THIRD SEMESTER

Subject Code	SUBJECTS	Teaching Load Per Week			Credit *	Examination Marks							
						Max. Marks				Min. Marks			
		L	T	P		Th	Ses	Pr	Total	Th	Ses	Pr	Total
MSc(CS) 301	Data Science using Python	3	1	-	4	100	25	-	125	40	15	-	55
MSc(CS) 302	Software Engineering	3	1	-	4	100	25	-	125	40	15	-	55
MSc(CS) 303	Advanced Computer System Architecture	3	1	-	4	100	25	-	125	40	15	-	55
MSc(CS) 304	Elective – III	3	1	-	4	100	25	-	125	40	15	-	55
MSc(CS) 305	Elective – IV	3	1	-	4	100	25	-	125	40	15	-	55
MSc(CS) 306	**Lab-VII:** Practical Based on Python	-	-	2x2	2	-	50	100	150	-	30	50	80
MSc(CS) 307	**Lab-VIII:** Programming in Linux	-	-	2x2	2	-	50	50	100	-	30	25	55
MSc(CS) 308	**Lab-IX**: Mini-Project	-	-	2x2	2	-	50	50	100	-	30	25	55
MSc(CS) 309	Internship	-	-	2x2	2	-	25	-	25	-	15	-	15
	TOTAL	15	5	16	28	500	300	200	**1000**	200	180	100	**480**

* **Note – Student should join Summer Internship of 4 to 6 weeks, after Second Semester Examination.**

S.No	Elective –III	Elective -IV
I.	Data Mining and Data Warehousing	Mobile Communication
II.	Digital Image Processing	Analysis and Design of Algorithms
III.	Compiler Design	Computer Graphics
IV.	MOOC	MOOC

Detailed Syllabus:
MSc(CS)301
Data Science using Python

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT – I: Data science in a big data world**: Why Data Science, Benefits and uses of data science; Facets of data. The data science process: Setting up goal, retrieving data, data preparation, data exploration, data modelling, Presentation and automation.	10	1
II	**UNIT – II: Mathematical Foundations** Mathematical Foundations Linear Algebra: Vectors, Matrices, Statistics:DescribingaSingleSetofData,Correlation,Simpson'sParadox,CorrelationandCausation Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables,ContinuousDistributions,TheNormalDistribution,TheCentralLimitTheorem,Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P-hacking, Bayesian Inference.	10	2
III	**UNIT – III: MachineLearning:**OverviewofMachinelearningconcepts– Overfittingandtrain/testsplits,Typesof Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, RuleInduction	10	3
IV	**UNIT – IV: Introduction to Python :** Data science using python, IDEs, Sequence data: string, list, dictionary, array and tuple, Control Structure, Functions. Tools for Data Science- Toolkits using **Python**: Matplotlib, NumPy, Scikit-learn, NLTK 2.2 Visualizing Data: Bar Charts, Line Charts, Scatter plots.	10	4
V	**UNIT – V: Implementation with Python**: Working with data- Reading Files - Panda data frame: Reading data: txt, xlxs, csv files; indexing attributes of data, converting data types, Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction ,Developing a model-using scikit library(classification:Use Naïve bayes,SVM; Prediction Model: logistic Regression; Clustring K-mean clustering), Analyze performance.	10	5

BOOKS RECOMMENDED:

JoelGrus,"DataScience fromScratch:FirstPrincipleswithPython",O'ReillyMedia
DavyCielen,Arno,D,BMeysmen,MohamedAli"IntroducingDataScience",Manning
Python Data Science Handbook: Essential Tools for Working with Data, by Jake VanderPlas, O'reilly Media, 2017.
Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniquesto Build Intelligent Systems", 1st Edition, O'Reilly Media

ReferenceBooks

1. JainV.K.,"DataSciences",KhannaPublishingHouse,Delhi.
2. JainV.K.,"BigDataandHadoop",KhannaPublishingHouse,Delhi.
3. JeevaJose,"MachineLearning",KhannaPublishingHouse, Delhi.
4. ChopraRajiv,"MachineLearning",KhannaPublishingHouse,Delhi.
5. IanGoodfellow,YoshuaBengioandAaronCourville,"DeepLearning",MITPresshttp://www.de

eplearningbook.org
6. Hanand JianPei,"DataMiningConceptsand Techniques
7. NPTELcourseon"Datascienceusingpython"
8. **Web references**: 1. https://nptel.ac.in/courses/106/106/106106212/
9. 2. https://www.coursera.org/professional-certificates/ibm-data-science

