

Hindi Vidya Prachar Samiti's, **Ramniranjan Jhunjhunwala College of Arts, Science & Commerce**

(Empowered Autonomous College)

M.Sc. Computer-Science Syllabus Semester III & IV



Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College of Arts, Science & Commerce

(Empowered Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the M.Sc.

Program: M.Sc. COMPUTER-SCIENCE

Program Code: RJSPCS

National Education Policy (NEP 2020)

Level 6.0

(CBCS 2025-2026)

THE PREAMBLE

Why Computer Science?

Education is the key to the development of any society. Role of higher education is crucial for securing the right kind of employment and also to pursue further studies in best available world class institutes elsewhere within and outside India. Quality education in general and higher education in particular deserves high priority to enable the young and future generation of students to acquire skill, training and knowledge in order to enhance their thinking, creativity, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes.

Why Computer Science at R J College?

The Computer Science department was established in the year 1999 with strength of 60 Students and M.Sc CS with strength of 40 Seats was introduced in the year 2001. Today the strength has reached 120 at UG level and 48 at PG level. The department offers both UG and PG programs in the subject of CS and is affiliated to, and recognized by the University of Mumbai. College facilitates a departmental library with nearly 1200+ books. There are 3 dedicated well-upgraded laboratories for the CS department. With the management's extensive support, the department believes in "**1 Student 1 PC policy**" which helps students to rigorous practice and focus. Projects, hands on training sessions, guest lectures, laboratory experimentation, lecture-based learning, industry visits etc. motivate students to explore more in terms of applications of the subject. Under autonomy, the department has made curriculum more robust by incorporating skill-based learning and value-added courses that impart practical knowledge of the subject to the students. Department of CS (DBT), New Delhi has identified CS Department of R J College as DBT Star College Department which has further strengthened our hands in being able to provide hands-on training to the students to satisfy their curiosity.

Our Curriculum, Your Strength

This syllabus is an honest attempt to include following ideas, among other things, into practice:

- Bring a new approach to the syllabus, not a revision of the existing syllabus.
- Create a unique identity for MSC in Computer Science distinct from similar degrees in other related subjects.
- Offers focus on core Computer Science subjects.
- Incorporate advanced and most recent trends.
- Identify and nurture research temper among students.
- Offer provision for internship with industry at semester IV.
- Focus, as far as possible, only on open source software.

This syllabus for the semester III and semester IV have initiated steps to meet these goals. In order to give an impetus to research among students, one of the courses in the semester - I give an overview on how to do research in Computer Science. In a nutshell, the core philosophy of the syllabus is to - (i) Give strong foundation on core Computer Science subjects (ii) expose the student to emerging trends in a gradual and incremental way (iii) create a research temper among students in the whole process (v) Prepare student community for the demands of ICT industry. We hope that the student and teaching community will appreciate the thrust, direction and treatment given to the courses in the syllabus. We sincerely believe that a student who takes up this course will be a better fit for industry as he or she will have a strong foundation on fundamentals and exposure to advanced and emerging trends. We earnestly believe that by focusing on student driven research, learning will be more interesting and stimulating.

PROGRAM OUTCOMES OF GENERAL POSTGRADUATE DEGREE PROGRAMS

Students of all Postgraduate degree program at the time of graduation will be benefited and will be able to:

Critical Thinking

Comprehend the matter they come across and be capable to take a sound viewpoint about things which will highlight their intellectual acumen as well as enable them to look at the world through multiple lenses.

Effective communication

Listen, speak, read and write. They should communicate properly by conveying their thoughts. They will use technology for communication. Will be able to network with people with all available channels. They will be developing communication skills in English; Hindi and a local language would be an added advantage.

Social Interaction

Respect each other and should be able to resolve conflicts and help in reaching amicable Solution. They should be able to work in diverse teams. They should be able to distinguish When and what is socially acceptable.

Responsible citizen

Contribute to Nation development through social service. Being empathetic and Sympathetic to fellow beings.

Honesty and Integrity, Ethics

Recognize different values and systems and respect them. In decision making moral values should be given prime importance.

Environmental and Sustainability

Environmental issues would be considered and problem solving with sustainable development would be chosen.

LifeLong learning

Enjoy learning in every situation.

Program Specific Outcome M.Sc. Program with Computer Science

M.Sc. Computer Science course allows the candidates to learn technology-oriented knowledge and ability to develop creative solutions. An ability to critically analyze a problem and to design, implement, and evaluate a computing solution that meets requirements. An ability to work effectively in small groups on medium scale computing projects. The program provides the students with knowledge, general competence, and analytical skills on an advanced level, needed in academics, industry.

PSO1:	Ability to be technology-oriented with the knowledge and ability to develop creative solutions, and better understand the effects of future developments of computer systems and technology on people and society. Enrich the knowledge in the areas like Artificial Intelligence, M/C and Deep Learning, Paradigm of Programming language, Design and Analysis of Algorithms, computing subjects, Research methodologies.
PSO2:	Students understand all dimensions of the concepts of software application and projects. Students understand the computer subjects with demonstration of all programming and theoretical concepts. Developed in-house applications in terms of projects. Interact with IT experts & knowledge by IT visits. Get industrial exposure through the “On Job Training” in the IT industry. To make them employable according to current demand of IT Industry and responsible citizen.

