NATIONAL EDUCATION POLICY-2020

Common Minimum Syllabus for all Uttarakhand State Universities and Colleges

Syllabus Proposed 2023-24

Sri Dev Suman Uttarakhand University
Badshahithol, Tehri (Garhwal)

		Subject I (Computer Science)		Subject II	Subject III	Subject IV	Vocational	Co-Curricular	Industrial Training / Survey / Research Project	{Minimum Credits} for the Year	{Cumulative Minimum Credits} Required for Award of Certificate/ Diploma/ Degree
		Major		Major	Major	Minor Elective	Minor	Minor	Major		
		4/5/6 Credits		4/5/6 Credits	4/5/6 Credits	4/5/6 Credits	3 Credits		4 Credits		
Year	Sem	Science Faculty		Science Faculty	Science/Other Faculty	Science/Other Faculty	Vocational/Skill Development Course	Co-Curricular Courses (Qualifying)	Inter/Intra Faculty related to main subject		
1	I	CS401 - Discrete Mathematics	Th (4)	N/A	N/A	To be opted by the students of other Faculty. List of offered minor elective courses is given below (**EL3)	N/A	N/A	CS411: Industrial Training/Research Project (4)	52	{184} Bachelor (Research in Computer Science)
		CS403 - Theoretical foundation of Computing	Th (4)								
		CS405 - Artificial Intelligence	Th (4)								
		CS407 - Design and Analysis of Algorithms	Th (4)								
		CS409 - Lab: Design and Analysis of Algorithms	Pract (4)								
	II	CS402 - Compiler Design	Th (4)						CS412: Industrial Training/Research Project (4)		
		CS404 - Research trends in Computer Science	Th (4)								
		CS406 - Machine Learning with Python	Th (4)								
		CS408 - Software Engineering & Software Project Management	Th (4)								
		CS410 – Lab:Machine Learning with Python	Pract (4)								

		Subject I (Computer Science)		Subject II	Subject III	Subject IV	Vocational	Co-Curricular	Industrial Training / Survey / Research Project	{Minimum Credits} for the Year	{Cumulative Minimum Credits} Required for Award of Certificate/ Diploma/ Degree
		Major		Major	Major	Minor Elective	Minor	Minor	Major		
		4/5/6 Credits		4/5/6 Credits	4/5/6 Credits	4/5/6 Credits	3 Credits		4 Credits		
Year	Sem	Science Faculty		Science Faculty	Science/Other Faculty	Science/Other Faculty	Vocational/Skill Development Course	Co-Curricular Courses (Qualifying)	Inter/Intra Faculty related to the main subject		
2	III	CS501 - Cyber Security	Th (4)	N/A	N/A	N/A	N/A	N/A	CS511: Industrial Training/Research Project (4)	48	{232} Master (Computer Science)
		CS503 - Data Mining with Python	Th (4)								
		CS505 - Digital Image Processing with OpenCV	Th (4)								
		CS507 - Internet of Things	Th (4)								
		CS509 - Lab: Advance Lab 1	Pract (4)								
	IV	CS502 - Network Security and Cryptography	Th (4)						CS512: Industrial Training/Research Project (4)		
		CS504 - Advanced Java	Th (4)								
		CS506 - Cloud Computing	Th (4)								
		CS508 - Web Application Development	Th (4)								
		CS510 - Lab: Advance Lab 2	Pract (4)								

Department of Computer Science

Semester-wise Titles of the Papers in Computer Science(Major)					
Year	**Semester**	**Course Code**	**Course Title**	**Theory/Practical**	**Credits**
Bachelor (Research In Computer Science)					
First Year	I	CS401	Discrete Mathematics	Theory	4
		CS403	Theoretical Foundation of Computing	Theory	4
		CS405	Artificial Intelligence	Theory	4
		CS407	Design and Analysis of Algorithms	Theory	4
		CS409	Lab:Design and Analysis of Algorithms	Practical	4
		CS411	Industrial Training/Research Project		4
	II	CS402	Compiler Design	Theory	4
		CS404	Research Trends in Computer Science	Theory	4
		CS406	Machine Learning with Python	Theory	4
		CS408	Software Engineering & Software Project Management	Theory	4
		CS410	Lab:Machine Learning with Python	Practical	4
		CS412	Industrial Training/Research Project		4
Master of Science (Computer Science)					
Second Year	III	CS501	Cyber Security	Theory	4
		CS503	Data Mining with Python	Theory	4
		CS505	Digital Image Processing with OpenCV	Theory	4
		CS507	Internet of Things	Theory	4
		CS509	Lab: Advance Lab 1	Practical	4
		CS511	Industrial Training/Research Project		4
	IV	CS502	Network Security and Cryptography	Theory	4
		CS504	Advanced Java	Theory	4
		CS506	Cloud Computing	Theory	4
		CS508	Web Application Development	Theory	4
		CS510	Lab: Advance Lab 2	Practical	4
		CS512	Industrial Training/Research Project		4

**List of Elective Papers offered by the department (EL3)					
S. No.	**Course Code**	**Course Title**		**Credits**	**To be opted in the Semester**
1	CS413E	Basics of Remote sensing, GIS & GNSS technology and their applications (SWAYAM) https://onlinecourses.swayam2.ac.in/aic22_ge16/preview	Theory	4	VII/VIII
3	CS414E	Digital Forensics(SWAYAM) https://onlinecourses.swayam2.ac.in/nou22_cs05/preview	Theory	4	VII/VIII
4	CS415E	E-Commerce Technologies(SWAYAM) https://onlinecourses.swayam2.ac.in/cec22_mg05/preview	Theory	4	VII/VIII