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	Course Title		Course Type
MSc(CS)302	Software Engineering		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	Sessional	Theory
125	25	100

Learning Objective (LO):

Objective of this course is to develop a skill to analysis the software requirement and students will be able to know about SDLC and how that phases can be used for designing and implementation of software.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn idea about the importance of using software engineering principles in real life projects and also be able to pick an appropriate software development model for developing systems.	U
2	Prepare software requirement sheet for a real life project, keeping in mind the properties of an SRS document.	Ap
3	Use mathematical models for calculating the size, cost and duration of real life projects.	An
4	Test the developed system using different testing techniques.	E
5	Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns.	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)302
Software Engineering

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT – I: Software Engineering Fundamentals:** Introduction to Software Engineering; Software Engineering Principles(Layers); Software Process – Process Framework, Umbrella Activities, Process Adaptation; Software Crisis; Process Models-Waterfall Model, Prototype Model, Incremental Model, Spiral Model, RAD Model; Agile Process.	10	1
II	**UNIT – II: Software Analysis and Design:** Requirement Engineering; Analysis Model-Data Flow Diagram, Data Dictionary, E-R Diagram, Decision Table; Software Requirements Specification(SRS), Structure of SRS; Pseudo code; Software Design; Design Process; Design Concepts-Abstraction, Partitioning, Modularity, Information Hiding, Refinement, Refactoring; Function Oriented Design; Object Oriented Design; Cohesion and Coupling.	10	2
III	**UNIT – III: Software Quality and Case Tools:** Software Metrics, Categories of Metrics, Function Point Metric; Software Quality; McCall's Quality Factors; Software Maturity Model-CMM,CMMI; Software Quality Assurance; ISO Standards-9000, 9001 and 9126; Software Reliability; Case Tools and its Scope; Case Objectives; Architecture of Case Tools; Case Classification.	10	3
IV	**UNIT – IV: Coding and Testing:** Programming Style; Structured Programming; Coding Standard; Internal Documentation; Software Testing-Verification and Validation; Alpha and Beta Testing; Levels of Testing-Unit, Integration and System Testing; Testing Techniques- White Box, Black Box; Cyclomatic Complexity; Test Plan; Debugging-Debugging Process, Debugging Strategies(Approaches).	10	4
V	**UNIT – V: Software Maintenance and Project Management:** Risk Management – Software Risk, Risk Identification; Introduction to Software Maintenance, Categories of Maintenance; Belady and Lehman Model; Boehm Model; Project Management Concept – People, Product, Process, Project; Software Team; Software Project Planning; Software Project Estimation; Cost Estimation Model(COCOMO, COCOMO II, Putnam-SLIM, Walston and Felix); Software Reengineering.	10	5

Books Recommended:

- **Software Engineering: A Practitioner's Approach**, *Roger S. Pressman*, TMH
- **An Integrated approach to Software Engineering**, *Pankaj Jalote*, Narosa Publications
- **Software Engineering**, *Bharat Bhushan Agarwal.*

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III

Course Code	Course Title	Course Type
MSc(CS)304-II	Elective–III(Digital Image Processing)	Elective

Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	Sessional	Theory
125	25	100

S.No	Elective -III
I	Data Mining and Data Warehousing
II	Digital Image Processing
III	Compiler Design

Learning Objective (LO):

Digital Image Processing is a course used to inculcate skills like creativity, analysis of the images, finding conclusions, enhancing picture quality etc.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Review the fundamental concepts of a digital image processing system and analyze images in the frequency domain using various transforms.	An
2	Evaluate the techniques for image enhancement and image restoration and categorize various compression techniques.	E
3	Increase the employability.	R
4	Interpret Image compression standards, image segmentation and representation techniques.	E
5	Know about the application area and use of image processing in different research area mostly in image diagnosis, medical.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	**Course Title**		**Course Type**
MSc(CS)303	Advanced Computer System Architecture		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
4	3	1	0
Maximum Marks	**Sessional**		**Theory**
125	25		100

