Curriculum and Credit Framework

For

B.Sc Data Science (Four Year Degree Programme)
(Single Major) as per NEP-2020

(3RD and 4th Year)

Board of Studies

24/05/2024

Staff Council

20/5/2024

FET

22/5/2024

Department of Computer Science & Engineering

Faculty of Engineering & Technology

Chaudhary Devi Lal University

Sirsa-125055, Haryana

(For Batch 2022-23 Only)

Committee

20/5/2024

Committee

20/5/24

Semester-V

	Course Code	Course Title	Level	Credits			Marks		
				L	P	Total	Int	Ext	Total
1. DSC	B.Sc/DS/SM/5/DSC/301	Data Science	300	4	-	4	30	70	100
	B.Sc/DS/SM/5/DSC/302	Computer Networks	300	4	-	4	30	70	100
	B.Sc/DS/SM/5/DSC/303	Introduction to Compiler Design	300	4	-	4	30	70	100
	B.Sc/DS/SM/5/DSC/304	Data Analytics Using Python	300	2	-	2	15	35	50
	B.Sc/DS/SM/5/DSC/305	Data Analytics Using Python Lab-Work	300	-	2	2	-	50	50
2. MIC	B.Sc/DS/SM/5/MIC/301	Network Security	300	4	-	4	30	70	100
3. SEC		Internship*	300	-	-	4	-	100	100
Total						**24**			**600**

Semester-VI

	Course Code	Course Title	Level	Credits			Marks		
				L	P	Total	Int	Ext	Total
1. DSC	B.Sc/DS/SM/6/DSC/306	Theory of Computation	300	4	-	4	30	70	100
	B.Sc/DS/SM/6/DSC/307	Big Data	300	4	-	4	30	70	100
	B.Sc/DS/SM/6/DSC/308	Wireless Networks	300	4	-	4	30	70	100
	B.Sc/DS/SM/6/DSC/309	Computer Graphics	300	4	-	4	30	70	100
2. MIC	B.Sc/DS/SM/6/MIC/302	Data Handling and Visualization	300	2	-	2	15	35	50
	B.Sc/DS/SM/6/MIC/303	Data Handling and Visualization Lab-work	300	-	2	2	-	50	50
3. SEC		To be opted by the student from the pool of SEC	300	-	-	2	-	-	50
Total						**22**			**550**

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Secretary

SC 20/5/24

BoS 21/5/24

Faculty EC 22/5/2024

Semester-VII(Honours)

	Course Code	Course Title	Level	Credits			Marks		
				L	P	Total	Int	Ext	Total
1. DSC	B.Sc/DS/SM/7/DSC/401	Research Methodology	400	4	-	4	30	70	100
	B.Sc/DS/SM/7/DSC/402	Machine Learning	400	4	-	4	30	70	100
	B.Sc/DS/SM/7/DSC/403	R Programming	400	2	-	2	15	35	50
	B.Sc/DS/SM/7/DSC/404	R Programming Lab-Work	400	-	2	2	-	50	50
	B.Sc/DS/SM/7/DSC/405	Internet of Things	400	4	-	4	30	70	100
	B.Sc/DS/SM/7/DSC/406	Genetic Algorithms	400	4	-	4	30	70	100
2. MIC	B.Sc/DS/SM/7/MIC/401	MATLAB	400	2	-	2	15	35	50
	B.Sc/DS/SM/7/MIC/402	MATLAB Lab-Work	400	-	2	2	-	50	50
Total						**24**			**600**

Semester-VIII(Honours)

	Course Code	Course Title	Level	Credits			Marks		
				L	P	Total	Int	Ext	Total
1. DSC	B.Sc/DS/SM/8/DSC/407	Social Network Analytics	400	4	-	4	30	70	100
	B.Sc/DS/SM/8/DSC/408	Evolutionary Algorithms	400	4	-	4	30	70	100
	B.Sc/DS/SM/8/DSC/409	Soft Computing	400	4	-	4	30	70	100
	B.Sc/DS/SM/8/DSC/410	Business Data Analytics	400	4	-	4	30	70	100
	B.Sc/DS/SM/8/DSC/411	Android Development	400	2	-	2	15	35	50
	B.Sc/DS/SM/8/DSC/412	Android Development Lab-Work	400	-	2	2	-	50	50
2. MIC	B.Sc/DS/SM/8/MIC/403	Data Analytics Using R	400	2	-	2	15	35	50
	B.Sc/DS/SM/8/MIC/404	Data Analytics Using R Lab-Work	400	-	2	2	-	50	50
Total						**24**			**600**

- **Note: In 8th Semester student can opt Research/Project Dissertation of 12 credits in place of any 3 DSC courses.**

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SEMESTER-V

B.Sc/DS/SM/5/DSC/301: Data Science							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
DSC	04	04	Lecture	70	30 (20 / 5 / 5)	3 Hours	TEE/MTE/ Assignment/ Attendance

Instructions to paper setter for Term-End Examination: The Term-End examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of Seven short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four sections in the question paper each consisting of two questions. The student will attempt one question from each section in addition to the compulsory question. All questions will carry equal marks.

Course Objectives	The objective of this course is to get the students familiar with fundamental concepts of data science, analysis of data, modern data analytic tools and fuzzy logic.
Course Outcomes	At the end of this course, the student will be able to:
CO1	Knowledge: the key features and applications of data scienc, process of exploratory data analysis and the methods for data collection, classification, storage, and retrieval.
CO2	Understand: the types of correlation, regression, and key statistical measures like mean, median, mode, standard deviation, and skewness, the concepts of probability, conditional probability, and random variables in the context of data analysis.
CO3	Apply: appropriate data collection methods and data analytic tools and techniques for different types of data analysis.
CO4	Analyze: various data mining techniques and their applicability in different data sets.
CO5	Evaluate: the impact of using modern analytic tools on the efficiency and scalability of data analysis processes.

Unit I

Introduction to Data Science: Challenges of conventional systems, data science process, applications and features of data science, exploratory data analysis, collection of data, graphical presentation of data, classification of data, storage and retrieval of data.

Modern data analytic tools: Big data, web data, evolution of analytic scalability, analytic processes and tools, analysis vs reporting.

Unit II

Analysis: Introduction to data analysis, types of Correlation & regression, probability, Conditional ability, random variables, analysis using mean, median, mode, standard deviation, skewness, ression modelling, multivariate analysis.

Unit III

Statistical Concepts: Sampling distributions, re-sampling, statistical inference, prediction error.

Data Mining Techniques: Rule induction & neural networks- learning and generalization, competitive learning, principal component analysis and neural networks.

Unit IV

Fuzzy Logic: extracting fuzzy models from data, fuzzy decision trees, stochastic search methods, neuro fuzzy modelling.

Association Rule Mining: Clustering, outlier analysis, sequential pattern mining, temporal mining, spatial mining, web mining.

Text Books:

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.

Reference Books:

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & Sons, 2012.
2. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", 2e, Elsevier.
3. Rachel Schutt, Cathy O'Neil, "Doing Data Science", O'Reilly Publishers, 2013.
4. Foster Provost, Tom Fawcet, "Data Science for Business", O'Reilly Publishers, 2013.
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2014.

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B.Sc/DS/SM/5/DSC/302: Computer Networks								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Term-End Examination: The Term-End examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting Seven short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four sections in the question paper each consisting of two questions. The student will attempt one question from each section in addition to the compulsory question. All questions will carry equal marks.

Course Objectives	To impart the basic concepts of computer networks, hardware and software used, switching methods, protocols present at different layers.
Course Outcomes	At the end of this course, the student will be able to:
CO1	Knowledge: the terms and concepts of data communication and computer networking including types of network topologies, reference models, protocols used in data communication, transmission modes and media, switching and multiplexing.
CO.2	Understand: various concepts of data communication and computer networking including network topologies, reference models, protocols used in data communication, data transmission modes and transmission media, switching and multiplexing.
CO3	Apply: the techniques learnt here in the design and evaluation of computer and communication networks and decide which competing communication media, and network topology/switching/protocol/technology will suit a particular situation.
CO4	Analyze: various types of: computer and data communication networks, network topologies, switching and multiplexing mechanisms, error control mechanisms, routing protocols, transmission modes, transmission media, congestion control techniques.
CO5	Evaluate: network topologies, transmission media, switching and multiplexing techniques, protocols and different layers, error control mechanisms, congestion control techniques.