Programme outcomes (POs):	
PO 1	Gain a complete exposure to the theories and practices of Computer science.
PO 2	Get transformed into a skilled learner and active programmer, enabling the students to focus on their higher studies.
PO 3	Value computer professionals and programmers.
PO 4	Explore how the concepts and applications of Computer science lead to innovative thinking with a problem-solving attitude.
Programme specific outcomes (PSOs): Bachelor (Research In Computer Science)	
PSO 1	Learn the concepts of software development life cycle models.
PSO 2	Discuss the key technological components of the Network.
PSO 3	Gain knowledge of advanced and sophisticated data structures, their mechanism, operations, and interconnection with algorithms.
PSO 4	Analyze & implement required module, which may include front-end, back-end, and a small set of middle-end optimizations.
Programme specific outcomes (PSOs): Master of Science (Computer Science)	
PSO 1	To demonstrate an understanding of the principles and mechanisms of theconceptual and software aspects of computer systems.
PSO 2	To become able to understand the design, architecture, and developmentmethodologies of computational techniques and software systems.
PSO 3	To possess professional knowledge and skills of the software design process.Familiarity and practical competence with current programming languages,technologies, and open-source platforms.
PSO 4	To polish project development skills with insight into real-world problems,enhancement of researcher aptitude to solve them, and to work in a team cooperatively.

Year-wise Structure of M.Sc. in Computer Science (CORE / ELECTIVE COURSES & PROJECTS)																
Subject: Computer Science																
Programme	**Year**	**Sem**	**Paper I**	**Credit /hrs**	**Paper 2**	**Credit /hrs**	**Paper 3**	**Credits /hrs**	**Paper 4**	**Credits /hrs**	**Paper 5**	**Credits /hrs**	**Elective Paper**	**Credits /hrs**	**Research Project**	**Credits /hrs**
Bachelor (Research in Computer Science)	I	I	Discrete Mathematics	4/60	Theoretical Foundation of Computing	4/60	Artificial Intelligence	4/60	Design and Analysis of Algorithms	4/60	Lab: Design and Analysis of Algorithms	4/60	***Elective Paper [from the list] EL3		Industrial Training/ Research Project	4/60
		II	Compiler Design	4/60	Research trends in Computer Science	4/60	Machine Learning with Python	4/60	Software Engineering	4/60	Lab: Machine Learning with Python	4/60	***Elective Paper [from the list] EL3		Industrial Training/ Research Project	4/60
Master in Computer Science	II	III		4/60	Data Mining with Python	4/60	Digital Image Processing with OpenCV	4/60	Internet of Things	4/60	Lab: Advance Lab 1	4/60			Industrial Training/ Research Project	4/60
		IV	Network Security and Cryptography	4/60	Advanced Java	4/60	Cloud Computing	4/60	Web Application Development	4/60	Lab: Advance Lab 2	4/60			Industrial Training/ Research Project	4/60

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**I
Course Code: CS401	**Course Title:** Discrete Mathematics		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Analyze logical propositions via truth tables.		
CO 2:	Understand and construct correct mathematical arguments.		
CO 3:	Understand sets and perform operations and algebra on sets.		
CO 4:	Determine properties of relations, identify equivalence and partial order relations, sketch relations.		
CO 5:	Identify functions and determine their properties.		
CO 6:	Understand algebraic structures.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Propositional Logic: Propositions, Logical connectives, Compound propositions, Conditional and biconditional propositions, Truth tables, Tautologies and contradictions, Contrapositive, Logical equivalences and implications, DeMorgan's Laws, Normal forms, Principal conjunctive and disjunctive normal forms, Rules of inference, Arguments, Validity of arguments.	8
II	Predicate Calculus: Predicates, Statement function, Variables, Free and bound variables, Quantifiers, Universe of discourse, Logical equivalences and implications for quantified statements, Theory of inference, The rules of universal specification and generalization, Validity of arguments.	12
III	Set Theory: Basic concepts, Notations, Subset, Algebra of sets, The power set, Ordered pairs and Cartesian product, Relations on sets, Types of relations and their properties, Relational matrix and the graph of a relation, Partitions, Equivalence relations, Partial ordering, Poset, Hasse diagram, Lattices and their properties, Sublattices, Boolean algebra, Homomorphism.	16
IV	Functions: Definitions of functions, Classification of functions, Type of functions, Examples, Composition of functions, Inverse functions, Binary and n-ary operations, Characteristic function of a set, Hashing functions, Recursive functions, Permutation functions.	12
V	Groups: Algebraic systems, Definitions, Examples, Properties, Semigroups, Monoids, Homomorphism, Sub semigroups and Submonoids, Cosets and Lagrange's theorem, Normal subgroups, Normal algebraic system with two binary operations.	12

Suggested Readings:

- Richard Johnsonbaugh, "Discrete Mathematics", Pearson Pub.
- Kenneth H. Rosen, "Discrete Mathematics and Its Applications", Tata McGraw-Hill Pub.
- Harry Lewis, Rachel Zax, "Essential Discrete Mathematics for Computer Science" Princeton University Press Pub.

Suggested equivalent online courses:

- https://nptel.ac.in/courses/106/106/106106183/
- https://nptel.ac.in/courses/106/103/106103205/

This course can be opted as an elective by the students of the following subjects: Students of B.Sc. with Mathematics/Statistics as a major subject

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	**Marks**
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: To study this course, a student must have had the subject Mathematics in class 12thand B.Sc.