Learning Objective (LO):
Students will develop a cognitive understanding of parallel processing and hardware architecture of CPU for its implementation.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Make the students aware about Parallel Computing.	U
2	Learn the concepts of Multiprocessors, Multicomputer, Pipelining etc.	U
3	Increase the employability.	Ap
4	Make the students aware about advanced processor technology.	An
5	Open up new areas in the field of research and development in the area of computer architecture.	R

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)303
Advanced Computer System Architecture

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT I:** Introduction - Feng's and Flynn's classification scheme-SISD, SIMD,MISD, MIMD Multiprocessor and Multicomputer, UMA, NUMA, COMA, NORMA, memory models, parallel computer and its type. Applications of Parallel Computers. Cache Coherence Protocols – Snoopy and Directory Protocols.	10	1
II	**UNIT II:** System Interconnect Architecture – Static and Dynamic, Hypercube Interconnection network, multistage interconnection networks-architecture and routing, design consideration, throughput delay. Architecture and routing of 3 stage and 4 stage Banyan Network. Routing and Addition in Hypercube Interconnection network. Performance Metrics and Benchmarks.	10	2
III	**UNIT III:** Principle of pipelining-overlapped parallelism, Linear and non-linear pipelining, reservation table, calculation of MAL.Types of Instruction Pipeline. Arithmetic pipeline designs example – Floating point adder, pipelined multiplier.	10	3
IV	**UNIT IV:** Advanced processor Technology – RISC, CISC, VLIW architectures, Hazard detection and resolution, functional organization of instruction in IBM 360/91. Numerical Problems based on CPI, IPC and MIPS.	10	4
V	**UNIT V**: Exploring parallelism in program- Parallel Algorithm for Matrix addition and subtraction. Bitonic sort, sorting on linear array processors or odd even sort, PRAM algorithm for addition of numbers or Parallel Reduction. Bernstein's condition, ISO efficiency concept.	10	5

Books Recommended:

- **Computer Architecture & Parallel Processing**, *Kai Hwang and F.A. Briggs*, McGraw Hill.
- **Advanced Computer Architecture**, *Kai Hwang*, McGraw Hill.
- **Parallel Computing**, *M.R. Bhujade*, New Age Publication.
- **Parallel Computing Theory and Practice**, *Michael J. Quinn*, Tata McGraw Hill

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III

Course Code	Course Title	Course Type
MSc(CS)304-I	Elective–III(Data Mining and Data Warehousing)	Elective

Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0

Maximum Marks	Sessional	Theory
125	25	100

S.No	Elective -III
I	Data Mining and Data Warehousing
II	Digital Image Processing
III	Compiler Design

Learning Objective (LO):

Data mining and Data Warehousing is a course used to inculcate skills like Critacal thinking to process data of large ammont and find patterns in it computationally.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the KDD process which leads to Data Mining processes.	An
2	Learn about mathematical details of data mining process.	E
3	Learn the algorithms which mines the data.	R
4	Learn Structures of multi dimensional data handling.	E
5	Learn Application of Data Mining in research.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)304
Data Mining and Data Warehousing