Credit Structure for M.Sc. Semester-III as per NEP 2020

To be implemented from the academic year 2024-2025.

Papers	Number of Papers	Credits	Total Credits
Major Subject theory	3	4 * 3 = 12	12
Major Subject Practical	3	2 * 3 = 6	6
Elective 1 Natural Processing Language Practical	1 + 1 (P)	2 2	4
Elective 1 Data Visualization Practical	1 + 1 (P)	2 2	4
Total Credits		22	22

TOTAL MARKS: 550 Marks

THEORY: 300 Marks

PRACTICAL: 150 Marks

ELECTIVES: 100 Marks (50 Theory + 50 Practical)

Credit Structure for M.Sc. Semester-IV as per NEP 2020

To be implemented from the academic year 2024-2025.

Papers	Number of Papers	Credits	Total Credits
Major Subject theory	2	4 * 1 = 4 2 * 1 = 2	6
Major Subject Practical	1	2 * 1 = 2	2
Elective1 NO SQL Practical	1 + 1 P	2 2	4
Elective 2 Robotics Practical	1 + 1 (P)	2 2	4
Research Project	1	10	10
Total Credits		22	22

TOTAL MARKS: 550 Marks

THEORY: 150 Marks

PRACTICAL: 50 Marks

ELECTIVES: 100 Marks (50 Theory + 50 Practical)

RESEARCH PROJECT: 250 March

DISTRIBUTION OF TOPICS AND CREDITS

M.Sc. COMPUTER-SCIENCE SEMESTER III

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS301	Paper Title: Compiler			
	I	1. Structure of a compiler 2. Lexical Analysis Phase 3. Grammars	4	1
	II	1. Parsers 2. Construction of parser		1
	III	1. Syntax directed Translation 2. Intermediate code and its type		1
	IV	1. Loop Optimization 2. Some more Optimization Techniques		1

Course Code	Topic Headings	Credits
RJSPCSP301	Tokenization, evaluate of arithmetic expression, error checking, regular expression, parsing, context free grammar, loop controlling & jamming	2

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS302	Paper Title: Cyber Forensics and Laws			
	I	Computer Forensic Fundamental	4	1
	II	Data backup and Recovery and Network forensics		1
	III	Cyber Laws		1
	IV	Information Technology Act 2000		1

Course Code	Topic Headings	Credits
RJSPCSP302	Encryption-decryption, creating logs, searching word, creating virus, recovery & inspection of deleted files, port scan, vulnerability scan, connecting to LAN with port scanners, network scanning, IP scanners etc.	2

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS303	Paper Title: Augmented Reality & Virtual Reality			
	I	Introduction & Graphics ForVR	4	1
	II	VR Geometrical Concepts, Virtualization & Transformation		1
	III	Introduction to AR & AR Hardware		1
	IV	AR Software's & Techniques		1

Course Code	Topic Headings	Credits
RJSPCSP303	Unity Installation, working of Vive, Cardboard, Daydream, gear, developing scene (Geometrical shape), designing UI, 3D games objects, animation & interaction, developing games.	2

Elective Course 1

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS304A	Paper Title: Natural Processing Language			
	I	1. Introduction to Natural Language Processing (NLP) and Language Modelling 2. Morphology & Parsing in NLP	2	1
	II	1. Semantic and Word Embedding Semantics 2. NLP Applications and Case Studies		1

Course Code	Topic Headings	Credits
RJSPCSP304A	Sentence segmentation, Word tokenization, Stemming, Lemmatization, HMM & Neural Model, Parsing, Named Entity Recognition, Text Summarization	2

Elective Course 2

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS304B	Paper Title: Data Visualization			
	I	1. Introduction to Business Intelligence 2. Data Visualization and Dashboard Design	2	1
	II	1. Power BI: Introduction to power BI. 2. Modeling and Analysis		1

Course Code	Topic Headings	Credits
RJSPCSP304B	Big data & advance data visualization using python, data visualization using plotly & Tableau, creating dashboard & story telling using tableau, data visualization using Power BI, creating dashboard & story telling using power BI, Data visualization using Excel	2

M.Sc. COMPUTER-SCIENCE SEMESTER IV

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS401	Paper Title: Big Data			
	I	Big Data and Hadoop	4	1
	II	Map Reduce and HBASE		1
	III	Spark Framework and Applications		1
	IV	Tools for Data Analytics		1

Course Code	Topic Headings	Credits
RJSPCSP401	Setting up a Hadoop environment, WordCount with MapReduce, HBASE, Spark to handle error and recovery of data, Access to graphical data using Spark, Spark to handle streaming of data, Handling tools like Hive, Pig, Flume and Sqoop.	2

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS402	Paper Title: Operation Research			
	I	1. Linear Programming 2. Graphical Method 3. Simplex Method	2	1
	II	1. Transportation Problem 2. Assignment Problem 3. Sequence Problem		1

Elective Course 1

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS403A	Paper Title: NO SQL			
	I	Introduction to NoSQL and Interfacing with NoSQL Data Stores	2	1
	II	Querying, Indexing, and Data Management in NoSQL Databases		1

Course Code	Topic Headings	Credits
RJSPCSP403A	Setting up and Exploring MongoDB, Interacting with Redis, Working with HBase, Apache Cassandra Operations, Querying MongoDB and HBase, Redis Data Manipulation Implementing Indexing in MongoDB, Data Storage in Redis, Using Google App Engine Data Store, Amazon SimpleDB Data Management	2