Unit I

Introduction: Network applications, network hardware, network software, reference models: OSI, TCP/IP.
Physical Layer: Theoretical basis for communication, guided transmission media, wireless transmission

Unit II

Data Link Layer: Design issues, error detection and correction, elementary data link protocols, sliding window protocols, switching technologies, packet switching, message switching and circuit switching.

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Unit III

Network Layer: Network layer design issues, routing algorithms, Congestion control algorithms, Internetworking, the network layer in the internet (IPv4 and IPv6), Quality of Service.

Transport Layer: Transport service, elements of transport protocol, Simple Transport Protocol, Internet transport layer protocols: UDP and TCP.

Unit IV

Application Layer: Domain name system, electronic mail, World Wide Web, Hyper Text Transfer Protocol, Simple Network Management Protocol, File Transfer Protocol, Simple Mail Transfer Protocol, Telnet.

Text Books:

1. A. S. Tanenbaum (2003), Computer Networks, 4th edition, Pearson Education/ PHI, New Delhi, India.

Reference Books:

1. Behrouz A. Forouzan (2006), Data communication and Networking, 4th Edition, Mc Graw-Hill, India. 2. Kurose, Ross (2010), Computer Networking: A top down approach, Pearson Education, India.

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B.Sc/DS/SM/5/DSC/303: Introduction to Compiler Design								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Term-End Examination: The Term-End examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will consist of Seven short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four sections in the question paper each consisting of two questions. The student will attempt one question from each section in addition to the compulsory question. All questions will carry equal marks.

Course Objectives	This course deals with the basic techniques of compiler construction tools that can used to perform syntax-directed translation of a high-level programming language into an executable code. This will provide deeper insights into the more advanced semantics aspects of programming languages, code generation, machine independent optimizations, dynamic memory allocation, types and their inferences, object orientation.
Course Outcomes	At the end of this course, the student will be able to:
CO1	Knowledge: the phases of a compiler and the roles of lexical analyzer, parser, and code generator.
CO.2	Understand: the concepts of parsing, including top-down and bottom-up parsing techniques, the process of converting regular expressions to finite automata
CO3	Apply: methods to eliminate ambiguity and left recursion in grammars, syntax trees and intermediate code representations for given expressions and statements.
CO4	Analyze: parsing techniques including recursive descent parsing and LR parsing (SLR, CLR, LALR).
CO5	Evaluate: the efficiency of different parsing algorithms, the effectiveness of code optimization techniques on the generated code.

Unit – I

Introduction to Compiler: Definition of compiler, phases of a compiler, role of lexical analyser, regular expressions, finite automata, from regular expressions to finite automata, pass and phases of translation, bootstrapping, LEX-lexical analyser generator.

Parsing: Parsing, role of parser, context free grammar, derivations, parse trees, ambiguity, elimination of left recursion, left factoring, eliminating ambiguity from dangling-else grammar, classes of parsing, top down parsing - backtracking, recursive descent parsing, predictive parsers, LL(1) grammars.

Unit - II

m-up Parsing: Definition of bottom up parsing, handles, handle pruning, stack implementation of shift-ce parsing, conflicts during shift-reduce parsing, LR grammars, LR parsers-simple LR, canonical LR(CLR) d Look Ahead LR (LALR) parsers, ambiguous grammars, YACC-automatic parser generator.

Unit - III

Syntax Directed Translation: Syntax directed definition, construction of syntax trees.

Intermediate Code Generation: abstract syntax tree, polish notation and three address code, types of three address statements and its implementation, syntax directed translation into three-address code, translation of simple statements, boolean expressions and flow-of-control statements.

Type Checking: Definition of type checking, type expressions, type systems, static and dynamic type checking, type conversions, overloading of functions and operators, storage organization, storage-allocation strategies, symbol tables.

Unit - IV

Code Optimization: Organization of code optimizer, basic blocks and flow graphs, optimization of basic blocks, the principal sources of optimization, the directed acyclic graph (DAG) representation of basic block, global data flow analysis.

Code Generation: Machine dependent code generation, object code forms, the target machine, a simple code generator, register allocation and assignment, peephole optimization.

Text Books:

1. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman (2007), Compilers Principles, Techniques and Tools, 2nd edition, Pearson Education, New Delhi, India.

Reference Books:

1. Alfred V. Aho, Jeffrey D. Ullman (2001), Principles of compiler design, Indian student edition, Pearson Education, New Delhi, India.

2. Kenneth C. Louden (1997), Compiler Construction– Principles and Practice, 1st edition, PWS Publishing.

3. K. L. P Mishra, N. Chandrashekaran (2003), Theory of computer science- Automata Languages and computation, 2nd edition, Prentice Hall of India, New Delhi, India.

4. Andrew W. Appel (2004), Modern Compiler Implementation C, Cambridge University Press, UK

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B.Sc/DS/SM/5/DSC/304: Data Analytics using Python								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	02	02	Lecture	35	15		2 Hours	TEE/MTE/ Assignment/ Attendance
					10	2 3		

Note for the Paper Setter: The question paper will consist of ***five*** questions in all. The first question will be compulsory and will consist of seven short questions of 1 mark each covering the whole syllabus. In addition, four more questions of 14 marks each will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting one question from each unit.

Course Objectives	The objective of this course is to understand the concept of data analytics, techniques of data analysis, clustering and classification. The students will become familiar with tools used for data visualization and data manipulation.
Course Outcomes	After completing this course the students will be able to use tools such as Python, Pandas and Hadoop for big data applications.

Unit I

Data Analytics and Big Data: Types of data analytics, Phases, Quality and Quantity of data Measurement, Exploratory data analysis, Evolution of Big data, Best Practices for Big data Analytics, Big data characteristics.

Introduction to Python: Structure of Python Program, Python data structures, Underlying mechanism of Module Execution-Branching and Looping-Problem Solving Using Branches and Loops-Functions, Object Oriented programming concepts using classes, objects and methods

Data Analysis, Clustering and Classification: Regression Modeling, Multivariate Analysis, and Bayesian Modeling.

Clustering: Overview and importance of clustering, K-means clustering, Centroid-based Clustering. Density-based Clustering, Distribution-based Clustering, Hierarchical Clustering.

Classification: Decision Trees, Overview of a Decision Tree, The General Algorithm, Decision Tree Algorithms, Evaluating a Decision Tree, Decision Trees in R, Naïve Bayes, Bayes,, Theorem, Naïve Bayes Classifier.

Unit II

Frameworks And Visualization: Introduction to Hadoop, Apache Hadoop, Hadoop Distributed File Systems, Hive, MapReduce, Data Serialization, Data Extraction, Stacking Data, dealing with data.

Introduction to data visualization: Visual Data Analysis Techniques Interaction Techniques, Data visualization options.

Data Manipulation with Pandas: Introduction to Pandas Objects, Data indexing and Selection, Operating on Data in Pandas, Handling Missing Data, Hierarchical Indexing, Combining Data Sets, Aggregation and Grouping, Pivot Tables.

Visualization and Matplotlib: Basic functions of matplotlib, Simple Line Plot, Scatter Plot, Density and Contour Plots, Histograms, Binnings and Density. Customizing Plot Legends, Colour Bars, Three- dimensional Plotting in Matplotlib.

Text/Reference Books

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ooks	1. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools,Techniques, NoSQL, and Graph", 2021. 2. AnandRajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2019 3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
Reference Books	1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2018. 2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2021. 3. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2020

B.Sc/DS/SM/5/DSC/305 Data Analytics using Python (Lab Work)							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
DSC	02	04	Practical	50	-	3 Hours	Practical/Viva-voce

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B.Sc/DS/SM/5/MIC/301: Network Security

	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
MIC	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final Term Examination: The question paper will consist of ***nine*** questions in all. Question No. 1 will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, 8 more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit. All questions carry equal marks.