Unit No.	Topics	No. of Hours	CO No.
I	**Unit1 :Introduction to Data Warehousing and OLAI Technology for Data Mining** What is Data Mining?, Data Mining: On what kind of data?, KDD Process, Data Mining Functionality, Are all the patterns interesting?, Attribute Types,What is Data Warehouse?, Data Cube: A multi-dimensional data model, Data Warehouse Architecture, Data Warehouse Implementation, Data Warehouse Usage(Applications), OLAP Operations, Concept of Transaction, Transactional Database, Distributed Database, Commit Protocols.	10	1
II	**Unit – II Data Preprocessing, Data Mining Primitive Languages and SystemArchitecture** Why preprocess the data?, Data Cleaning, Data Integration, Data Transformation, DataReduction, Concept Hierarchy Generation, Data Mining Primitive, Data Mining Query Language, Architecture of Data Mining System.	10	2
III	**Unit – III Mining Association Rules in Large Databases** Association Rule Mining, Mining Single-dimensional Boolean Association Rules from Transactional Databases(Apriori algorithm, FP-Tree growth algorithm), Mining Multilevel Association Rules from Transactional Databases, Mining Multi dimensional Association Rules from Transactional Databases and Data Warehouses, From Association Mining to Correlation Analysis, Constraint-based Association Mining..	10	3
IV	**Unit – IV Classification, Prediction and Cluster Analysis** What is Classification?, What is Prediction?, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back Propagation, Classification based on Association, Other Classification Methods, Prediction, Classification Accuracy What is Cluster Analysis?, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Model Based Clustering Methods, Outlier Analysis.	10	4
V	**Unit – V Mining Complex Types of Data & Applications and Trends in Data Mining** Mining Time-series and Sequence Data, Mining Spatial Databases, Mining Multimedia Databases Mining Text Databases, Mining World Wide Web, Data Mining Applications, Social Impact of Data Mining, Trends in Data Mining.	10	5

Books Recommended:

- **Data Mining: Concepts and Techniques**, *Jiawei Han and MichelineKamber*
- **Data Mining Techniques**, *Arun K Pujari,*
- **Data Mining Introductory and Advanced Topics**,*Margaret H Dunham*, Pearson

Detailed Syllabus:
MSc(CS)304
Digital Image Processing

Unit No.	Topics	No. of Hours	CO No.
I	**Unit – I** **Introduction:** Digital Image Fundamentals Origins of Digital Image Processing, examples, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sensing and acquisition Basic Concepts in Sampling and Quantization, Representing Digital Images, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.	10	1
II	**Unit – II** **Image Enhancement Spatial Domain**: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods, **Frequency Domain**: Background, Image Enhancement in the Frequency Domain, Introduction to the Fourier Transform and the Frequency, Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering	10	2
III	**Unit – III** **Image Restoration** A Model of the Image degradation/Restoration process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering.	10	3
IV	**Unit – IV** **Image Compression:** Fundamentals, Image Compression Models, Error-Free Compression, Lossy Compression, Image Compression Standards. **Morphological Image Processing**: Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformations, Some Morphological Algorithms.	10	4
V	**Unit – V** **Segmentation** Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation. **Representation and Description:** Representation, Boundary Description and Regional Descriptor.	10	5

Books Recommended:

- **Digital Image Processing**, *Rafel C Gonzalez and Richard E. Woods*, Pearson
- **Fundamentals of DIP**, *A.K. Jain*, PHI.

Digital Image Processing Using MATLAB, *Gonzalez, Woods and Eddins, McGraw Hill Education*

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	**Course Title**		**Course Type**
MSc(CS)304-III	Elective – III (Compiler Design)		Elective
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
4	3	1	0

Maximum Marks	Sessional	Theory
125	25	100

S.No	Elective -III
I	Data mining and Data warehousing
II	Digital Image Processing
III	Compiler Design

Learning Objective (LO):

Compiler design course aims to make students understand that how high level language is translated into low level languages. It also develops an insight for deep analysis of code optimization for the fast execution of the programming code.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Know about various phases of compiler design.	U
2	Aware of the function and complexity of modern compilers.	An
3	Aware of generation of intermediate code.	An
4	Concrete view on the theoretical and practical aspects of compiler design.	E
5	Apply ideas and techniques discussed to various software design.	R