Elective Course 2

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS403B	Paper Title: Robotics			
	I	Introduction To Robotics & Control Techniques and Implementation in Robotics	2	1
	II	Control Architectures in Robotics, Artificial Intelligence and Its Usage in Robotics		1

Course Code	Topic Headings	Credits
RJSPCSP403B	To move robot in different directions & in patterns, circular motion of robot, circular motion of a robot using gear & without using gear, line following the robot, path finding robot, obstacle resistance robot with ultrasonic sensor, torch-following robot, shadow-following robot	2

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS403B	Paper Title: Research Project		10	1

SEMESTER III (THEORY)		L	Cr
Paper-I: Compiler	Paper Code: RJSPCS301	40	4
UNIT I		10	
INTRODUCTION TO COMPILER			
1	The structure of a compiler, A simple approach to the design of lexical analyzers, Regular expressions, Finite automata, from regular expressions to finite automata, Minimizing the number of states of a DFA.		
2.	Context-free grammars, Derivations and Parse trees. Simple precedence Grammar, Parsing using SPM.		
UNIT II		10	
AUTOMATIC CONSTRUCTION OF EFFICIENT PARSERS			
1	Parsers, Shift-reduce parsing, Top- down parsing, Predictive parsers.		
2	LR parsers, Constructing SLR parsing tables, Constructing LALR parsing tables.		
UNIT III		10	
ADVANCED SYNTAX ANALYSIS AND BASIC SEMANTIC ANALYSIS			
1.	Syntax-directed translation schemes, Implementation of syntax-directed translators, translation to intermediate code.		
2	intermediate code and its type.		
UNIT IV		10	
DATAFLOW ANALYSIS AND LOOP OPTIMIZATION			
1	The principle sources of optimization, Loop optimization: The DAG representation of basic blocks, Dominators, Reducible flow graphs, Loop- invariant computations, Induction variable elimination.		
2	Some other loop optimizations. Dataflow Analysis: intermediate representation for flow analysis, various dataflow analysis, transformations using dataflow analysis, speeding up dataflow analysis.		

Suggested References:

1. Compilers: Principles, Techniques and Tools 2nd edition, Alfred V. Aho ,Monica S. Lam , Ravi Sethi , Jeffrey D. Ullman , Pearson (2011)
2. Modern Compiler Implementation in Java, Second Edition, Andrew Appel and Jens Palsberg, Cambridge University Press (2004).
3. Principles of Compiler Design, Alfred Aho and Jeffrey D. Ullman, Addison Wesley (1997).
4. Compiler design in C, Allen Holub, Prentice Hall (1990).
5. J.P. Bennet, “Introduction to Compiler Techniques”, Second Edition, McGraw-Hill,2003.
6. V Raghvan, “ Principles of Compiler Design”, McGraw-Hill,

COURSE OUTCOMES (COs) M. Sc. COMPUTER SCIENCE

SEMESTER	:	III MAJOR (CORE) SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Compiler
COURSE CODE	:	RJSPCS301
CREDITS	:	04
DURATION	:	40 LECTURES

LEARNING OBJECTIVES	
1	After completion of this course each student will be able to implement a compiler for a small programming language.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Acquire knowledge of different phases and passes of the compiler and also able to use the compiler tools like LEX, YACC, etc. Students will also be able to design different types of compiler tools to meet the requirements of the realistic constraints of compilers.	1,2	BT Level III,VI
CO2	Understand the parser and its types i.e. Top-Down and Bottom-up parsers and construction of LL, SLR, CLR, and LALR parsing table.	1,2	BT Level III,VI
CO3	Implement the compiler using syntax-directed translation method and get knowledge about the synthesized and inherited attributes.	1,2	T Level IV,V
CO4	Understand the target machine's run time environment, its instruction set for code generation and techniques used for code optimization.	1,2	BT Level II,IV

Practical-I: Compiler		Paper Code: RJSPCSP301 Credits: 02
1	(Tokenizing). A program that reads a source code in C/C++ from an unformatted file and extract various types of tokens from it (e.g. keywords/variable names, operators, constant values).	
2	(Tokenizing) Use Lex and yacc to extract tokens from a given source code.	
3	Study the LEX and YACC tool and Evaluate an arithmetic expression with parentheses, unary and binary operators using Flex and Yacc. [Need to write yylex() function and to be used with Lex and yacc.].	
4	Using JFLAP, create a DFA from a given regular expression. All types of error must be checked during the conversion.	
5	Using JFLAP create LL(1) parse table for a given CFG and hence Simulate LL(1) parsing.	
6	Using JFLAP create SLR(1) parse table for a given grammar. Simulate parsing and output the parse tree proper format.	
7	Write a suitable data structure to store a Context Free Grammar. Prerequisite is to eliminate left recursion from the grammar before storing. Write functions to find FIRST and FOLLOW of all the variables. [May use unformatted file / array to store the result].	
8	Accept the input string with Regular expression of Finite Automaton.	
9	Write a code to generate the DAG for the input arithmetic expression.	
10	Write a program to demonstrate loop unrolling and loop jamming for the given code sequence containing the loop.	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	III MAJOR (CORE) SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Compiler
COURSE CODE	:	RJSPCSP301
CREDITS	:	02
DURATION	:	40 HOUR