Course Objective: The objective of this course is to understand concepts of security attacks, cryptography techniques, digital signature, web security and email security.

Course Outcome: After completing this course the students will be able to define security attacks, architecture of IP addresses, encryption standards and email security.

Course Content Network Security

Unit I	**Overview and Security Attacks:** Introduction to Network Security, Principals of Security, Security Approaches, Security Threats, Types of Attacks, Malware, Virus, Worms, Trojan Horse, Logic Bombs, DoS, Major attacks of history, Data Security, Phishing, Trapping.
Unit II	**Authentication and Cryptography:** Overview of Authentication, Authentication of People, Message Authentication, Public Key Infrastructure, Digital Signature, Kerberos, Overview of Cryptography, Application of Cryptography, Data Encryption Standard, Advance Encryption Standard.
Unit III	**IP and Web Security:** IP Security Overview, Architecture, Authentication Header, Encapsulation Security Payload, Key Management, IKE, Web Security Considerations, Secure Socket Layer, Transport Layer Security, Secure Electronic Transaction, Web issues.
Unit IV	**System and Email Security:** Intruders, Intrusion Detection, Password Management, Malicious Software, Firewalls, Firewall Design Principles, Firewall Configurations, Trusted Systems, Email Security, PEM, S/MIME, PGP.

Text/Reference Books

Text Books	1. Cryptography and Network Security, Principles and Practice Sixth Edition, William Stallings, Pearson. 2. Cryptography & Network Security, Forouzan, Mukhopadhyay, McGrawHill. 3. Cryptography and Network Security, Atul Kahate, TMH. Dan W. Patterson Introduction to Artificial Intelligence and Expert system, PHI.
Reference Books	1. Information Systems Security, Godbole, Wiley India. 2. Information Security Principles and Practice, Mark Stamp, Willy India.

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SEMESTER-VI

B.Sc/DS/SM/6/DSC/306: Theory of Computation								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Term-End Examination: The Term-End examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will consist of Seven short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four sections in the question paper each consisting of two questions. The student will attempt one question from each section in addition to the compulsory question. All questions will carry equal marks.

Course Objectives	To understand fundamental concepts of finite automata, regular grammar, mealy and Moore machine, context free language and grammar their properties, context free language and grammar.
Course Outcomes	By the end of this course, the student will be able to
CO1	Knowledge: fundamental concept of finite automata, pushdown automata, Linear bound automata, Turing machine, context free language & grammar, context sensitive language & grammar.
CO2	Understand: concept of context free language and grammar, pushdown automata, equivalence of deterministic and non-deterministic finite automata, ambiguity in grammars and languages, concept of Turing machine.
CO3	Apply: Pumping lemma to check language is not regular, pushdown automata to check context free language, Turing machine to solve basic calculation.
CO4	Analyze: finite automata, regular grammar, context free grammar, context free language, context sensitive grammar, normal forms, pushdown automata, Turing machine.
CO5	Evaluate: NFA & DFA, mealy and Moore machine, CNF& GNF, languages, grammars, different automata's, Turing machine.

Unit 1

Finite Automata: Deterministic and non-deterministic finite automata, applications of finite automata, equivalence of deterministic and non-deterministic finite automata, state minimization of DFA, Kleen's characterization theory for sets accepted by finite automata, regular grammar, mealy and Moore machine.

Unit 2

Context Free Language and Grammar: Context free grammar, parse tree, application of context free grammars, ambiguity in grammars and languages.

Pushdown Automata: Deterministic pushdown automata and non-deterministic pushdown automata, language of pushdown automata, equivalence of PDA's and CFG's.

Unit 3

perties of Context-Free Languages: Normal form of context free grammars, pumping lemma for context-e grammars, closure properties of context-free languages, decision properties of context free languages.
Context Sensitive Language and Grammar: Introduction, closure properties of CSL.

Unit 4

Turing machine: Construction of Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine (multi-tape Turing machine, equivalence of one-tape and multi-tape Turing machine, Non-Deterministic Turing machine), restricted Turing machine (multi-stack machines, counter machines).

Text Books:

1.John C. Martin, Introduction to Languages and the Theory of Computation, McGraw Hill.
2.Peter Linz, An introduction to formal language & automata, Jones & Bartlett publications.

Reference Books:

1. Hopcroft J. E. & Ullman J. D, Formal languages and their relation to Automata, Pearson Education.
2. Lewis, H.R. &Papadimitrious, C. H., Elements of the theory of computation, PHI Learning.
3. Michael Sipser, Introduction to the Theory of Computation, Cengage Learning.

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B.Sc/DS/SM/6/DSC/307: Big Data								
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will consist of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with the concepts and processes of Data Science including collection, filtering, processing, analysis and visualization.

Course Outcomes	At the end of this course, the student will be able to :
CO1	Knowledge: the stages of the data science process and the key concepts in exploratory data analysis, key terms related to big data, such as web data, analytic scalability, and modern data analytic tools.
CO2	Understand: the concepts of correlation, regression, probability, conditional probability, and random variables, Summarize methods of data mining, including rule induction, neural networks, principal component analysis, and fuzzy logic.
CO3	Apply: modern data analytic tools for practical data analysis tasks, rule induction and neural network algorithms for data mining applications.
CO4	Analyze: the components and processes involved in modern data analytics, including the use of tools like Hadoop and NoSQL databases, different data analysis frameworks and visualization techniques to interpret and present data insights.
CO5	Evaluate: the performance of regression modeling, Bayesian networks, support vector, and kernel methods in predictive analytics.

Unit I

Introduction to Data Science: data science process, exploratory data analysis, collection of data, graphical presentation of data, classification of data, storage and retrieval of data, big data, challenges of conventional systems, web data, evolution of analytic scalability, analytic processes and tools, analysis vs reporting, modern data analytic tools.

Statistical Concepts: sampling distributions, re-sampling, statistical inference, prediction error.

Unit II

Data Analysis: Correlation, regression, probability, Conditional probability, random variables, analysis using mean, median, mode, standard deviation, skewness, kurtosis, regression modeling, multivariate analysis, Bayesian modeling, inference and Bayesian networks, support vector and kernel methods;

Analysis of Time Series: linear systems analysis, nonlinear dynamics.

Unit III

Data Mining Techniques: Rule induction: neural networks: learning and generalization, competitive learning, principal component analysis and neural networks.

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Logic: extracting fuzzy models from data, fuzzy decision trees, stochastic search methods, neuro fuzzy ling.

Unit IV

Association Rule Mining: clustering, outlier analysis, sequential pattern mining, temporal mining, spatial mining, web mining.

Data Analysis Frameworks and Visualization: Map Reduce, Hadoop, Hive, sharding, NoSQL databases, cloud databases, S3, Hadoop Distributed File Systems, visualizations, visual data analysis techniques, interaction techniques, social network analysis, collective inferencing, Egonets systems and applications.

Text Books:

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.

Reference Books:

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & Sons, 2012.
2. Jiawei Han, MichelineKamber, "Data Mining Concepts and Techniques", 2e, Elsevier.
3. Rachel Schutt, Cathy O'Neil, "Doing Data Science", O'Reilly Publishers, 2013.
4. Foster Provost, Tom Fawcet, "Data Science for Business", O'Reilly Publishers, 2013.
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications ", Wiley Publishers, 2014.

B.Sc/DS/SM/6/DSC/308: Wireless Network								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final Term Examination: The question paper will consist of ***nine*** questions in all. Question No. 1 will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, 8 more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit. All questions carry equal marks.

Course Objective: The objective of this course is to study fundamental concepts in wireless network, various LAN standards, IP and IPV6 Layer, Transmission protocols and WAN standards.

