give the knowledge of the CDMA. To give the knowledge of network layer protocols viz. Ipv4, ARP, RARP. To give the knowledge of routing. To give the knowledge of TCP & UDP. To give the knowledge of congestion control. To give the knowledge of quality of service. To give the knowledge of DNS, FTP, TELNET and remote logging.						

Course Outcomes	
CO1	Acquire fundamental concepts of computer components functions regarding interaction with human and vice versa
CO2	Analyze interface problems to recognize what design approach and interaction styles are required in the light of usability standards and guidelines.
CO3	Utilize basic concepts to construct a user-interaction strategy for a given problem its usability evaluation and to meet desired needs within realistic constraints such as social, political and ethical norms.
CO4	Ability to design and develop an interface by using appropriate HCI techniques that are preferred by the user.
CO5	Ability to apply different evaluation technique with case studies.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to user-centric design	Introduction to user-centric design – case studies, historical evolution, issues and challenges and current trend, Engineering user-centric systems – relation with software engineering, iterative life-cycle, prototyping, guidelines, case studies	8	1
2	User-centric computing	User-centric computing – framework, introduction to models, model taxonomy, Computational user models (classical) – GOMS, KLM, Fitts' law, Hick-Hymans law.	8	2
3	Computational user models	Computational user models (contemporary) 2D and 3D pointing, constrained navigation, mobile typing, touch interaction, Formal models – case study with matrix algebra, specification and verification of properties, formal dialog modeling.	8	3
4	Empirical research	Empirical research – research question formulation, experiment design, data analysis, statistical significance test. Case Study 1- Multi-Key press Hindi Text Input Method on a Mobile Phone.	8	4
5	User-centric design evaluation	User-centric design evaluation – overview of evaluation techniques, expert evaluation, user evaluation, model-based evaluation with case studies. Case Study 2 – GUI design for a mobile phone based Matrimonial application.	8	5

Reference Books:

1- Samit Bhattacharya (July, 2019). Human-Computer Interaction: User-Centric Computing for Design, McGraw-Hill India, Print Edition: ISBN-13: 978-93-5316-804-9; ISBN-10: 93-5316-804-X, E-book Edition: ISBN-13: 978-93-5316-805-6; ISBN-10: 93-5316-805-8.

2- Dix A., Finlay J.,Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.

3- Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction,Addison-Wesley, 1994.

4- B. Shneiderman; Designing the User Interface,Addison Wesley 2000 (Indian Reprint).

e-Learning Source:

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

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