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**I
Course Code: CS403	**Course Title:** Theoretical Foundation of Computing		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Introduce the basic preliminaries and theoretical foundations of computer science.		
CO 2:	Understanding of the notion of a regular set and its representation by DFA's, NFA's, and regular expressions.		
CO 3:	Design of the notion of a context-free language and its representation by context-free grammars and push-down automata.		
CO 4:	Construction of the notion of a universal model of computation and its representation by a Turing machine.		
CO 5:	Basic understanding of the notion of an undecidable problem.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	FINITE AUTOMATA (FA): Introduction, Deterministic Finite Automata (DFA) - Formal definition, simpler notations (state transition diagram, transition table), language of a DFA. Nondeterministic Finite Automata (NFA)- Definitionof NFA, language of an NFA, Equivalence of Deterministic and Nondeterministic Finite Automata, Applications of Finite Automata, Finite Automata with Epsilon Transitions, Eliminating Epsilon transitions, Minimization of Deterministic Finite Automata, Finite automata with output (Moore and Mealy machines) and Interconversion.	12
II	REGULAR EXPRESSIONS (RE): Introduction, Identities of Regular Expressions, Finite Automata and Regular Expressions- Converting from DFA's to Regular Expressions, Converting Regular Expressions to Automata, applications of Regular Expressions. REGULAR GRAMMARS: Definition, regular grammar and FA, FA for regular grammar, Regular grammar for FA. Proving languages to be non-regular -Pumping lemma, applications, Closure properties of regular languages.	12
III	CONTEXT FREE GRAMMER (CFG): Derivation Trees, Sentential Forms, Rightmost and Leftmost derivations of Strings. Ambiguity in CFGs, Minimization of CFGs, CNF, GNF, Pumping Lemma for CFLs.	12
IV	PUSHDOWN AUTOMATA: Definition, Model, Acceptance of CFL, Acceptance by Final State and Acceptance by Empty stack and its Equivalence, Equivalence of CFG and PDA. TURING MACHINES (TM): Formal definition and behaviour, Languages of a TM, TM as accepters, and TM as a computer of integer functions, Types of TMs.	12
V	RECURSIVE AND RECURSIVELY ENUMERABLE LANGUAGES (REL): Properties of recursive and recursively enumerable languages, Universal Turing machine, The Halting problem, Undecidable problems about TMs. Context-sensitive language and linear bounded automata (LBA), Chomsky hierarchy, Decidability, Post's correspondence problem (PCP), undecidability of PCP.	12

Suggested Readings:

- John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman (2007), Introduction to Automata Theory Languages andComputation, 3rdedition, Pearson Education, India.
- Dexter C. Kozen, Automata and Computability, Springer Publishers, 2007.

Suggested equivalent online courses:

- https://nptel.ac.in/courses/106/106/106106049/
- https://nptel.ac.in/courses/106/104/106104148/
- https://nptel.ac.in/courses/106/105/106105196/

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	**Marks**
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites:B.Sc. with Computer Science as a major subject

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**I
Course Code: CS405	**Course Title:** Artificial Intelligence		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Understand the basics of Artificial Intelligence.		
CO 2:	Gain knowledge of the learning process and its models.		
CO 3:	Understand the AI applications in the design of expert systems.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Introduction:AI problems, the foundation of AI and history of AI intelligent agents: Agents and Environments, the conceptof rationality, the nature of environments, structure of agents, problem-solving agents, problemformulation	12
II	Problem-Solving Methods: Searching for solutions, uniformed search strategies, Breadth-first search, depth-first Search, Search with partial information (Heuristic search) Hill climbing, A*,AO* Algorithms, Problemreduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayergames, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.	12
III	Knowledge Representation: First Order Predicate Logic, Prolog Programming, Unification, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information	12
IV	Natural Language Processing: Introduction, Problems in Natural Language Understanding, Overview of Linguistics, Grammars and Languages, Natural Language Generation, Natural Language Systems, Top-Down Parser, Bag of Words Model.	12
V	Evolutionary Computation, Genetic Algorithms, Terminologies and Operators of GA, Ant Colony Optimization, Particle Swarm Optimization, GA Tool usingPython/OCTAVE/R etc.	12

Suggested Readings:

- Russel and Norvig, “AI: A modern approach”, Pearson Education
- Elian Rich and Kelvin Knight, “AI”, TMH
- Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”
- K M FU,” Neural Network in Computer Intelligence”, Mc Graw Hill

Suggested equivalent online courses:

- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/lecture-videos/
- https://nptel.ac.in/courses/106/102/106102220/
- https://nptel.ac.in/courses/106/105/106105078/

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5

	Quiz/ Assignments	5	
	Seminar/Presentation	5	
	Unit Test/Class Test	10	
	Total	25	
Course Prerequisites: B.Sc. with Computer Science as a major subject			

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**I
Course Code: CS407	**Course Title:** Design and Analysis of Algorithms		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Learn the basic and advanced design and analysis procedures.		
CO 2:	Gain knowledge of advanced and sophisticated data structures, their mechanism, operations, and interconnection with algorithms.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Algorithms, Analysis of Algorithm, Design of Algorithms, Time and space complexities, Asymptotic notations, Growth+ of Functions, Recurrences. Sorting in Polynomial Time: Insertion Sort, Merge Sort, Heap sort, and Quick Sort. Sorting in Linear Time: Counting Sort, Radix Sort, Bucket Sort	12
II	Elementary Data Structure: Stacks, Queues, Linked List, Binary Search Tree, Hash Table, Red-Black Trees, AVL Tree, Splay Tree, Augmenting Data Structure Advanced Data Structure: Binomial Heap, B-tree, Fibonacci Heap, and Data Structure for Disjoint sets.	12
III	Advanced Design and Analysis Techniques: Dynamic Programming, Greedy Algorithm, Backtracking, Branch- and- Bound. Huffman Coding.	12
IV	Graph Algorithms: Elementary Graph Algorithm, Breadth First Search, Depth First Search, Minimum Spanning Tree, Kruskal's Algorithm, Prim's Algorithm, Single Source Shortest Path, All Pair Shortest Path, Maximum Flow and Travelling Salesman Problem.	12
V	Randomized Algorithm: String Matching, NP-Hard and NP-Completeness, Approximation Algorithms.	12

Suggested Readings:

- T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein. Introduction to Algorithms, MIT Press, 3rd edition, 2009. ISBN 0-262-03384-4
- Horowitz Sahni, "Fundamentals of Computer Algorithm", Galgotia.
- M.T. Goodrich etal, "Algorithms Design", John Wiley and Sons.