Course Outcome: After completing this course the students will be able to analyze WLAN technologies, IEEE 802.16, IPV6, Routing, TCP improvements, UMTS core network architecture, firewall, 3G, 4G and 5G networks.

Course Content Wireless Network	
Unit I	**Multiple Radio Access:** Medium Access Alternatives: Fixed-Assignment for voice oriented networks, random access for data oriented networks, Handoff and Roaming Support, Security and Privacy.
Unit II	**Wireless WANs:** First Generation Analog, Second Generation TDMA- GSM, Short Messaging Service in GSM, Second Generation CDMA- IS-95,GPRS, Third Generation Systems- WCDMA, CDMA2000, Introduction to LTE.
Unit III	**Wireless LANs:** Introduction to Wireless LANs- IEEE 802.11 WLAN-Architecture and Services, Physical Layer, MAC Sub layer, MAC Management Sub layer, Other IEEE 802.11standards, Wi-Max standard.
Unit IV	**System and Email Security:** Intruders, Intrusion Detection, Password Management, Malicious Software, Firewalls, Firewall Design Principles, Firewall Configurations, Trusted Systems, Email Security, PEM, S/MIME, PGP.
Text/Reference Books	
Text Books	1. Vijay. K. Garg, Wireless Communication and Networking, Morgan Kaufmann Publishers. 2. Kaveth Pahlavan, Prashant Krishnamurthy, Principles of Wireless Networks, Pearson Education.
Reference Books	1. Adrian Farrel, Bruce S. Davie, P.Z & Larry L. Peterson, Wireless Networking Complete, Morgan Kaufmann Publishers. 2. C. Siva Ram Murthy and B. S. Manoj, Ad hoc Wireless Networks, Pearson Education. 3. William Stalling, Wireless Communications and Networks, Pearson/Prentice Hall of India.

committee

B.C

BOS

B.Sc/DS/SM/6/DSC/309: Computer Graphics								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Term-End Examination: The Term-End examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will consist of Seven short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four sections in the question paper each consisting of two questions. The student will attempt one question from each section in addition to the compulsory question. All questions will carry equal marks.

Course Objectives	To understand fundamental concepts of finite automata, regular grammar, mealy and Moore machine, context free language and grammar their properties, context free language and grammar.
Course Outcomes	At the end of this course, the student will be able to:
CO1	Knowledge: computer graphics, soft copy computer devices, hard copy computer devices use in computer graphics , 2D graphics, 3D graphics, multimedia , 2D transformation, 3D transformation, resolution, graphic operation.
CO2	Understand: computer graphic application, random scan, raster scan, scan conversion , DDA, Bresenham line drawing algorithm, coordinate system and 2D and 3D transformation, projection
CO3	apply algorithms: line drawing, clipping, hidden surface removal, projection.
CO4	Analyze: scan conversion methods, projection techniques, clipping algorithms, shading methods.
CO5	Evaluate: scan conversion methods, projection techniques, clipping algorithms, shading methods.

Unit 1

Introduction: Survey of computer graphics and its applications, interactive and passive graphics; introduction to GKS primitives, display processors.

Graphic Devices: Display system-refresh CRTs, raster scan and random scan monitors grey shades, Interlacing, beam penetration, shadow mask monitors, look up tables, plasma panel, LED and LCD monitors, LCD monitors, VGA and SVGA resolution, hard copy devices-printers and plotters.

Unit 2

Drawing Geometry: Coordinate system, resolution, use of homogeneous coordinate system;
Scan Conversion: Symmetrical DDA, simple DDA, Bresenham's line drawing algorithm, generation of ellipse;
2-D Transformation: Translation, rotation, scaling, mirror reflection, shearing, zooming, panning, **Input Techniques**: Pointing, positioning, rubber and methods and dragging, tweezing

Unit 3

Graphic Operations: clipping-line clipping using Sutherland-Cohen and midpoint sub-division algorithm, polygon clipping, window and view port, windowing transformation, filling-stack based fill algorithm.

Multimedia: concepts of hypertext/hypermedia, multimedia applications, multimedia authoring, multimedia hardware, images, bitmaps and windows paint brush.

Unit 4

3-D Graphics: 3D modeling of objects,3D display techniques, coordinate system, 3D transformation matrices for translation, scaling and rotation, parallel projection, perspective projection.

Hidden surface removal: Z-buffer, back face, scan line, depth sorting and area subdivision.

Text Books:

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI.
2. Newman & Sproull, Principles of Interactive Computer Graphics, McGraw Hill.

Reference Books:

1. John F. Koegel Bufore, Multimedia Systems, Addison Wesley.
2. Foley, Computer Graphics Principles & Practice, Addison Wesley.
3. Rogers, Procedural elements of Computer Graphics, McGraw Hill.
4. D.P. Mukherjee, Fundamentals of computer Graphics and Multimedia, PHI.

committee

SC

BOS

B.Sc/DS/SM/6/MIC/302: Data Handling &Visualization							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
MIC	02 (L)	02	Lecture	35	15 (10 / 2 / 3)	2 Hours	TEE/MTE/ Assignment/ Attendance

*Note for the Paper Setter: The question paper will consist of **five** questions in all. The first question will be compulsory and will consist of seven short questions of 1 mark each covering the whole syllabus. In addition, four more questions of 14 marks each will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt one compulsory question and two more questions selecting one question from each unit.*

Course Objective: The objective of this course is to discuss about the designing and evaluation of color palettes for visualization based on principles of perception.

Course Outcomes: After completing this course students will be able to use knowledge of perception and cognition to evaluate visualization design alternatives.

Unit I

Visualizing Data: Mapping Data onto Aesthetics-Aesthetics and types of Data, Scales Map Data values onto Aesthetics.

Coordinate Systems and Axes: Cartesian Coordinates, Nonlinear Axes, Coordinate Systems with Curved Axes.

Color Scales: Color as a Tool to Distinguish, Color to Represent Data Values, Color as a Tool to Highlight.

Directory of Visualizations: Amounts, Distributions, Proportions, x–y relationships, Geospatial Data.

Visualizing Amounts: Bar Plots, Grouped and Stacked Bars, Dot Plots and Heat maps.

Visualizing Distributions: Single Distribution, Multiple Distributions at the Same Time.

Unit II

Visualizing Many Distributions at Once: Visualizing Distributions Along the Vertical Axis, Visualizing Distributions Along the Horizontal Axis.

Visualizing Proportions: Pie Charts, Side-by-Side Bars, Stacked Bars and Stacked Densities.

Visualizing Nested Proportions: Mosaic Plots and Tree-maps, Nested Pies, Parallel Sets.

Visualizing Associations Among Two or More Quantitative Variables: Scatter plots, Correlograms, Dimension Reduction, Paired Data.

Visualizing Time Series and Other Functions of an Independent Variable: Individual Time Series, Multiple Time Series.

The Principle of Proportional Ink: Visualizations Along Linear Axes, Visualizations Along Logarithmic Axes, Direct Area Visualizations.

Text/Reference Books

Text Books	1. Claus Wilke: "Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures", O"Reilly.
Reference Books	1. Tony Fischetti, Brett Lantz: "R: Data Analysis and Visualization", O"Reilly. 2. OssamaEmbarak: "Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems", Apress.

committee

B.S

BOS

B.Sc/DS/SM/6/MIC/303: Data Handling &Visualization (Lab Work)							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
MIC	02	04	Practical	50	-	3 Hours	Practical/Viva-voce

committee

SC

BOS

Semester-VII

B.Sc./DS/SM/7/DSC/401: Research Methodology								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final Term Examination: The Final Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to get the students familiar with different aspects of research methodology, namely, research design, collection and analysis of data, and interpretation of results.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: objectives, hypothesis, interpretation, data analysis, data collection, research design and method, interpretation, data analysis, sampling.
CO2	describe: objectives, hypothesis, interpretation, data analysis, data collection, research design and method, interpretation, data analysis, sampling.
CO3	Illustrate: measurement. data collection, processing, sampling, analysis and its strategies, reports.
CO4	categorize: research, sampling methods, data collection techniques, reports and data processing strategies. perform: data analysis.
CO5	compare: sampling methods, data collection techniques, reports and data processing strategies.
CO6	create: thesis, reports. design: research tool . interpret(drive): results.