LEARNING OBJECTIVES	
1	After completion of this course each student will be able to implement a compiler for a small programming language.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Acquire knowledge of different phases and passes of the compiler and also able to use the compiler tools like LEX, YACC, etc. Students will also be able to design different types of compiler tools to meet the requirements of the realistic constraints of compilers.	1,2	BT Level III , VI
CO2	Understand the parser and its types i.e. Top-Down and Bottom-up parsers and construction of LL, SLR, CLR, and LALR parsing table.	1,2	BT Level II,VI
CO3	Implement the compiler using syntax-directed translation method and get knowledge about the synthesized and inherited attributes.	1,2	BT Level IV,V
CO4	Understand the target machine's run time environment, its instruction set for code generation and techniques used for code optimization.	1,2	BT Level II,IV

SEMESTER III (THEORY)		L	Cr
Paper-II: Cyber Forensics and Laws	Paper Code: RJSPCS302	40	4
UNIT I		10	
INTRODUCTION TO CYBER FORENSIC			
1	Computer Forensic Fundamentals: Introduction to Computer Forensics and objective, the Computer Forensics Specialist, Use of Computer Forensic in Law Enforcement, Users of Computer Forensic Evidence, Case Studies, Information Security Investigations.		
2	Types of Computer Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement Computer Forensic Technology, Types of Business Computer Forensic Technology, Specialized Forensics Techniques, Hidden Data, Spyware and Adware, Encryption Methods and Vulnerabilities, Protecting Data forming		
3	Types of Computer Forensics Systems: Study different Security System: Internet, Intrusion Detection, Firewall, Storage Area, Network Disaster Recovery, Public Key Infrastructure, Wireless Network, Satellite Encryption, Instant Messaging (IM), Net Privacy, Identity Management, Biometric, and Identity Theft.		
UNIT II		10	
NETWORK FORENSIC			
1	Network Forensics: Introduction to Network Forensics Sources of Network Based Evidence, Principles of Internetworking, Internet Protocol Suite. Data Recovery: Data Recovery and Backup, Role of Data Recovery, Hiding and Recovering Hidden Data. Evidence Collection: Need to Collect the Evidence, Types of Evidence, The Rules of Evidence, Collection Steps. Computer Image Verification and Authentication: Special Needs of Evidence Authentication. Identification of Data: Time keeping, Forensic Identification and Analysis of Technical Surveillance Devices, Reconstructing Past Events: How to Become a Digital Detective, Useable File Formats, Unusable File Formats, and Converting files.		
2	Computer Image Verification and Authentication: Special Needs of Evidence Authentication. Identification of Data: Time keeping, Forensic Identification and Analysis of Technical Surveillance Devices. Reconstructing Past Events: How to Become a Digital Detective, Useable File Formats, Unusable File Formats, and Converting files.		

UNIT III		10	
CYBER LAWS			
1	Fundamentals of Cyber Law: Regulation of Information Society, Need for Cyber Laws, ICANN, UNCITRAL, Indian Scenario in regulation, Investigation and Ethics: Cyber Crime, Information Security and Law, Types & overview of Cyber Crimes, Cyber Law Issues in E-Business Management, Indian IT Act, Digital signature in IT act.		
2	Intellectual property rights and types, Cyber squatters and Copy Right Protection, Patents, Data privacy and protection, Domain Name, Software piracy, Plagiarism, Issues in ethical hacking.		
UNIT IV		10	
INFORMATION TECHNOLOGY ACT 2000			
1	Information Technology Act 2000: Information Technology Act-2000-1 (Sec 1 to 13), Information Technology Act-2000-2 (Sec 14 to 42 and Certifying authority Rules), Information Technology Act-2000-3 (Sec 43 to 45 and Sec 65 to 78), Information Technology Act-2000-4 (Sec 46 to Sec 64 and CRAT Rules) Information Technology Act-2000-5 (Sec 79 to 90), Information Technology Act-2000-6 (Sec 91-94) Amendments in 2008.		

Suggested References:

1. Computer Forensics Computer Crime Scene Investigation, John R. Vacca, Second Edition, 2005.
2. Network Forensics, Sherri Davidoff, Jonathan HAM, Prentice Hall, 2012.
3. Mobile Phone Security and Forensic: A Practical Approach, Second Edition, Iosif I. Androulidkis, Springer, 2012.
4. Digital forensics: Digital evidence in criminal investigation", Angus M. Marshall, John - Wiley and Sons, 2008.
5. Computer Forensics with FTK, Fernando Carbone, PACKT Publishing, 2014.
6. Practical Mobile Forensics, Satish Bommisetty, Rohit Tamma, Heather Mahalik, PACKT Publishing, 2014.
7. Nina Godbole, Information System Security Wiley India, New Delhi. The Information technology Act, 2000; Bare Act- Professional Book publishers, New Delhi

COURSE OUTCOMES (COs) M. Sc. COMPUTER SCIENCE

SEMESTER	:	III MAJOR (CORE) SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Cyber Forensics and Laws
COURSE CODE	:	RJSPCS302
CREDITS	:	02
DURATION	:	40 LECTURES