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)304
Compiler Design

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT - I** **Introduction to Compiling and one pass compiler:** Compilers & translators, Phases of compilers, Compiler writing tools, Bootstrapping; overview of one pass compiler. **Finite Automata and Lexical Analysis:** Role of Lexical Analyzer; specification of tokens, Recognition of tokens, Regular expression, Finite automata, from regular expression to finite automata, DFA and NFA, Implementation of lexical analyzer; tools for lexical analyzer -LEX.	10	1
II	**UNIT - II** **Syntax analysis & Parsing Technique:** Context free grammars; Bottom up parsing, Shift reduce parsing, Operator Precedence parsing, Top down parsing, elimination of left recursion; recursive descent parsing, Predictive parsing. **Automatic Construction of Efficient parsers:** LR parser, construction of SLR and canonical LR parser table, Using ambiguous grammar, An automatic parser the generator, YACC, Using YACC with ambiguous grammar, creating YACC lexical analyzer with LEX, Error recovery in YACC.	10	2
III	**UNIT - III** **Syntax Directed Translation:** Syntax directed schema, Construction of syntax tree, Translation with top down parser. **Run Time Environment:** Source Language issues, Storage organization and allocation strategies, Parameter passing, Implementation of block-structured language.	10	3
IV	**UNIT - IV** **Intermediate Code Generation:** Intermediate languages; Postfix notation, Three-address code, Quadruples and triples, Translation of assignment statements, Boolean expression, and Procedure call. **Error Detection & recover:** Lexical & syntactic phase error, semantics error.	10	4
V	**UNIT - V** **Code Optimization:** Optimization of basic block, Loop optimization global data flow analysis, Loop in variant computation. **Code Generation:** Issue and design of code generator, the target machine, a simple code generator.	10	5

Books Recommended:

- **Principles of Compiler Designing** - Alfred V. Aho and J.D. Ullman.
- **Principles of Compiler-Principles, Technique and Tools** - Alfred V. Aho, Ravi Sethi

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	Course Title		Course Type
MSc(CS)305-I	Elective–IV (Mobile Communication)		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	3	1	0
Maximum Marks	Sessional		Theory
125	25		100

S.No	Elective -IV
I	Mobile Communication
II	Analysis and Design of Algorithms
III	Computer Graphics

Learning Objective (LO):

Mobile Communication course will develop and understanding among student how communication technology. They will also develop an insight view for networking technologies and devices.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the cellular concepts and infrastructure such as frequency reuse.	U
2	Understand the concept of Satellite systems.	U
3	Hand off and how interference between mobiles and base stations affects the capacity of cellular systems.	An
4	Identify the technical aspects of wireless and mobile communications along with the knowledge about the wireless LAN, PAN, MANET and its routing protocol.	E
5	Mobile Computing plays important role in research in wireless communication.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)305
Mobile Communication

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT – I: Introduction.** Introduction to Mobile Communication, Short history of wireless communication, Applications, Vehicles, Emergency, Business, Replacement of wired network, Location dependent services, infotainment, Mobile and Wireless devices, A Simplified reference model, some open research topics in mobile communication.	10	1
II	**UNIT – II: Satellite Systems** History of satellite system, Applications of satellite systems, Type of satellite systems, characteristics of satellite systems, satellite system infrastructure, satellite system architecture, Global Positioning system (GPS), Limitations of GPS. Beneficiaries of GPS, Applications of GPS	10	2
III	**UNIT – III: Mobile Communication Systems** Introduction, Cellular System Infrastructure,, Registration, Handoff Parameters and Underlying support, Roaming Support Using System Backbone, to Mobile IP, Functions of Mobile IP, Mobile Node, Corresponding Node, Home Network, Foreign Network, Home Agent, Foreign Agent, Care-of Address, IP Packet Delivery, Agent Discovery, Agent Solicitation, Registration, Tunneling, Dynamic host configuration protocol.	10	3
IV	**UNIT – IV: Wireless LANs and PANs** Introduction to IEEE 802.11, Ricochet, Ricochet Wireless Modem, Services Provided by Ricochet , Home RF, Home RF Technology, Hiper LAN, Blue tooth , Advantages and disadvantages of Wireless LAN, Infra red vs radio transmission , introduction to MAC. Technologies influence WLANs / WPANs in future.	10	4
V	**UNIT – V: Mobile Adhoc Network** Introduction to Mobile Adhoc Network(MANET), Characteristics of MANET, Applications of MANET, Routing, Need for Routing, Routing Classification, Table-Driven Routing Protocol – Destination Sequenced Distance Vector Routing Protocol, Cluster-Head Gateway Switch Routing, Wireless Routing Protocol. Source initiated On-demand Routing- Adhoc on Demand Distance Vector Routing, Dynamic Source Routing, Temporarily Ordered Routing Algorithms, Hybrib Protocol – Zone Routing Protocol.	10	5