Unit I

Objectives and types of research: motivation and objectives- research methods vs. methodology, types of research- descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical research formulation: defining and formulating the research problem-. selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review- primary and secondary source reviews, hypothesis- definition, qualities of a good hypothesis, null hypothesis and alternatives.

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Unit II

Research design and methods: basic principles, need of research design- features of good design, important concepts relating to research design, criteria of selecting a sampling procedure, characteristics of a good sample design, sampling methods, measurement: concept of measurement, problems in measurement in research - validity and reliability, levels of measurement- nominal, ordinal, interval, ratio.

Unit III

Data collection and analysis: execution of the research, observation and collection of data, methods of data collection, data processing and analysis strategies, data analysis with statistical packages, hypothesis testing, generalization and interpretation, univariate analysis (frequency tables, bar charts, pie charts, percentages).

Unit IV

Meaning of interpretation, need of interpretation, technique of interpretation, precaution in interpretation, layout of a research paper, journals in computer science, impact factor of journals, ethical issues related to publishing, plagiarism and self-plagiarism. reports and thesis writing: structure and components of scientific reports, types of report- technical reports and thesis, writing-synopsis, abstract, illustrations and tables, results, summary, reference citing and listing.

Text Books:

1. J. Garg, B.L. Karadia, R. Aggarwal F, An Introduction to Research Methodology, RBSA Publishers, 2002.
2. Kothari,C.R, Research Methodology: Methods and Techniques. New Age International, 1990.
3. Santosh Gupta, Research Methodology and Statistical Techniques, Deep & Deep Publications Pvt. Ltd., 2008

Reference Books:

1. N. Gurumani, Scientific Thesis Writing and Paper Presentation, MJP Publishers. Montgomery, Douglas C, Design and Analysis of Experiments, Wiley India Pvt. Ltd.

committee

S.C

BOS

B.Sc./DS/SM/7/DSC/402: Machine Learning								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Outcomes	At the end of this course, the student will be able to :
CO1	define: the terms of machine learning: types of machine learning, data preprocessing, classification, regression, and neurons.
CO2	explain: learning types, data preprocessing and architecture of ANN.
CO3	apply: training and testing data using data pre processing and model selection techniques and classification, regression, clustering techniques according to their problem.
CO4	Classify: data preprocessing, model selection, regression, classification, and unsupervised learning techniques.
CO5	compare: Data Preprocessing techniques, Supervised and unsupervised learning.

Unit I

Basics of Machine Learning: Introduction to artificial Intelligence and machine learning, types of machine learning and its comparisons, applications of machine learning, issues in machine learning.

Unit II

Preparing to Model: Introduction, machine learning activities, types of data in machine learning, exploring structure of data, data pre-processing (dimension reduction and feature subset selection), model selection..

Unit III

Supervised Learning: Introduction, classification (introduction, classification model, learning steps, common classification algorithm), regression (linear regression, multivariable regression, logistic regression).

Unit IV

Unsupervised Learning: Introduction and its applications, techniques in unsupervised learning (clustering, K-means).
Neural Network: Introduction, architecture of artificial neural network.

Text Books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited.
2. EthemAlpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press.

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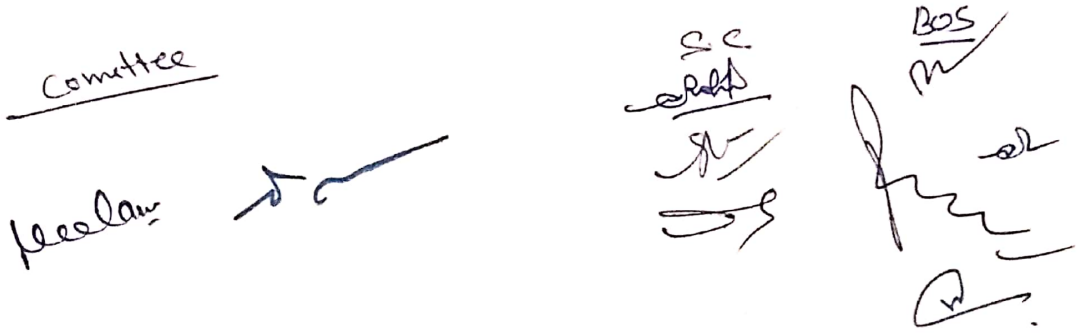
Reference Books:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press.
2. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press.
3. Peter Harrington, Machine Learning in Action, Manning.
4. ShaiShalevShwartz and Shai Ben David, Understanding Machine Learning From Theory to Algorithms, Cambridge University Press



B.Sc./DS/SM/8/MIC/403: Data Analytics Using R								
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
MIC	02	02	Lecture	35	15		2 Hours	TEE/MTE/ Assignment/ Attendance
					10	2 3		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be five. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be two units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study the fundamental concepts in R programming language, data types, operators, decision making statements and iteration, functions, different data structures like list, vectors, matrices, data frames, charts and graphs, graphics functions and statistical analysis.

Course Outcomes	At the end of this course, the student will be able to:
CO1	list : data types, functions in R programming, visualization.
CO2	describe: the syntax of decision making statements, loops, user defined functions,used define packages; explain: the process of import and export of data in text file, excel file and MYSQL .
CO3	use: various in built ,user defined function and packages . apply: R programming constructs to solve real world problems.
CO4	categorize:datatypes,conditional & control statements, in built and user defined functions and packages.
CO5	compare: datatypes, conditional & control statements,functions, packages in R programming.
CO6	design:basic and advanced applications in R programming.

Unit I

Basic of R: Introduction to R, Features of R, Variables in R, In-Built Functions in R (mathematical, trigonometric, logarithmic, Date and Time, Sequence, I/O).
Data Types in R: Vectors, Matrices, Arrays, Lists, Factors, Data Frames.

Programming in R: Decision making structures (if, Switch), Loops (For, while, repeat), User Defined functions (with argument without argument), User Defined Package. Reports using remark down (direct rendering, in-direct rendering.

Unit II

Import and Export of Data, visualisation techniques, basic visualization, advance visualization statistical analysis, basic statistics , parametric and non-parametric techniques .

Text Books:

1. Christian Heumann, Michael Schomaker and Shalabh, Introduction to Statistics and Data Analysis - with Exercises, Solutions and Applications in R, Springer, 2016.
2. Pierre Lafaye de Micheaux, RémyDrouilhet, Benoit Liquet, The R Software-Fundamentals of Programming and Statistical Analysis, Springer 2013.

Committee

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BOS

B.Sc./DS/SM/7/DSC/404: R Programming (Lab Work)							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
DSC	02	04	Practical	50	-	3 Hours	Practical/Viva-voce

Committee

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BOS

B.Sc./DS/SM/7/DSC/405: Internet of Things								
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	04	04	Lecture	70	30		3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5 5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study the fundamental concepts of cloud computing, its enabling technologies, cloud service models and security concerns, to learn core issues of Internet of Things, IOT communication protocols and security concerns.

Course Outcomes	At the end of this course, the student will be able to:
CO1	Define IoT: framework, architecture, design, communication challenges, applications, principles of web connectivity. list/define cloud computing: evolution, characteristics, working, service models, virtualization, architecture, security challenges and risks.
CO2	understand and describe IoT: framework, architecture, design, communication challenges, applications, principles of web connectivity. understand and describe cloud computing: evolution, characteristics, working, service models, virtualization, architecture, security challenges and risks.
CO3	use cloud computing services in different fields of applications.
CO4	diagrammatise IOT: framework, architecture, physical and logical design. diagrammatise cloud computing: service models, service-oriented architecture.
CO5	grade/compareIoT: communication challenges, security issues, enabling technologies, application areas, and protocols. grade/compare cloud computing: service models. virtualization, and hypervisors.