LEARNING OBJECTIVES	
1	Understand the definition of computer forensics fundamentals.
2	Describe the types of computer forensics technology.
3	Analyze various computer forensics systems.
4	Illustrate the methods for data recovery, evidence collection and data seizure.
5	Summarize duplication and preservation of digital evidence.
6	Summarize Different cyber laws.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Understand the definition of computer forensics fundamentals.	1,2	BT Level I, II
CO2	Describe the types of computer forensics technology and tools.	1,2	BT Level II,III
CO3	Analyze various computer forensics cryptography tools, pattern searching	1,2	BT Level III
CO4	Illustrate the tools for data recovery from deleted files.	1,2	BT Level IV, V
CO5	Illustrate the tools for data Backup and recovery	1,2	BT Level IV, V
CO6	Understand Information Technology Act	1,2	BT Level V

Practical-2: Cyber Forensics and Laws		Paper Code: RJSPCSP302 Credits: 02
1	Create a java application to send encrypted message from sender and decrypted message at receiver end.	
2	Write a program for creating log files	
3	Write a java program for searching file in given directory.	
4	Write a java program to Search a particular word in a file.	
5	create a virus for eating space of particular drive	
6	Use DriveImage XML to image a hard drive	
7	Create forensic images of digital devices from volatile data such as memory using Imager for Computer System	
8	Recovering and Inspecting deleted files (use Autopsy)	
9.	Registry Editor	
10	Perform 5 different types of (port) scanning using nmap on a single port capture the packets using Wireshark and analyze the output	
11	Perform a Vulnerability Scan on a system within the Local Area Network and Submit the report	
12	Implementation to gather information from any PC connected to the LAN using whois, port scanners, network scanning, IP scanners etc.	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	III MAJOR (CORE) SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Cyber Forensics and Laws
COURSE CODE	:	RJSPCSP302
CREDITS	:	02
DURATION	:	40 HOUR

LEARNING OBJECTIVES	
1	Understand the definition of computer forensics fundamentals.
2	Analyze various computer forensics cryptography tools, pattern searching techniques.
3	Describe the types of computer forensics technology and tools.
4	Illustrate the tools for data recovery from deleted files.

COURSE OUTCOM E NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	After completion of the course the students will be able to learn investigation tools and techniques.	1,2	BT Level III, IV
CO2	Analysis of data to identify evidence, Technical Aspects & Legal Aspects related to cyber crime.	1,2	BT Level III, V
CO3	Study the tools used for data Backup and recovery.	1,2	BT Level IV,V

SEMESTER III (THEORY)		L	Cr
Paper-III: Augmented Reality & Virtual Reality	Paper Code: RJSPCS303	40	4
UNIT I		10	
Introduction & Graphics for VR			
1	Introduction: Definition of X-R (AR, VR, MR), Virtual Reality & Virtual Environment, Virtual environment requirement, Benefits of VR, Applications of Virtual Reality, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays.		
2	Graphics: Computer graphics, Real time computer graphics, Flight Simulation, Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR.		
UNIT II		10	
VR Geometrical Concepts, Virtualization & Transformation			
1	Geometrical Concepts: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR. Geometric & Virtualization: The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Colour theory, Conversion From 2D to 3D, 3D spaces curves, 3D boundary representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, shading algorithms,		
2	Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection.		
UNIT III		10	
Introduction to AR & AR Hardware			
1	Introduction Augmented Reality - Defining augmented reality, AR Vs VR, Challenges with AR, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, AR systems and functionality, Augmented Reality Methods, Enhancing interactivity in AR Environments, Features of Augmented Reality, applications of augmented reality, Evaluating AR systems, Visualization Techniques for Augmented Reality, Examples of Augmented Reality Augmented Reality Concepts- How Does Augmented Reality Work? Concepts		

	Related to Augmented Reality, Ingredients of an Augmented Reality Experience.		
2	Augmented Reality Hardware: Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner, etc.), Output (Visual/Auditory/Haptic Devices) Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.		
UNIT IV		10	
AR Software's & Techniques			
1	Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application. AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene AR Devices – Optical See- Through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, Video see-through systems		
2	AR Techniques- Marker based & Marker less tracking Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication Marker types- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real world examples Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialisation and recovery.		

Suggested References:

1. Allan Fowler-AR Game Developmentll, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
3. Coiffet, P., Burdea, G. C., (2003), "Virtual Reality Technology," Wiley-IEEE Press, ISBN: 9780471360896
4. Schmalstieg, D., Höllerer, T., (2016), "Augmented Reality: Principles & Practice," Pearson, ISBN: 9789332578494
5. Norman, K., Kirakowski, J., (2018), "Wiley Handbook of Human Computer Interaction," Wiley-Blackwell, ISBN: 9781118976135
6. LaViola Jr., J. J., Kruijff, E., McMahan, R. P., Bowman, D. A., Poupyrev, I., (2017), "3D User Interfaces: Theory and Practice," Pearson, ISBN: 9780134034324
7. Fowler, A., (2019), "Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#," Apress, ISBN: 9781484246672
8. Hassanien, A. E., Gupta, D., Khanna, A., Slowik, A., (2022), "Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications," Springer, ISBN: 9783030941017

E-Books

1. <https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf>
2. <https://docs.microsoft.com/en-us/windows/mixed-reality/>
3. <https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololens-introduction-to-the-hololens>