Books Recommended:

- **Mobile Communication**: *Jochen H. Schiller*, Pearson Education Publication
- **Introduction to Wireless and Mobile Systems**: *D.P. Agrawal, Qing-An Zing*, Vikas Publishing House

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	**Course Title**		**Course Type**
MSc(CS)305-II	Elective–IV (Analysis and Design of Algorithms)		Elective
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
4	3	1	0
Maximum Marks	**Sessional**		**Theory**
125	25		100

S.No	Elective -IV
I	Mobile Communication
II	Analysis and Design of Algorithms
III	Computer Graphics

Learning Objective (LO):

The course aims to equip students with a deep understanding of algorithm analysis and designing a better programming by adopting better approach for solving any software problem.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains.	An
2	Apply the algorithms and design techniques to solve problems.	Ap
3	Enabling comprehension of complicated structures.	U
4	Familiar with the step wise representation of solving a particular problem.	Ap
5	Analyze the complexities of various problems in different domains.	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)305
Analysis and Design of Algorithms

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT – I INTRODUCTION & ANALYSIS:** Analyzing algorithms, Algorithm types, Recurrence Equations, Growth function: Asymptotic notation, Standard notation & common functions, Recurrence relation, different methods of solution of recurrence equations with examples.	10	1
II	**UNIT – II DYNAMIC PROGRAMMING & GREEDY PARADIGM:** The basic dynamic programming paradigm, Dynamic programming solution to the optimal matrix chain multiplication and the longest common subsequence problems, Top down recursive algorithms, Greedy Paradigm: The basic greedy strategy & computing minimum spanning trees, Algorithms of Kruskal and Prim, Union to Find Algorithm & their applications, Disjoint Set, The relationship in Dijkstra's and Prim's algorithms, Use of greedy strategy in algorithms for the Knapsack problem and Huffman trees.	10	2
III	**UNIT – III DIVIDE AND CONQUER & BACKTRACKING PARADIGM:** Introduction to Divide and Conquer paradigm, Quick and merge sorting techniques, Linear time selection algorithm, the basic divide and conquer algorithm for matrix multiplication, Backtracking & Recursive backtracking, Applications of backtracking paradigm. heaps, Representation of heaps, Red Black tree, Binary Search tree , heap sort, shell & bucket sort, Amortized Analysis.	10	3
IV	**UNIT – IV GRAPH ALGORITHMS & STRING MATCHING ALGORITHMS:** Representational issues in graphs, Depth first search & Breath first search on graphs, Computation of biconnected components and strongly connected components using DFS, Topological sorting of nodes of an acyclic graph & applications, Shortest Path Algorithms on Graphs: Bellman-Ford algorithm, Dijkstra's algorithm & Analysis of Dijkstra's algorithm using heaps, Floyd-Warshall's all pairs shortest path algorithm and its refinement for computing the transitive closure of a graph.	10	4
V	**UNIT – V NP-COMPLETE PROBLEMS**: Solvable problems, Types of problems, The notion of a non-deterministic algorithm and its basic relationship to backtracking. Polynomial time non deterministic algorithms for problems like satisfiability, clique problem, Hamiltonian path problems, The definition of NP-hardness and NP-completeness, The notion of polynomial transformation and reductions, Reductions to show that the clique problem, vertex cover, subset sum and Hamiltonian cycle problems are NP-complete.	10	5

Books Recommended:

- **Introduction to Algorithms**; *Cormen, Leiserson, Rivest, Stein*; PHI.
- **Fundamentals of Algorithms**, Horowitz and Sahni; Galgotia.
- **The Design & Analysis of Computer Algorithms**, *Hopcroft – Aho – Ullman*, AWL.
- **Handbook of Algorithms & Data Structures**, *G.H.Gonnet*, AWL.
- **Introduction to Design & Analysis of Algorithms**, *Levitin*, PE-LPE.