Suggested equivalent online courses:

- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-046j-introduction-to-algorithms-sma-5503-fall-2005/
- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/index.htm
- https://nptel.ac.in/courses/106/106/106106131/
- https://nptel.ac.in/courses/106/101/106101060/

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5

	Unit Test/Class Test	10	
	Total	25	
Course Prerequisites: B.Sc. with Computer Science as a major subject			

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**I
Course Code: CS409	**Course Title:** Lab: Design and Analysis of Algorithms		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Design and implement various algorithms effectively.		
CO 2:	Implement various Searching and Sorting algorithm and understand their performance in terms of Space and Time complexity.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
	Write a program to implement: 1. Insertion sort 2. Merge sort 3. Heap sort 4. Quick sort 5. Counting sort 6. Radix sort 7. Bucket sort 8. Stack 9. Queue 10. Binary Search tree 11. AVL tree 12. Red black tree 13. Breadth-first search 14. Depth-first search 15. A topological ordering of vertices 16. Minimum Cost Spanning Tree using Prim's algorithm 17. Minimum Cost Spanning Tree using Kruskal's algorithm 18. Implement 0/1 Knapsack problem using Dynamic Programming. 19. N Queen's problem using Back Tracking. 20. Dijkstra's algorithm	60

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Record File	5
Viva Voce	5
Practical Assessment	15
Total	25

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**II
Course Code: CS402	**Course Title:** Compiler Design		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Understand the fundamentals of the compiler and identify the relationships among different phases of the compiler.		
CO 2:	Understand the application of finite state machines, recursive descent, production rules, parsing, and language semantics.		
CO 3:	Analyze & implement the required modules, which may include front-end, back-end, and a small set of middle-end optimizations.		
CO 4:	Use modern tools and technologies for designing new compilers.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Introduction to compilers:Structure of a compiler, Lexical Analysis, Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, Lex, Finite Automata, Regular Expressions to Automata, Minimizing DFA.	12
II	Syntax Analysis: Role of Parser, Grammars, Error Handling, Context-free grammars, Writing a grammar, Top Down Parsing, General Strategies Recursive Descent Parser Predictive Parser, LL(1) Parser, Shift Reduce Parser, LR Parser, LR (0)Item, Construction of SLR Parsing Table, Introduction to LALR Parser, Error Handling and Recovery in Syntax Analyzer, YACC.	12
III	Semantic Analysis and Intermediate Code Generation: Introduction to semantic analysis, Type checking and type conversions, Symbol tables, and attribute grammar Intermediate code generation: three-address code, quadruples, and postfix notation	12
IV	Run-time environment and code generation: Storage Organization, Stack Allocation Space, Access to Non-local Data on the Stack, Heap Management Issues in Code Generation,and Design of a simple Code Generator.	12
V	Code Optimization: Principal Sources of Optimization, Peep-hole optimization, DAG, Optimization of Basic Blocks, Global Data Flow Analysis, Efficient Data Flow Algorithm.	12

Suggested Readings:

- Compilers Principles, Techniques and Tools, Second Edition, Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman., Pearson.
- Compiler Design, K. Muneeswaran., Oxford University Press, 2012

Suggested equivalent online courses:

- **https://nptel.ac.in/courses/106/105/106105190/**

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5

	Seminar/Presentation	5	
	Unit Test/Class Test	10	
	Total	25	
Course Prerequisites: B.Sc. with Computer Science as a major subject			

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**II
Course Code: CS404	**Course Title:**Research Trends in Computer Science		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Understand the fundamentals of the latest trends in Computer Science Research.		
CO 2:	Learn about the workings of the latest technologies like web3 & IoT.		
CO 3:	Analyze problems related to soft computing.		
CO 4:	Solve statistical data problems using R.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Introduction to Research Oriented AI: Introduction to AI, Modern Research Trends in AI, Introduction to, Deep Learning, NLP, Computer Vision, Big Data Analysis, Applications of AI, AI for Healthcare, AI for Education, AI for Commerce.	12
II	Introduction to Blockchain and Web3: Introduction to Blockchain, Blockchain design principle, Blockchain ecosystem, Implementation challenges, Applications of Blockchain Systems, Cryptocurrency, Decentralization, Introduction to Web3.	12
III	Introduction to Soft Computing:What is Soft Computing?Why Soft Computing is needed?Soft Computing techniques: Neural networks, Swarm intelligence	12
IV	Introduction to fuzzy logic, Fuzzy Sets and Membership, Chance versus Ambiguity. Classical Sets - Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions Fuzzy Sets - Fuzzy Set operations, Properties of Fuzzy Sets.	12
V	Introduction to R: Introduction to R interpreter, R data structures like vectors, matrices, arrays, list and data frames, Control Structures, vectorized if and multiple selections, functions, Statistical analysis of data for summarizing and understanding data, Visualizing data.	12

Suggested Readings:

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Suggested equivalent online courses:

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This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites:B.Sc. with Computer Science as a major subject

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:** 1st	**Semester:** II
Course Code: CS406	**Course Title:** Machine Learning with Python		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Develop an appreciation for what is involved in Learning models from data		
CO 2:	Understand a wide variety of learning algorithms		
CO 3:	Understand how to evaluate models generated from data		
CO 4:	Apply the algorithms to a real-world problem.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	

Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0

Unit	Topic	No. of Lectures
I	Introduction: Machine Learning Definitions, Application of Machine Learning, Problems, Data and Tools, Python for Machine Learning, Data Pre-processing in Python	12
II	Regression: Linear Regression-Simple, Multiple, Polynomial Regression, Support Vector Regression, Regression Trees, Evaluating Regression Models Performance	12
III	Classification: Logistic Regression, K-Nearest Neighbors (K-NN), SVM, Naïve Bayes, Decision tree and Random Forest, Artificial Neural Network, The Neuron, The Activation Function, Neural Networks Working, How Neural Networks Learn, Gradient Descent, Stochastic Gradient Descent, Backpropagation,	12
IV	Convolution Neural Networks: What is Convolutional Neural Network, Foundation of Convolutional Neural Network, ResNet Case Study, Object Detection, Application: Face Recognition and Style Transfer	12
V	Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference Systems, Coactive Neuro-Fuzzy Modeling, Rule base Structure Identification, ANFIS Applications.	12