Web References

1. Manivannan, M., (2018), "Virtual Reality Engineering," IIT Madras, <https://nptel.ac.in/courses/121106013>
2. Misra, S., (2019), "Industry 4.0: Augmented Reality and Virtual Reality," IIT Kharagpur, <https://www.youtube.com/watch?v=zLMgdYI82IE>
3. Dube, A., (2020), "Augmented Reality - Fundamentals and Development," NPTEL Special Lecture Series, <https://www.youtube.com/watch?v=MGuSTAqLZ9Q>
4. <http://cambum.net/course-2.htm>

MOOC Courses:

1. <https://www.coursera.org/learn/ar>
2. <https://www.udemy.com/share/101XPi/>

COURSE OUTCOMES (COs) M. Sc. COMPUTER SCIENCE

SEMESTER	:	III MAJOR (CORE) SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Augmented Reality & Virtual Reality
COURSE CODE	:	RJSPCS303
CREDITS	:	02
DURATION	:	20 LECTURES

LEARNING OBJECTIVES	
1	To understand the basic concepts, graphics of VR
2	To understand VR Geometrical Concepts, Virtualization & Transformation
3	To understand the basics of AR & AR hardware.
4	To understand the AR Software's & Techniques

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Understand the basic concepts, graphics of VR	1,2	BT Level II, III
CO2	Understand VR Geometrical Concepts, Virtualization & Transformation	1,2	BT Level III, IV, V
CO3	Understand the basics of AR & AR hardware.	1,2	BT Level III, IV,
CO4	Understand the AR Software's & Techniques	1,2	BT level III, IV and V

Practical-3: Augmented Reality & Virtual Reality		Paper Code: RJSPCSP303 Credits: 02
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.	
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.	
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source.	
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click.	
5	Develop a scene in Unity that includes a sphere and plane. Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using the vr controller.	
6	Develop a simple UI (User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene ..	
7	Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.	
8	Include animation and interaction in the immersive environment created in the assignment.	
9.	Develop a VR Ball Game. The scene should contain a play area surrounded by four walls and a ball that acts as a player. The objective of the game is to keep the ball rolling without colliding with the walls. If it collides with either of the walls, the wall color should change and a text should display on the screen indicating the collision.	
10	Develop a VR game in Unity such that on each gun trigger click, destroy the cubes placed on the plane and gain a score point. Make a score UI and display it on the screen	
11	Develop a VR Golf Game. The scene should contain a play area (golf course), which consists of a series of cups/holes each having different scores. Display the score card.	
12	Develop a VR Basketball Game. The scene should contain a basketball court. The developed game should be a single player game. The objective of the game is to let the player put the ball in the basket maximum number of times. Display the score card.	
13	Develop an AR bowling game with one image target. The image target should include 3d models as per requirement. Write a c# program to develop a score point system for bowling games. Build an apk. (Note: Vuforia plugin should be installed in unity.)	
14	Develop a VR environment for flying helicopter/moving car simulation.	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	III MAJOR (CORE) SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Augment Reality & Virtual Reality
COURSE CODE	:	RJSPCSP303
CREDITS	:	02
DURATION	:	40 HOUR

LEARNING OBJECTIVES	
1	To understand softwares of AR VR.
2	To develop a different scene.
3	To develop a different gaming scene & simulation.

COURSE OUTCOM E NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Understand environment of ARVR softwares	1,2	1,2,4
CO2	Understand the 3D environment.	1,2	1,2,3,,5
CO3	Understand the execution of simulation	1,2	1,2,3,4,5

SEMESTER III (THEORY)		L	Cr
Paper-IV: Natural Processing Language	Paper Code: RJSPCS304A	20	2
UNIT I		10	
1	Introduction to Natural Language Processing (NLP) and Language Modelling Introduction to NLP: Introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts-of speech and Formal Grammar of English. Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development Python Libraries for NLP: Using Python libraries/packages such as Natural Language Toolkit (NLTK), spaCy, genism		
2	Morphology & Parsing in NLP: Computational morphology & Parts-of-speech Tagging; basic concepts; Tagset; Lemmatization, Early approaches: Rule-based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model. Parsing Basic concepts: top-down and bottom-up parsing, treebank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context-Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs.		
UNIT II		10	
1	Semantic and Word Embedding Semantics Vector Semantics: Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis Embeddings from prediction: Skip-gram and Continuous Bag of words; Concept of Word Sense; Introduction to WordNet		
2	NLP Applications and Case Studies Intelligent Work Processors: Machine Translation; User Interfaces; man-machine Interfaces: Natural language Querying Tutoring and Authoring Systems. Speech Recognition Commercial use of NLP: NLP in customer Service, Sentiment Analysis, Emotion Mining, Handling Frauds and SMS, Bots, LSTM & BERT models, Conversations		

Suggested References:

Text Books:

1. Speech and Language Processing, Jurafsky Dan and Martin James H., 3rd Edition, Pearson, 2018.
2. Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2nd Edition, O'Reilly, 2016.

References:

1. Natural Language Processing with Python, Mathangi Sri, Apress, 2021 .
2. "Handbook of Computational Linguistics and Natural Language Processing, Martin Whitehead, Clanrye International, 2020.
3. Handbook of Natural Language Processing, Nitin Indurkha, and Fred J. Damerau, Pearson; 2nd edition, 2008.