Unit I

Internet of Things: what is the IOT and why is it important, IoT conceptual framework, IoT architectural view, technology behind IoT, sources of IoT, examples of IoT, M2M communication, layered architecture (3 & 5 Layered) of IoT, physical design and logical design, domain-specific IoTs, security issues of IoT.

Unit II

Communication challenges related to IoT, enabling technologies for IoT.
Applications of IoT: home automation, smart cities, social life and entertainment, health & fitness, smart environment and agriculture, supply chain and logistics, energy conservation.

Unit III

Design principles for web connectivity: web communication protocols for connected devices, message communication protocols for connected devices. Design Challenges.

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Unit IV

Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model.

IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Text Books:

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing a Practical Approach, Tata McGraw Hill, New Delhi, 2010
2. Robert Elsenpeter, Toby J. Velte, Anthony T. Velte, Cloud Computing: A Practical Approach, 1e, Tata McGraw Hill Education, 2011.
3. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, Cloud Computing for Dummies, Wiley Publishing, 2010

Reference Books:

1. RajkumarBuyya, James Broberg, AndrzejGoscinski, Cloud Computing- Principles and Paradigms, Wiley, 2011.
2. Raj Kamal, Internet of Things-Architectures and Design Principles, McGraw Hill Education, 2017.

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B.Sc./DS/SM/7/DSC/406: Genetic Algorithms

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
DSC	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study fundamental concepts of evolutionary algorithm, genetic algorithm, their applications, genetic operators, the theoretical Analysis of Evolutionary Algorithms , Niche and Speciation

Course Outcomes	At the end of this course, the student will be able to:
CO1	define concepts of: evolutionary algorithms, population, gene, alleles, phenotype, fitness function, crossover, selection and mutation.
CO2	describe/explain: crossover, selection mutation, Diploid, dominance, abeyance, Niche and Speciation. understand: application of genetic algorithms for job shop scheduling problems.
CO3	use: encoding scheme, crossover, selection, mutation operators and fitness scaling.
CO4	differentiate: evolutionary algorithms and traditional algorithms, types of crossover, mutation, selection, inversion and reordering operator, crowding and restricted mating.
CO5	select and defend: crossover, mutation and selection operators of genetic algorithms.

Unit I

Introduction: Introduction to evolutionary algorithm, history of evolutionary algorithm, advantage of evolutionary algorithm, application of evolutionary algorithm - biological and AI, introduction of genetic algorithm, difference between traditional approach and evolutionary algorithm.

Unit II

Genetic modelling: Basic terminologies and operators like individual, gene, alleles, phenotype and fitness function. simple genetic algorithm, its representation, advantage and limitation of genetic algorithm.

Unit III

Operators of GA Selection: Roulette wheel selection, random, rank, tournament, Boltzmann selection.
Crossover and its types: Single point crossover, two point crossover, multipoint crossover, ordered crossover, uniform crossover, crossover for real-valued representation.
Mutation and its types: Flipping, Interchanging, reversing, replacement, mutation for real-valued representation, crossover rate, mutation rate and convergence criteria

Unit IV

Theoretical Analysis of Evolutionary Algorithms: Diploid, dominance and abeyance, inversion and reordering operator, fitness scaling.

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Niche and Speciation: Fitness sharing, crowding and restricted mating.
Application of GA: Genetic Algorithm for job shop scheduling problems (JSSP).

Text Books:

1. S.N. Sivanandam, S.N. Deepa, Introduction to Genetic Algorithms, Springer.
2. Mitchell, Melanie, An Introduction to Genetic Algorithms, United Kingdom, MIT Press, 1998.

Reference Books:

1. Goldberg, David Edward, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 2002.
2. D. Nagesh Kumar, Multicriterion Analysis in Engineering and Management, PHI Learning, 2010.
3. Lance Chambers, The Practical Handbook of Genetic Algorithms: Applications, 2e, United Kingdom, CRC-Press, 1995.

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SC

BOS

B.Sc./DS/SM/7/MIC/401: MATLAB

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
MIC	02	02	Lecture	35	15		2 Hours	TEE/MTE/ Assignment/ Attendance
					10	2 3		

Instructions to paper setter for Final Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be five. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be two units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to study, learn, and understand the major concepts of MATLAB Programming, namely, data types, data structure, matrices, data import/export, graphics, control structure, toolboxes, image and video processing.

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: features, commands, data types, hierarchy of operations, matrix, tools, functions related to input/output, file handling and graphics, control structure and toolboxes used in MATLAB.
CO2	describe: history, origin, features, commands, data types, hierarchy of operations, matrix, tools, functions related to file, function related to graphics, control structure and various toolboxes of MATLAB.
CO3	use: commands, operations, tools, menus, toolbars, input/output functions, file handling, functions related to graphics, 2D and 3D plotting, control structure, debugging, simulink and image & video processing toolboxes in MATLAB.
CO4	analyze: commands, data types, operations, control structure, matrix, tools, different functions related to graphics and file handling in given MATLAB program.
CO5	determine: command, data type, tool, menu, control structure, debugging technique, function, feature or toolbox of MATLAB to use in given condition.
CO6	create: basic or advanced program in MATLAB using different commands, 2D and 3D plotting, functions, tools, features, simulink, fuzzy logic, neural network and image & video processing toolbox of MATLAB.

Unit I

MATLAB: Introduction, history, origin, growth and development, features, menus and the toolbar, computing, types of file, editor debugger, useful commands, help system, creating directory and saving files, constants variables and expressions-character set, data type, constants, variables and expressions, operators, hierarchy of operations, built-in-function, assignment statements.

Vectors and matrices: scalars and vectors, entering data in matrices, line continuation, matrices subscripts, multi-dimensional matrices and arrays, matrix manipulation, special matrices, commands related to matrices, structure arrays, cell arrays.

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Unit II

B.Sc BOS

MATLAB graphics: 2d/3d plotting visualization, 2d plot , multiple plot, style options, legends, subplots, specialized 2d plot- logarithmic, polar, area, bar, barh, hist, rose, pie, stairs, stem, compass. 3d plot - plot3, bar3, bar3h, pie3, stem 3, meshgrid, mesh, surf, contour, contour3.
Control Structures: for, nested for, while, branch control structure- if, switch, break, continue, error, try-catch, debugging.

Text Books:

1. Raj Kumar Bansal, Ashok Kumar Goel, Manoj Kumar, MATLAB and its Application in Engineering, Pearson Education.
2. Ram N.Patel, Ankush Mittal, Programming in MATLAB, A Problrm Solving Approach, Pearson Education.
3. Duane Hanselman, Bruce L Littlefield, Mastering MATLAB 7, Prentice Hall.
4. Amos Gilat, MATLAB: An Introduction with Application, Wiley Publisher.

Reference Books:

1. Jim Sizemore, John P.Mueller, MATLAB for Dummies, Wiley.
2. Stephen J.Chapman, Matlab Programming for Engineers, Thomson-Engineering Publisher, CENGAGE Learning.

B.Sc./DS/SM/7/MIC/402: MATLAB (Lab Work)							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
MIC	02	04	Practical	50	-	3 Hours	Practical/Viva-voce

Committee

SC

BOS

Semester-VIII

B.Sc./DS/SM/8/DSC/407: Social Network Analytics

Course Type	Course Credits	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
DSC	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance
					20 | 5 | 5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will consist of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to understand the concept of Social Media Analytics, NLP techniques, analytics of Facebook, collection and analysis of data related to social media.

Course Outcomes	At the end of this course, the student will be able to :
CO1	**define:** Social Media Analytics, Web analytics tools, Network Analysis(LinkedIn, Instagram, YouTube Twitter etc. Google analytics).
CO2	**understand and describe:** Link Prediction, Collective Classification, Applications in Advertising and Game Analytics.
CO3	**apply and use:** techniques of Processing and Visualizing Data, Natural Language Processing Techniques for Micro-text Analysis.
CO4	**classify:** Social Media Analytics, Web analytics and Facebook Analytics.
CO5	**compare:** techniques of Processing and Visualizing Data, Natural Language Processing Techniques for Micro-text Analysis.