Suggested Readings:

- Machine Learning Algorithms by Giuseppe Bonaccorso
- Hands-on Machine Learning with Scikit-Learn, Keras& TensorFlow
- Make Your Own Neural Network by Tariq Rashid
- Neural Networks Math A Visual Introduction for Beginners by Michael Taylor

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: B.Sc. with Computer Science as a major subject

Subject: Computer Science			
Programme/Class: Bachelor (Research In Computer Science)		**Year:**1st	**Semester:**II
Course Code: CS408	**Course Title:** Software Engineering& Software Project Management		
Course outcomes:	After successful completion of the course the student should be able to :		
CO 1:	Learn the concepts of software developmentlife cycle models.		
CO 2:	Develop correct and robust softwareproducts by gathering requirements.		
CO 3:	Analyze various metrics for the estimation ofsoftware.		
CO 4:	Manage and maintain Software Projects toensure good quality software with highreliability.		
CO 5:	Gain knowledge in different Key ProcessAreas like planning and estimation ofsoftware projects, implementation issues,validation, and verification procedures.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	**Introduction**: Software Engineering vs. Traditional Programming, System Development Life Cycle (SoftwareProduction Process, Conception, Initiation, Analysis Design, Construction, Testing, Implementation). WaterfallModel, Evolutionary Model. Factors affecting Software Development and Maintenance.	12
II	**Software Project Management**: Defining the Problem, developing a Solution Strategy, Planning theDevelopment Process, Measurement of Software Productivity and Quality.	12
III	**Software Engineering Principles &Tools**: Tools of Design (Data Flow Diagrams, Data Dictionary, DecisionTree, Decision Tables), Modularization (Coupling).	12
IV	**Testing**: Testing fundamentals, Unit testing, Blackbox testing, Whitebox testing, Basic Path testing, ControlStructure testing, Integration testing.	12
V	**Software maintenance**: Introduction to Software Maintenance, Enhancing Maintainability during development (analysis Activities, Standards, and Guidelines, Design activities, Implementation Activities, Supporting Documents) Managerial Aspects of Software Maintenance (Change Control Board, ChangeRequest summaries, Quality Assurance Activities, Organizing Maintenance Programs).	12

Suggested Readings:

- R.S.Pressman, "Software Engineering A Practitioners Approach" McGraw Hill.
- R.F.Fairley, "Software Engineering Concepts", McGraw Hill

Suggested equivalent online courses:

- https://nptel.ac.in/courses/106/105/106105087/

This course can be opted as an elective by the students of the following subjects:B.Sc. with mathematics/statistics as a major subject.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10

	Total	25	
Course Prerequisites: To study this course, a student must have had the subject mathematics in class 12^{th} and B.Sc.			

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**1st	**Semester:**II
Course Code: CS410		**Course Title:**Lab: Machine Learning with Python	
Course Outcomes:	On completion of the course, the student will be able to:		
CO 1:	Solve Data Analysis Problems using various Machine Learning algorithms.		
CO 2:	Analyze and Implement Digital Image Processing Techniques.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. ofLectures-Tutorials-Practical (in hours per week): 0-0-4			

Unit	Topic	No. of Lectures
	Lab Experiment List	
	1. Process Excel sheet using Python Pandas and visualize the dataset using matplotlib. 2. Apply Data Preprocessing Techniques of Encoding, Scaling and Imputation using Python Libraries in a given Data Set. 3. Apply Simple Linear Regression and Predict Values for a Given Dataset using Python Libraries. 4. Apply Multiple Regression and Predict Values for a Given Dataset using Python Libraries. 5. Apply Polynomial Regression and Predict Values for a Given Dataset using Python Libraries. 6. Apply Support Vector Regression and Predict Values for a Given Dataset using Python Libraries. 7. Compare Results of previous Regression Models. 8. Apply Logistic Regression to Solve the Classification problem for the given dataset. Generate a Confusion Matrix and Calculate Accuracy. 9. Apply KNN Classifier to Solve the Classification problem for the given dataset. Generate a Confusion Matrix and Calculate Accuracy. 10. Apply the Naive Bayes Classifier to Solve Classification problems for a given dataset. Generate a Confusion Matrix and Calculate Accuracy. 11. Apply Decision Tree and Random Forest Classifiers o Solve Classification problems for a given dataset. Generate a Confusion Matrix and Calculate Accuracy. 12. Compare Results of previous Classification Models. 13. Write a Program in Python to Implement ANN from Scratch and test the model on NIMST Handwriting Dataset. 14. Use a CNN model to Classify Images of Cats and Dogs.	**60**

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Record File	5
Viva-Voce	5
Practical Assessment	15
Total	25

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**III
Course Code: CS501	**Course Title:**Cyber Security		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Understanding the principles of Cyber Security: This includes gaining a comprehensive understanding of the concepts, theories, and practices of Cyber Security.		
CO 2:	Developing skills to protect computer systems: This includes developing skills to secure networks, computers, and other electronic devices from unauthorized access, data theft, and other security threats.		
CO 3:	Understanding Cyber Security threats: This includes gaining knowledge about various Cyber Security threats such as malware, phishing, hacking, and other cyber-attacks.		
CO 4:	Developing skills in Cyber Security tools and technologies: This includes gaining knowledge about the latest Cyber Security tools and technologies such as firewalls, antivirus software, intrusion detection systems, and encryption techniques.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Introduction to Cyber Security: Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats: - Cyber Warfare-Cyber Crime-Cyber Terrorism-Cyber Espionage, need for a Comprehensive Cyber Security Policy, need for a Nodal Authority, Need for an International Convention on Cyberspace.	12
II	Cyber Security Vulnerabilities and Cyber Security Safeguards: Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.	12
III	Securing Web Application, Services, and Servers: Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, and Challenges.	12
IV	Intrusion Detection and Prevention: Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsiders, Malware infection, Intrusion Detection and Prevention Techniques, Anti-Malware software, Network- based Intrusion Detection Systems, Network-based Intrusion Prevention Systems, Host-based Intrusion Prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.	12
V	Cryptography and Network Security: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPsec.	12