COURSE OUTCOMES (COs) M. Sc. COMPUTER SCIENCE

SEMESTER	:	III ELECTIVE SUBJECT THEORY
TITLE OF THE SUBJECT/COURSE	:	Natural Processing Language
COURSE CODE	:	RJSPCS304A
CREDITS	:	02
DURATION	:	20 LECTURES

LEARNING OBJECTIVES

1	The prime objective of this course is to introduce the students to the field of Language Computing and its applications ranging from classical era to modern context.
2	To provide understanding of various NLP tasks and NLP abstractions such as Morphological analysis, POS tagging, concept of syntactic parsing, semantic analysis etc.
3	To provide knowledge of different approaches/algorithms for carrying out NLP tasks.
4	To highlight the concepts of Language grammar and grammar representation in Computational Linguistics.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To Understand the importance and concepts of Natural Language Processing (NLP)	1	BT Level II Identify, locate
CO2	Applying algorithms available for the processing of linguistic information and computational properties of natural languages.	1,2	BT Level III, IV Apply, evaluate
CO3	Knowledge on various morphological, syntactic, and semantic NLP tasks.	1,2	BT Level II, III Identify, locate and apply
CO4	Introducing various NLP software libraries and data sets publicly available.	1	BT Level II, III Identify, locate and apply
CO5	Designing and developing practical NLP based applications	1,2	BT Level III, IV and VI Apply, evaluate and create

Practical-4A Natural Processing Language		Paper Code: RJSPCSP304A
		Credits: 02
1	Write a program to implement sentence segmentation and word tokenization	
2	Write a program to Implement stemming and lemmatization	
3	Write a program to Implement a tri-gram model	
4	Write a program to Implement PoS tagging using HMM & Neural Model	
5	Write a program to Implement syntactic parsing of a given text	
6	Write a program to Implement dependency parsing of a given text	
7	Write a program to Implement Named Entity Recognition (NER)	
8	Write a program to Implement Text Summarization for the given sample text	
9	Consider a scenario of applying NLP in Customer Service. Design and develop an application that demonstrates NLP operations for working with tasks and data like voice calls, chats, Ticket Data, Email Data. Process the data to understand the voice of the Customer (intent mining, Top words, word cloud, classify topics). Identify issues, replace patterns and gain insight into sales chats.	
10	Consider a scenario of Online Review and demonstrate the concept of sentiment analysis and emotion mining by applying various approaches like lexicon-based approach and rule-based approaches.	
11	Apply NLP in Banking, Financial Services, and Insurance. Design Application to detect frauds and work with SMS data	
12	Demonstrate the use of NLP in designing Virtual Assistants. Apply LSTM, build conversational Bots	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	III ELECTIVE SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Natural Processing Language
COURSE CODE	:	RJSPCSP304A
CREDITS	:	02
DURATION	:	20 HOUR

LEARNING OBJECTIVES	
1	To make the students understand concepts of morphology, syntax, semantics, discourse & pragmatics of natural language
2	Study of spelling correction, parts-of-speech tagging, parsing, and semantic analysis
3	Solving & analysing NLP problem
4	To develop real-life problems

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	The ability to describe the concepts of morphology, syntax, semantics, discourse & pragmatics of natural language	1	BT Level
CO2	Discover various linguistic and statistical features relevant to the basic NLP task, namely, spelling correction, morphological analysis, parts-of-speech tagging, parsing, and semantic analysis	1	BT Level
CO3	Assess and Evaluate NLP based systems	1,2	BT Level
CO4	Ability to choose appropriate solutions for solving typical NLP subproblems (tokenizing, tagging, parsing)	1,2	BT Level
CO5	Analyse NLP problems to decompose them inadequate independent components and develop real-life applications	1,2	BT Level

SEMESTER III (THEORY)		L	Cr
Paper - IV: Data Visualization	Paper Code: RJSPCS304B	20	2
UNIT I		10	
Introduction to Business Intelligence			
Data Visualization and Dashboard Design			
1	Introduction to Business Intelligence: BI concept, BI architecture, BI in today's perspective, BI Process Applications of BI like Financial analysis, statistical analysis, sales analysis CRM, ERP, result pattern, and ranking analysis, Balanced Scorecard		
2	Data Visualization and Dashboard Design: Responsibilities of BI analysts by focusing on creating data visualizations and dashboards. Importance of data visualization, types of basic and composite charts		
UNIT II		10	
Introduction to Power BI, Tableau & Modeling and Analysis			
1	Power BI: Introduction to power BI, natural-language queries, power BI Visualization charts, BI reports and dashboard. Tableau: Uploading excel file, text and different files, Bins, Joining tables and data blending, Report generation, data labels, sorting data and performing aggregation function, data visualization, custom sql, tableau advance reports and calculations, dashboard design dataserver.		
2	Modeling and Analysis: Exploring Excel Modeling capabilities to solve business problems, summarize and present selected data, introduction to business metrics and KPIs, creating cubes using Microsoft Excel		

Suggested References:

1. "Interactive data visualization for the web", Scott Murray, O'Reilly Media, Inc., 2013.
2. "Visualizing Data", Ben Fry, O'Reilly Media, Inc., 2007.