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	**Course Title**		**Course Type**
MSc(CS)305-III	Elective–IV (Computer Graphics)		Elective
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
4	3	1	0
Maximum Marks	**Sessional**		**Theory**
125	25		100

S.No	Elective -IV
I	Mobile Communication
II	Analysis and Design of Algorithms
III	Computer Graphics

Learning Objective (LO):

The course computer graphics is designed to develop a knowledge how GUI environment is created in display devices. It also explains mathematical base of graphics design.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the core concepts of computer graphics, including viewing, projection, perspective, modeling and transformation in two and three dimensions.	U
2	Apply the concepts of colour models, lighting and shading models, textures, ray tracing, hidden surface elimination, anti-aliasing, and rendering.	Ap
3	Aware about the core technology in digital photography, film, video games, digital art, cell phone and computer displays and many specialized application.	U
4	Improve the ability to quickly visualize newly designed shapes is indispensable.	An
5	Interpret the mathematical foundation of the concepts of computer graphics.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)305
Computer Graphics

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT - I: Display Devices** Refresh Cathode-Ray tubes, Random Scan and Raster Scan Display, Color CRT Monitors, Color display techniques: shadow masking and Beam penetration, Direct view storage tubes, Flat Panel display: plasma panel displays, LED & LCD devices. **Interactive Graphics:** Physical Input devices, logical classification, input function, interactive picture construction techniques.	10	1
II	**UNIT - II: Output Primitives** Points and Lines, Line drawing Algorithms: DDA Algorithm and Bresenham's Line Algorithm, Antialiasing. Circle generating Algorithms: Bresenham's Circle Algorithms, Midpoint Circle Algorithm, Ellipse Generating Algorithm: Midpoint, Character generation and text display. Output command for various geometrical shapes, Filled Area Primitive: Scan line polygon fill algorithm, Boundary fill algorithm, Flood fill algorithm. Attribute of outputs primitives: line attribute, Area-fill Attribute, Text attribute, Bundled attributes, Area-Fill.	10	2
III	**UNIT -III:Two Dimensional Transformation and Viewing** **Transformation:** Translation, Scaling, Rotation, Reflection, Shearing. Matrix representations of Transformation and Homogenous Coordinates, Composite Transformations and Concatenation of transformation.**Two-Dimensional Viewing Coordinate system:** World/user coordinates, Device coordinate, Normalized device coordinates, Viewing pipeline: windows and viewports, Viewing transformation pipeling, Window-to-Viewport coordinate transformation, Clipping algorithm: point, line clipping algorithm: Cohen-Sutherland, Liang Barsky, Nicholl-Lee-Nicholl, Line Clipping, polygon clipping algorithm : Sutherland-Hodgman, Weiler-Atherton, text clipping.	10	3
IV	**UNIT - IV: 3-D Transformation and Viewing** **3-D Transformation:** Translation, Scaling, Rotation about standard and arbitrary axis, Other Transformation: Reflections and shears, Transformation commands. **Viewing:** Viewing Pipeline, Viewing Coordinates: transformation from world to viewing coordinates.	10	4
V	**UNIT - V: 3-D Projection** **Projection:** Parallel Projection, Perspective Projection, Normalized view volume, viewport Clipping, Clipping in Homogeneous Coordinate. **Visible-Surface detection algorithms**: Back-Face removal, Depth Buffer method, Scan line method, Depth sorting method, Area subdivision and Octree method.	10	5

Books Recommended:

- **Computer Graphics**, *Hearn D. & Baker P.M.*
- **Computer Graphics**: A Programming Approach, *Harrington S.*
- **Procedural Elements for Computer Graphics**, *Rogers D.F.*

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	Course Title		Course Type
MSc(CS)306	Lab-VII: Data Science using python		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4
Maximum Marks	Sessional		Practical
150	50		100

Learning Objective (LO):

This course introduces students to the basic concepts and techniques of Data Science. And this course also contains Basic of Python Programming to contain control structure, conditional statement, function Sequence Data type and toolkits

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn Python Programming.	Ap
2	Understand the concept of toolkits.	Ap
3	Learn to build data science model.	AP
4	Visualizing and understand the data semantics.	Ap
5	Build data science application using Python based toolkits.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)306
Lab-VII: Data Science using python