Suggested Readings:

- Cyber Security by Nina Godbole Sunit Belapure
- Cybersecurity - Attack and Defense Strategies: Infrastructure security with Red Team and

Blue Team tactics by Yuri Diogenes

- Cryptography and Network Security by Forouzan
- The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws by Dafydd Stuttard

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	**Marks**
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: Bachelor (Research In Computer Science)

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**III
Course Code: CS503	**Course Title:** Data Mining with Python		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Understand standard data mining methods and techniques such as association rules, data clustering, and classification.		
CO 2:	Learn new, advanced techniques for Data Warehousing.		
CO 3:	Gain practical intuition about how to apply these techniques to real-life datasets.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Introduction to Data Mining: What is data mining? Related technologies - Machine Learning, DBMS, OLAP, Statistics, Data Mining Goals, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, Applications Data Warehouse and OLAP: Data Warehouse and DBMS, Multidimensional data model, OLAP operations	12
II	A brief introduction to python language, literals, functions, operators, and anonymous functions. Introduction to Python packages for data science- NumPy, pandas, matplotlib,cubes.	12s
III	Data preprocessing:Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies Data mining knowledge representation: Task relevant data, Background knowledge, Interestingness measures, Representing input data and output knowledge, Visualization techniques	12
IV	Attribute-oriented analysis:Attribute generalization, Attribute relevance, Class comparison, Statistical measures Data mining algorithms: Association rules, Motivation and terminology ,Example: mining weather data, Basic idea: item sets , Generating item sets and rules efficiently, Correlation analysis	12
V	Data mining algorithms: Classification, Basic learning/mining tasks, Inferring rudimentary rules: 1R algorithm, Decision trees, Covering rules Data mining algorithms: Prediction, The prediction task, Statistical (Bayesian) classification, Bayesian networks, Instance-based methods (nearest neighbor) Linear models, Implementation of these techniques in Python	12

Suggested Readings:

- Introduction to Data Mining Tan, Steinbach, & Kumar Pearson-Addison Wesley 2006
- Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management (2nd eds) Berry & Linoff Wiley 2004
- Data Mining and Data Warehousing: Principles and Practical Techniques
- Mastering Data Mining with Python - Find patterns hidden in your data

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	**Marks**
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: Bachelor (Research In Computer Science)

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**III
Course Code: CS505	**Course Title:** Digital Image Processing with OpenCV		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Review the fundamental concepts of a digital image processing system.		
CO 2:	Analyze images in the frequency domain using various transforms		
CO 3:	Evaluate the techniques for image segmentation and object detection.		
CO 4:	Categorize various compression techniques.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Digital Image Processing System, Image Perception, Colour Representation, Image Acquisition, Image Digitization, Image model, Image scanning techniques, Noise, Image Processors, A brief overview of OpenCV, Installing OpenCV in Windows, Linux, how are Images formed and stored	12
II	Gray Level Transformation, Histogram Processing, Grey Level Transformation Techniques, Multi Image Operations, OpenCV-Gray scaling, histogram representation of images, drawing over images, Transformation, Scaling, Cropping, Darkening/Brightening Images, Masking Blurring, and Sharpening	12
III	Segmentation, Region Based Segmentation, Thresholding, Basic Edge Detection, Colour Edge Detection, Pyramid Edge Detection, OpenCV – Edge Detection using Image Gradient, Segmentation and Contours, Link Detection, Circle Detection, and Blob Detection	12
IV	System Component, Complexity of Object Recognition, Object Representation, Feature Detection, Recognition Strategies. OpenCV-Finding Corners, Extracting Features, Face Detection using HAAR's Cascade. Basic morphology operations: dilation and erosion, Structuring elements and their properties, Opening and closing operations, Hit-or-miss transform, Boundary extraction	12
V	Introduction to Image compression, Basic Requirements, Different Types of Compressions, Coding algorithms: Run Length Coding, Huffman Coding LZW, JPEG	12

Suggested Readings:

- S. Nagabhushana, "Computer Vision and Image Processing", New Age International Publishers.
- Rosenfield, "Digital Picture Processing", KAK Academic Press Orlando
- Gonzalez and Wintz, "Digital Image Processing", Addison Wesley
- Anil K. Jain, "Fundamentals of Digital Image Processing"

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5

	Unit Test/Class Test	10	
	Total	25	
Course Prerequisites: Bachelor (Research In Computer Science)			

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**III
Course Code: CS507	**Course Title:** Internet of Things		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Understand the definition and significance of the Internet of Things		
CO 2:	Discuss the architecture, operation, and benefits of an IoT solution		
CO 3:	Analyze and Evaluate various Protocols and their application in the IoT landscape.		
CO 4:	Understand the definition and significance of the Internet of Things		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, and standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking	12
II	Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints- hardware is popular again, Data representation and visualization, Interaction, and remote control	12
III	IOT DATA LINK LAYER & NETWORK LAYER PROTOCOLS: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP	12
IV	TRANSPORT & SESSION LAYER PROTOCOLS: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)- (TLS, DTLS) – Session Layer HTTP, CoAP, XMPP, AMQP, MQTT	12
V	SERVICE LAYER PROTOCOLS & SECURITY: Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer	12

Suggested Readings:

- Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From
- Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition,Academic Press, 2014.
- Peter Waher, “Learning Internet of Things”, PACKT publishing, BIRMINGHAM – MUMBAI
- Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-onApproach)”, 1st Edition, VPT, 2014.