Unit I

Introduction to Social Media Analytics (SMA): Social media landscape, Need for SMA; SMA in small organizations, SMA in large organizations, application of SMA in different areas.

Network fundamentals and models: The social networks perspective - nodes, ties and influencers, social network and web data and methods. Graphs and Matrices- Basic measures for individuals and networks. Information visualization

Unit II

Making connections: Link analysis. Random graphs and network evolution.

Social contexts: Affiliation and identity.

Web analytics tools: Click stream analysis, A/B testing, online surveys, Web crawling and Indexing. Natural Language Processing Techniques for Micro-text Analysis.

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Unit III

Facebook Analytics: Introduction, parameters, demographics. Analysing page audience. Reach and Engagement analysis. Post- performance on FB. Social campaigns. Measuring and Analyzing social campaigns, defining goals and evaluating outcomes, Network Analysis.(LinkedIn, Instagram, YouTube Twitter etc. Google analytics. Introduction. (Websites)

Unit IV

Data Collection and Analysis: Processing and Visualizing Data, Influence Maximization, Link Prediction, Collective Classification, Applications in Advertising and Game Analytics Introduction to Python Programming, Collecting and analyzing social media data; visualization and exploration.

Text Books:

1. Matthew Ganis, Avinash Kohirkar, "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media", Pearson.

Reference Books:

1. Jim Sterne, Jim Sterne, "Social Media Metrics: How to Measure and Optimize Your Marketing", Wiley.
2. Oliver Blanchard, "Social Media ROI: Managing and Measuring Social Media Efforts in Your Organization (Que Biz-Tech)", Que Publishing.

B.Sc./DS/SM/8/DSC/408: Evolutionary Algorithms

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
DSC	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study fundamental concepts of evolutionary algorithm, genetic algorithm, their applications, genetic operators, the theoretical Analysis of Evolutionary Algorithms , Niche and Speciation

Course Outcomes	At the end of this course, the student will be able to:
CO1	define: concepts of evolutionary algorithms, population, gene, alleles, ph fitness function, crossover, selection and mutation.
CO2	describe/explain: crossover, selection mutation, Diploid, dominance, a Niche and Speciation. understand: application of genetic algorithms for job shop scheduling proble
CO3	use: encoding scheme, crossover, selection, mutation operators and fitness
CO4	differentiate: evolutionary algorithms and traditional algorithms, types of c mutation, selection, inversion and reordering operator, crowding and mating.
CO5	select and defend: crossover, mutation and selection operators of genetic alg

Unit-I

Introduction: Introduction to evolutionary algorithm, history of evolutionary algorithm, advantage of evolutionary algorithm, application of evolutionary algorithm - biological and AI, introduction of genetic algorithm, difference between traditional approach and evolutionary algorithm.

Unit-II

Genetic modelling: Basic terminologies and operators like individual, gene, alleles, phenotype and fitness function. simple genetic algorithm, its representation, advantage and limitation of genetic algorithm.

Unit-III

Operators of GA Selection: Roulette wheel selection, random, rank, tournament, Boltzmann selection.
Crossover and its types: Single point crossover, two point crossover, multipoint crossover, ordered crossover, uniform crossover, crossover for real- valued representation.
Mutation and its types: Flipping, Interchanging, reversing, replacement, mutation for real-valued representation,crossover rate, mutation rate and convergence criteria

Unit-IV

Theoretical Analysis of Evolutionary Algorithms: Diploid, dominance and abeyance, inversion and reordering operator, fitness scaling.
Niche and Speciation: Fitness sharing, crowding and restricted mating.
Application of GA: Genetic Algorithm for travelling salesman problems (TSP).

Text Books:

1. Deepa, S.N. and Sivanandam, S.N. Principles of soft computing, 2011.
2. Michael D. Vose. The Simple Genetic Algorithm - Foundations and Theory. Prentice Hall India Learning Private Limited, 2004.

Reference Books:

1. David E. Goldberg, Genetic Algorithms in Search, Optimization and machine learning. Pearson Education India, 2008.
2. D. Nagesh Kumar, Multicriterion Analysis in Engineering and Management, PHI Learning, 2010.
3. Chambers, Lance D., ed. Practical Handbook of Genetic Algorithms: Complex Coding Systems, Volume III. Vol. 3. CRC press, 2019.

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B.Sc./DS/SM/8/DSC/409: Soft Computing

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
DSC	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be four units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to cover fundamental soft computing concepts with an exposure to ANN, fuzzy Logic, optimization techniques using Genetic Algorithm (GA).

Course Outcomes	By the end of this course, the student will be able to:
CO1	recognize the concept of: soft computing and hard computing, simple genetic al fuzzy set, neuron, neural network and activation function.
CO2	understand and describe: the role of genetic algorithm operators, representation set and its operation, types of neural network and activation function including t and cons.
CO3	use: genetic algorithm, fuzzy logic , ANN and their constituents for solving optimization problem.
CO4	differentiate: soft computing and hard computing, operators of genetic algori activation functions of ANN. Analyze: fuzzification and defuzzification.
CO5	compare: soft computing and hard computing, operators of genetic algorit different activation functions of ANN.

Unit I

Introduction to Soft Computing: Overview of Soft Computing, difference between soft and hard computing, brief descriptions of different components of soft computing including artificial neural networks, fuzzy logic, genetic algorithms.

Unit II

Genetic Algorithm- Introduction to genetic algorithm, simple genetic algorithm, its representation.
Selection: Roulette wheel selection, random, rank, tournament, Boltzmann selection.
Crossover and its types: Single point crossover, two point crossover, multipoint crossover, ordered crossover, uniform crossover, crossover for real-valued representation.
Mutation and its types: Flipping, Interchanging, reversing, replacement, mutation for real-valued representation, crossover rate, mutation rate and convergence criteria.

Unit III

Fuzzy Logic: Introduction to fuzzy logic, representation of a classical set, representation of fuzzy set, basic properties of fuzzy sets.
Fuzzy set operation: Intersection of fuzzy sets, union of fuzzy sets, complement of fuzzy sets, important terminologies in fuzzy set operations, properties of fuzzy sets, fuzzy arithmetic.
Fuzzy Composition: Max-Min composition, max-star composition, max-product composition, max average composition. fuzzification and de-fuzzification.

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Unit IV

Artificial Neural Network: Basic of neural network: neuron, artificial neuron, neural network, artificial neural network , perceptron, feed forward, multilayer perceptron neural network, advantage and disadvantage of ANNs. activation function and types of activation function. perceptron network, XOR problem.

Text Books:

1. David E. Goldberg, Genetic Algorithms in Search, Optimization and machine learning, Addison Wesley.
2. Zbigniew Michalewicz, Genetic algorithms +Data Structures = Evolution Programs, Springer's Verlag.

Reference Books:

1. M. Mitchell, An Introduction to Genetic Algorithms, Prentice-Hall.
2. S. Rajasekaran& G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI.
3. S. N. Sivanandam& S. N. Deepa, Principles of Soft Computing, Wiley - India.
4. Simon O. Haykin, Neural Networks, A Comprehensive Foundation, PHI.

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B.Sc/DS/SM/8/DSC/410: Business Data Analytics

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks				Exam Duration	Assessment Methods
				External	Internal				
DSC	04	04	Lecture	70	30			3 Hours	TEE/MTE/ Assignment/ Attendance
					20	5	5		

Instructions to paper setter for Final Term Examination: The question paper will consist of ***nine*** questions in all. Question No. 1 will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, 8 more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit. All questions carry equal marks.

Course Objective: The objective of this course is to understand the analysis of data, detailed concept of probability and sampling.

Course Outcome: After completing the course Students will be able to understand the important concepts of Business Data Analytics.