Unit No.	Topics	No. of Hours	CO No.
I	Learn basics of python –Variable, Data type , Control Statement Array	10	1
II	Understand toolkits using Python :Matplotlib,Numpy,Scikit-Learn	10	2
III	Visualizing and understand the data semantic.	10	3
IV	Learn working with data files.	10	4
V	Developing a model-using scikit library(classification:Use Naïve bayes,SVM; Prediction Model: logistic Regression; Clustring K-mean clustering), Analyze performance.	10	5

Books Recommended:

1. Python Programming- A modular Approach (with Graphics, database, Mobile and Web Applications by Sheetal Taneja and Naveen Kumar, Pearson.

2. Beginning Programming with Python Dummies by John Paul Meuller.

Web references:

1. https://nptel.ac.in/courses/106/106/106106212/
2. https://www.coursera.org/professional-certificates/ibm-data-science

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	Course Title		Course Type
MSc(CS)307	Lab-VIII: Programming in LINUX		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4

Maximum Marks	Sessional	Practical
100	50	50

Learning Objective (LO):

Students are going to be able to learn Shell Scripting paradigm in LINUX and its commands.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn about LINUX Commands.	Ap
2	Learn Vi editor commands.	Ap
3	Learn Shell Scripting	Ap
4	Manage administrative commands of LINUX	Ap
5	Handle security issues in LINUX environment.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:
MSc(CS)307
Lab-VIII: Programming in LINUX

Unit No.	Topics	No. of Hours	CO No.
I	**UNIT-1 Commands** :commonly used commands like who, pwd, cd, mkdir, rm, ls, mv, lp, chmod, cp, grep, sed, awk, pr, lex, yacc, make, etc. Getting started (login / logout), File system management, file operation, system calls, buffer cach .	10	1
II	**UNIT 2 Vi Editor**:-Intro to text processing, command and edit mode, invoking vi, command structure, deleting and inserting line, deleting and replacing character, searching strings, yanking, running shell command, command macros, set windows, set auto indent, set number, intro to exrc file.	10	2
III	**UNIT 3 Shell Script** : command line arguments, command substitution, read statement, conditional execution of commands, special shell variables $ #, #?, $* etc.	10	3
IV	**UNIT 4 Shell Script :** Shift commands, loops and decision making-for, while and until, choice making using case...esac, decision making if ....fi, using test, string comparison, numerical comparison, logical operation	10	4
V	**UNIT 5 Administrative Commands** :Process and Scheduling, Security, Basic System Administration:- Adding a User, User Passwords, Delete of a User, Adding a Group, Deleting a Group, Super User, Startup and Shutdown.	10	5

Books Recommended:

- Advanced Unix - Stephan Prata
- The Unix Programming Environment - Kennighan and Pike
- Unix Programmers Guide - P. P. Selvester
- Complete Reference Unix

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	Course Title		Course Type
MSc(CS)308	Lab-IX: Mini-Project		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4
Maximum Marks	Sessional		Practical
100	50		50

Learning Objective (LO):

Objective of minor project is to make student capable of implementing learnt programming concepts into practical by creating small software by applying SDLC concepts.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Enhance coding skills.	Ap
2	Enable to analyze system.	Ap
3	Learn about problem solving in software.	Ap
4	Learn about logic building in software.	Ap
5	Create small software using programming language.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

M.Sc. (CS) Semester-III

Program	Subject	Year	Semester
M.Sc.	Computer Science	2	III
Course Code	Course Title		Course Type
MSc(CS)309	Internship		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	4

Maximum Marks	Sessional	-
25	25	00

Learning Objective (LO):

Students will be able to polish their communication skill and presentation skills.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn how to make presentation PPT.	U
2	Learn how to present effectively.	U
3	Becomes Confident for their knowledge expression.	U
4	Improve their public speaking skills.	Ap
5	Learn novel topics and develop a more holistic perspective.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

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

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

MSc(CS)309 (Internship)

Unit No.	Topics	No. of Hours	CO No.
I	Internship	50	1
II	Internship Seminar		2
III	Internship Report		3
IV	Internship Presentation		4
V	Internship Viva		5