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5

	Unit Test/Class Test	10	
	Total	25	
Course Prerequisites: Bachelor (Research In Computer Science)			

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**III
Course Code: CS509		**Course Title:** Lab: Advanced Lab 1	
Course Outcomes:	On completion of the course, the student will be able to:		
CO 1:	Solve Data Analysis Problems using various Machine Learning algorithms.		
CO 2:	Analyze and Implement Digital Image Processing Techniques.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. ofLectures-Tutorials-Practical (in hours per week): 0-0-4			

Unit	Topic	No. of Lectures
	Lab Experiment List	
	1. Image Enhancement using OpenCV. 2. Edge Detection using OpenCV. 3. Face Detection using OpenCV. 4. Segmentation Technique using OpenCV. 5. Parse a webpage online and create a dataset from it saving it to an excel sheet. 6. Build a simple home automation system that can control lights, temperature, and other appliances using an IoT platform like Raspberry Pi or Arduino. 7. IoT sensors collect data on temperature, humidity, air quality, and other environmental factors, and visualize the data using a dashboard or mobile app. 8. IoT system to track and monitor assets such as vehicles, equipment, or inventory using GPS or RFID technology. 9. IoT system to monitor soil moisture, temperature, and humidity in a farm, and control irrigation systems and other farming equipment.	**60**

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Record File	5
Viva-Voce	5
Practical Assessment	15
Total	25

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**IV
Course Code:CS502	Course Title: Network Security and Cryptography		
Course outcomes:	After successful completion of the course, thestudents should be able to :		
CO 1:	Identify the security issues in the networkand resolve them.		
CO 2:	Analyze the vulnerabilities in any computingsystem and hence be able to design a securitysolution.		
CO 3:	Evaluate security mechanisms usingrigorous approaches by key ciphers and Hashfunctions.		
CO 4:	Demonstrate various network securityapplications, IPSec, Firewall, IDS, WebSecurity, Email Security, Malicioussoftware, etc.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	An illustrative communication game – safeguard versus attack – probability and Information Theory -Algebraic foundations – Number theory.	12
II	Substitution Ciphers – Transposition Ciphers – Classical Ciphers – DES – AES – Confidentiality Modes ofOperation – Key Channel Establishment for symmetric cryptosystems.	12
III	Diffie-Hellman Key Exchange protocol – Discrete logarithm problem – RSA cryptosystems & cryptanalysis –ElGamal cryptosystem – Need for stronger Security Notions for Public key Cryptosystems – Combination ofAsymmetric and Symmetric Cryptography – Key Channel establishment for Public key Cryptosystems - DataIntegrity techniques – Symmetric techniques - Asymmetric techniques	12
IV	Authentication Protocols Principles – Authentication protocols for Internet Security – SSH Remote logicprotocol – Kerberos Protocol – SSL & TLS – Authentication frame for public key Cryptography – Directory-Based Authentication framework – Non - Directory Based Public-Key Authentication framework.	12
V	Protecting Programs and Data – Information and the Law – Rights of Employees and Employers – SoftwareFailures – Computer Crime – Privacy – Ethical Issues in Computer Security	12

Suggested Readings:

- William Stallings, "Cryptography and Network Security: Principles and Practice", PHI
- Atul Kahate, "Cryptography and Network Security"

Suggested equivalent online courses:

- https://nptel.ac.in/courses/106/105/106105162/

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: Bachelor (Research In Computer Science)

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**IV
Course Code: CS504	**Course Title:** Advanced Java		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Remember the fundamentals of JAVA Programming.		
CO 2:	Understand Java Server Technologies and Create Web Server Applications		
CO 3:	Analyze various Mail Protocols and Build Mailing Applications.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Array and String, Multithreading, Collection Framework, Java Generics, Java Database Connectivity (JDBC) Java Server Pages (JSP):Introduction to JSP, JavaBeans, JSP tags, Expression Language (EL)	12
II	Servlets:Introduction to Servlets, HTTP Protocol, Servlet Life Cycle, Servlet API Enterprise Java Beans (EJB):Introduction to EJB, Session Beans, Entity Beans, Message-Driven Beans	12
III	Web Services:Introduction to Web Services, SOAP and RESTful web services, XML and JSON, WSDL and UDDI Design Patterns:Introduction to Design Patterns, Creational patterns, Structural patterns, Behavioral patterns	12
IV	Spring Framework:Introduction to Spring Framework, Inversion of Control (IoC), Dependency Injection (DI), Spring MVC framework	12
V	Hibernate:Introduction to Hibernate, Hibernate architecture, Hibernate mapping, Hibernate Query Language (HQL)	12

Suggested Readings:

- Murachs Java Servlets & JSP (Murach: Training & Reference)
- Head First Servlets & JSP: Passing the Sun Certified Web Component Developer Exam
- Web Development with Java: Using Hibernate, JSPs, and Servlets Kindle Edition

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: Bachelor (Research In Computer Science)

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**IV
Course Code:CS506	**Course Title:** Cloud Computing		
Course outcomes:	After successful completion of the course thestudent should be able to:		
CO 1:	Define cloud computing and relatedconcepts		
CO 2:	Understand the key dimensions of thechallenges and benefits of Cloud Computing		
CO 3:	Understand the hardware necessary for cloudcomputing and how components fit together.		
CO 4:	Determine the suitability of in-house v/shosted solutions		
CO 5:	Understanding the systems, protocols, andmechanisms to support cloud computing anddevelop applications for cloud computing.		
CO 6:	Determine numerous opportunities exist forpractitioners seeking to create solutions forcloud computing		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	

Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0

Unit	Topic	No. of Lectures
I	Cloud Computing Overview, Recent trends in Computing, Grid Computing, Cluster Computing, DistributedComputing, Utility Computing, Cloud Computing,	10
II	Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Benefits andlimitations of Cloud Computing,	10
III	Cloud Computing Architecture, Comparison with traditional computing architecture (client/server), Servicesprovided at various levels, Service Models- Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), How Cloud Computing Works, deployment Models- Public cloud, Private cloud,Hybrid cloud, Community cloud, a Case study of NIST architecture.	10
IV	Service Management in Cloud Computing, Service Level Agreements (SLAs), Billing & Accounting, ComparingScaling Hardware: Traditional vs. Cloud, Economics of scaling	10
V	Cloud Security: Infrastructure Security- Network level security, Host level security, Application level security,Data security, and Storage- Data privacy and security Issues, Jurisdictional issues raised by Data location,Authentication in cloud computing	10
VI	AWS Overview, Designing Highly Available, Cost-efficient, Fault-tolerant, and Scalable Systems, Identity Access Management (IAM), Amazon Virtual Private Cloud (VPC), Elastic Compute Cloud (EC2), Amazon Simple Storage Service (S3),Amazon Route 53,Databases,Application Services, Security Practices for Optimum Cloud Deployment, Disaster Recovery.	10

Suggested Readings:

- Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines,Wiley-India, 2010

Suggested equivalent online courses:

- https://nptel.ac.in/courses/106/105/106105167/

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	**Marks**
Class Interaction	5
Quiz/ Assignments	5
Seminar/Presentation	5
Unit Test/Class Test	10
Total	25

Course Prerequisites: Bachelor (Research In Computer Science)

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**IV
Course Code:CS508	**Course Title:** Web Application Development		
Course outcomes:	After successful completion of the course thestudent should be able to:		
CO 1:	Understand the best technologies for solving web client/server problems		
CO 2:	Analyze and design real-time web applications		
CO 3:	Use Javascript for dynamic effects and to validate form input entry		
CO 4:	Analyze to Use appropriate client-side or Server-side applications		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			

Unit	Topic	No. of Lectures
I	Introduction to HTML: Basics of HTML, formatting, and fonts, commenting code, hyperlink, lists, tables, images, forms, Meta tags, Character entities, frames and frame sets, Overview, and features of HTML5.	12
II	Style Sheets: Need for CSS, Introduction to CSS, basic syntax and structure, using CSS, background images, colors, and properties, manipulating texts, using fonts, borders, and boxes, margins, padding lists, positioning using CSS	12
III	Client-Side Scripting: Introduction to JavaScript, Variables and Data Types, Statements and Operators, Control Structures, Conditional Statements, Loop Statements, Object-Based Programming, Functions, Objects, Message box in JavaScript, Dialog Boxes, Alert Boxes, Confirm Boxes, Prompt Boxes, JavaScript with HTML, Events, Event Handlers, Forms, Forms Array. Document Object Model (DOM) manipulation, Validating user input using JavaScript	12
IV	Server-Side Scripting: Introduction to PHP, Variables, operators, and control structures in PHP, Functions, and arrays in PHP, Server-side form handling and processing, Advance Features: Cookies and Sessions, Introduction to MySQL and database connectivity	12
V	RESTful Web Services and APIs: Introduction to REST architecture, Understanding RESTful web services, Designing RESTful APIs, HTTP methods, and status codes for RESTful APIs, Implementing RESTful APIs using Node.js and Express	12

Suggested Readings:

- Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Prentice Hall, 2007
- JavaScript: The Good Parts by Douglas Crockford
- HTML5 for Web Designers by Jeremy Keith
- The Art and Science of CSS: Create Inspirational, Standards-Based Web Designs by Cameron Adams
- Beginning Node.js by Basarat Ali Syed
- Getting MEAN with Mongo, Express, Angular, and Node by Simon Holmes

Suggested equivalent online courses:

This course can be opted as an elective by the students of the following subjects: NONE

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5

	Quiz/ Assignments	5	
	Seminar/Presentation	5	
	Unit Test/Class Test	10	
	Total	25	
Course Prerequisites: Bachelor (Research In Computer Science)			

Subject: Computer Science			
Programme/Class: Master in Computer Science		**Year:**2nd	**Semester:**IV
Course Code: CS510	**Course Title:** Lab: Advanced Lab 2		
Course outcomes:	On completion of the course, the student will be able to:		
CO 1:	Create Server Technologies using Java Servlets.		
CO 2:	Create Modern Web Applications.		
Credits: 4		**Core Compulsory**	
Max. Marks: 25+75		**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			

Unit	Topic	No. of Lectures
	Lab Experiment List	
	1. Write the Servlet application to print the current date & time. 2. Write a Servlet application to demonstrate Html & Servlet Communication. 3. Write a Servelet application to implement an auto-refresh page. 4. Write a Servelet application to count the visits on a web page. 5. Write a Servelet application to demonstrate session tracking. 6. Write a Servelet application for the login page. 7. Write a Servelet application for adding cookie to the selected values. 8. Write a JSP program for displaying the date and time. 9. Write a JSP program to Embed an MP3 file in JSP. 10. Write a JSP program to upload a file to a server. 11. Write a Program in Java to Send an Email with an attachment. using Gmail servers using the OAuth2 Authentication method. 12. Create a basic HTML page with proper formatting, links, images, and lists. 13. Add CSS to the HTML page to enhance the visual design with backgrounds, colors, fonts, and layout. 14. Use JavaScript to manipulate the DOM of the HTML page, create event handlers, and validate user input in a form. 15. Develop a server-side script using PHP to process form submissions and save data to a MySQL database. 16. Design and implement a RESTful API using Node.js and Express to retrieve and display data from the MySQL database on a web page. 17. Practice debugging techniques for HTML, CSS, JavaScript, and PHP code. 18. Collaborate with a partner to build a simple web application using all the tools learned in the course, including HTML, CSS, JavaScript, PHP, and MySQL. 19. Perform website optimization techniques such as minification and caching to improve website performance. 20. Explore responsive web design by creating web pages that adapt to different screen sizes and devices. 21. Create a final project that showcases the student's knowledge of HTML, CSS, JavaScript, PHP, and MySQL. The project could be a simple website, a web application, or a RESTful API.	**60**

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignments and Class Tests. The marks shall

Internal Assessment	**Marks**
Record File	5
Viva Voce	5
Practical Assessment	15
Total	25