Unit I	Introduction to data analysis and decision making (model, graphical models, algebraicmodel, spreadsheet model) Describing the distribution of a single variable (introduction, basic concepts, descriptive measures, time series data, outliers)
Unit II	Finding relationship among variables (introduction, relationship among variables). Probability and probability distributions (probability essentials, probability distribution of a single random variable, introduction to simulation)
Unit III	Normal, Binomial, Poisson and Exponential Distribution (normal distribution, applicationof normal distribution, binomial distribution, Poison and exponential distribution), Decision making under uncertainty (elements of decision analysis, bayes" rule, multistage decision problems, risk aversion and expected utility)
Unit IV	Sampling and Sampling Distribution (sampling terminology, methods of selecting randomsamples, introduction to estimation) Hypothesis Testing (introduction, hypothesis test for population Mean, hypothesis test for other parameters, chi-square test for Independence).
Text/Reference Books	
Text Books	1. Business Analytics (Data Analysis and Decision Making) 5e, S. Christian Albright, Wayne L. Winston, Cengage Learning.
Reference Books	1.Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking by Foster Provost and Tom Fawcett, O'Reilly Media

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Unit IV

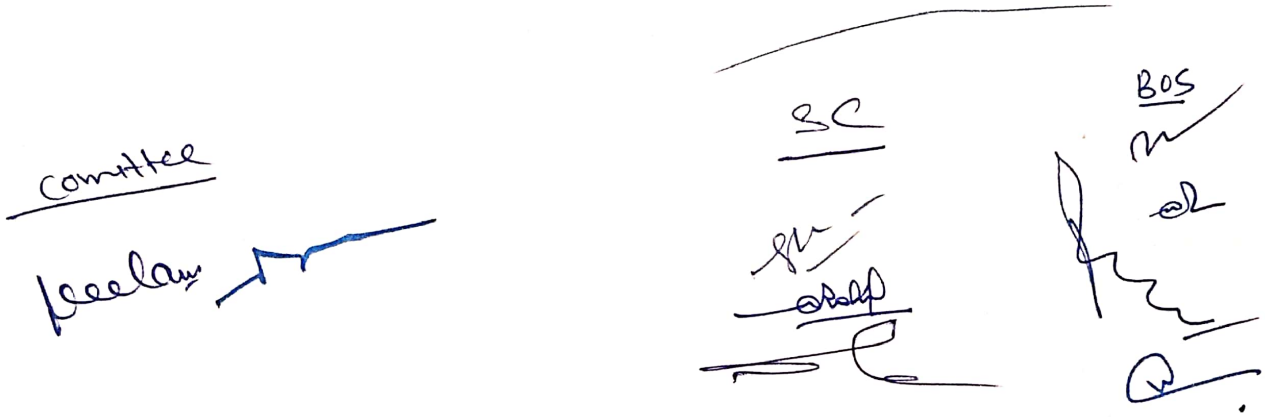
Wireless Security, wireless security measures, mobile device security - threats and strategy. Wireless LAN security, IEEE 802.11i - services, operation and phases. Email security, S/MIME, PGP, overview of IP security.

Text Books:

2. William Stallings, Cryptography And Network Security Principles And Practice, Pearson Education
3. Forouzan, Mukhopadhyay, Cryptography & Network Security, McGraw Hill

Reference Books:

3. AtulKahate, Cryptography and Network Security, TMH
4. Godbole, Information Systems Security, Wiley India Mark Stamp, Information Security Principles and Practice, Willy India



B.Sc/DS/SM/8/DSC/411:Android Development								
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks			Exam Duration	Assessment Methods
				External	Internal			
DSC	2	2	Lecture	35	15		2 Hours	TEE/MTE/ Assignment/ Attendance
					10	2 3		

Instructions to paper setter for Final Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be five. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be two units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide in-depth coverage of various concepts of android application development. This course will help the students in learning to develop and publish their own android applications.

Course Outcomes	At the end of this course, the student will able to:
CO1	define: android, features, development environment, architecture, software development platform and the framework related to android applications.
CO2	explain: versions of android, architecture, software development platform, JAVA SE, the Dalvik virtual machine and various android services.
CO3	demonstrate: android SDK, IDE, AVDs, project configuration settings, directory structure of android project, activities and services of android.
CO4	illustrate: android versions, features, system requirements, applications, directory structures, resource folders, android services, screen sizes and android framework.
CO5	compare and contrast: android versions with their functions, types of android applications, development platforms, layout of android applications, activities associated with android and user interfaces.
CO6	create: android applications using different types of resources and development platforms.

Unit I

Introduction: Android, Android versions and its feature.Android Development Environment: system requirements, Android SDK, installing Java, and ADT bundle, eclipse integrated development environment (IDE), creating Android Virtual Devices (AVDs).
Android Architecture Overview, creating a new Android project, defining the project name and SDK settings, project configuration settings, configuring the launcher icon, creating an activity, running the application in the AVD, stopping a running application, modifying the example application, reviewing the layout and resource files.

Unit II

Android software development platform, understanding Java SE, The directory structure of an Android project, common default resources folders, screen sizes, launching your application.
Android Framework overview, Android application components, Android activities: defining the

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TEXT BOOKS:

1. T1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)

REFERENCE BOOKS:

1 Reto Meier, "Professional Android

2 Application Development", Wiley India Pvt Ltd 2. R2. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd .

3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

B.Sc/DS/SM/8/DSC/412:Android Development (Lab Work)							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
DSC	02	04	Practical	50	-	3 Hours	Practical/Viva-voce

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B.Sc./DS/SM/8/MIC/403: Data Analytics Using R

Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
MIC	02	02	Lecture	35	15	2 Hours	TEE/MTE/ Assignment/ Attendance
					10 2 3		

Instructions to paper setter for Final-Term Examination: The Final-Term examination shall cover the whole content of the course. The total number of questions shall be five. Question number one will be compulsory and will be consisting of short/objective-type questions from the complete syllabus. In addition to the compulsory first question, there shall be two units in the question paper each consisting of two questions. The student will attempt one question from each unit in addition to the compulsory question. All questions will carry equal marks.

Course Objectives: To study the fundamental concepts in R programming language, data types, operators, decision making statements and iteration, functions, different data structures like list, vectors, matrices, data frames, charts and graphs, graphics functions and statistical analysis.

Course Outcomes	At the end of this course, the student will be able to:
CO1	list : data types, functions in R programming, visualization.
CO2	describe: the syntax of decision making statements, loops, user defined functions,used define packages; explain: the process of import and export of data in text file, excel file and MYSQL .
CO3	use: various in built ,user defined function and packages . apply: R programming constructs to solve real world problems.
CO4	categorize:datatypes,conditional & control statements, in built and user defined functions and packages.
CO5	compare: datatypes, conditional & control statements,functions, packages in R programming.
CO6	design:basic and advanced applications in R programming.

Unit I

Basic of R: Introduction to R, Features of R, Variables in R, In-Built Functions in R (mathematical, trigonometric, logarithmic, Date and Time, Sequence, I/O).
Data Types in R: Vectors, Matrices, Arrays, Lists, Factors, Data Frames.

Programming in R: Decision making structures (if, Switch), Loops (For, while, repeat), User Defined functions (with argument without argument), User Defined Package. Reports using remark down (direct rendering, in-direct rendering.

Unit II

Import and Export of Data, visualisation techniques, basic visualization, advance visualization statistical analysis, basic statistics , parametric and non-parametric techniques .

Text Books:

1. Christian Heumann, Michael Schomaker and Shalabh, Introduction to Statistics and Data Analysis - with Exercises, Solutions and Applications in R, Springer, 2016.
2. Pierre Lafaye de Micheaux, RémyDrouilhet, Benoit Liquet, The R Software-Fundamentals of Programming and Statistical Analysis, Springer 2013.

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Reference Books

2. Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters, Use R - A Beginner's Guide to R, Springer 2009.

B.Sc./DS/SM/8/MIC/404: Data Analytics Using R (Lab Work)							
Course Type	Course Credit	Contact Hours/ Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
MIC	02	04	Practical	50	-	3 Hours	Practical/Viva-voce

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