COURSE OUTCOMES (COs) M. Sc. COMPUTER SCIENCE

SEMESTER	:	III ELECTIVE SUBJECT THEORY
TITLE OF THE SUBJECT/COURSE	:	Data Visualization
COURSE CODE	:	RJSPCS304B
CREDITS	:	02
DURATION	:	20 LECTURES

LEARNING OBJECTIVES	
1	To understand how accurately represent voluminous complex data sets in business intelligence analytics.
2	To understand the methodologies used to visualize large data sets.
3	To understand the process involved in business processes and visualization aspects involved in data visualization.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Apply various data visualization concepts to the data sets.	1	BT Level II Identify ,locate
CO2	Design and use various methodologies present in business intelligence	1	BT Level II Identify ,locate
CO3	Design the process involved Power BI and Tableau present.	1,2	BT Level III, IV Apply, evaluate

Practical-4B Data Visualization		Paper Code: RJSPCSP304B Credits:02
1	Basic Data Visualization using Python	
2	Advance Data Visualization using Python	
3	Data Visualization Using Plotly.	
4	Data Visualization using Tableau	
5	Creating Dashboard using Tableau	
6	Creating storytelling using Tableau	
7	Data Visualization using PowerBI	
8	Creating Dashboard using PowerBI	
9	Creating storytelling using POverBI	
10	Data Visualization using Excel	
11	Write a program for a pathfinding robot but in a different image.	
12	Write a program for obstacle resistance using touch sensor	
13	Write a program to create a robot with ultrasonic sensor	
14	Write a program to create a torch-following robot.	
15	Write a program to create a shadow-following robot.	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	I ELECTIVE SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Data Visualization
COURSE CODE	:	RJSPCSP304B
CREDITS	:	02
DURATION	:	20 HOUR

LEARNING OBJECTIVES	
1	To understand how accurately represent voluminous complex data sets in business intelligence analytics.
2	To understand the methodologies used to visualize large data sets.
3	To understand the process involved in business processes and visualization aspects involved in data visualization.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Apply various data visualization concepts to the data sets.	1,2	BT Level II
CO2	Design and use various methodologies present in business intelligence	1,2	BT Level II, III
CO3	Design the process involved Power BI and Tableau present.	1,2	BT Level II, III

SEMESTER IV (THEORY)		L	Cr
Paper-I: Big Data	Paper Code: RJSPCS401	40	4
UNIT I		10	
Big Data and Hadoop			
1	Big Data: Characteristics of Big Data, Big Data importance, and Applications, Big Data Analytics, Typical Analytical Architecture, Requirement for new analytical architecture, Challenges in Big Data Analytics, Need of big data frameworks, Types and Sources of Big Data. Exploring the Use of Big Data in Business Context.		
2	Hadoop Framework: Requirement of Hadoop Framework, Design principle of Hadoop, Hadoop Components, Hadoop Ecosystem, Hadoop 2 architecture, Hadoop YARN Architecture, Advantage of YARN, YARN Command. HDFS: Design of HDFS, Benefits and Challenges, HDFS Commands.		
UNIT II		10	
Map Reduce and HBASE			
1	MapReduce Framework and Basics: Working of Map Reduce, Developing Map Reduce Application, I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining MapReduce jobs. Processing data using Map Reduce.		
2	HBASE: Role of HBase in Big Data Processing, Features of HBase. HBase Architecture, Zookeeper. HBase Commands for creating, listing, and Enabling data tables.		
UNIT III		10	
Spark Framework and Applications			
1	Introduction to Spark: Overview of Spark, Hadoop vs Spark, Cluster Design, Cluster Management, performance, Application Programming Interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations, Saving RDD - Lazy Operation, Spark Jobs.		
2	Writing Spark Application – Compiling and Running the Application. Monitoring and debugging Applications. Spark Programming.		

	UNIT IV	10	
	Tools for Data Analytics		
1	Spark SQL: SQL Context, Importing and Saving data, Data frames, using SQL, GraphX overview, Creating Graph, Graph Algorithms.		
2	Spark Streaming: Overview, Errors and Recovery, Streaming Source, Streaming live data with spark Hive: Hive services, Data Types, and Built-in functions in Hive. Pig: Working with operators in Pig, Working with Functions and Error Handling in Pig Flume and Sqoop: Flume Architecture, Sqoop, Importing Data. Sqoop2 vs Sqoop.		

Suggested References:

1. Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, Raj Kamal, Preeti Saxena, McGraw Hill, 2019
2. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, Dreamtech Press; 1st edition, 2016
3. Big Data Analytics with Spark, A Practitioner's Guide to Using Spark for Large Scale Data Analysis, Apress, 2015
4. Hadoop MapReduce v2 Cookbook - Second Edition, Packt Publishing, 2015
5. Big Data in Practice: How 45 Successful Companies Used Big Data Analytics to Deliver Extraordinary Results, Wiley, 1st edition, 2016
6. Hadoop – TheDefinitive Guide by Tom White, OReilly, 2012
7. Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGrawHill, 2012
8. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Wiley, 2013

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV MAJOR (CORE) SUBJECT THEORY
TITLE OF THE SUBJECT/COURSE	:	BIG DATA
COURSE CODE	:	RJSPCS401
CREDITS	:	04
DURATION	:	40 LECTURES

LEARNING OBJECTIVES	
1	Exposure to the fundamentals of business intelligence and big data analytics.
2	Understand basic concepts in Big Data analytics and parallel data processing.
3	Understand Hadoop Technology and its applications.
4	Exposure to real-life applications and solving them using big data toolkit

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Understands big data and the technologies associated with it.	1	BT Level III, IV Apply draw conclusions
CO2	Identify Big Data and its Business Implications.	1,2	BT level III, IV and V
CO3	List and understand the components of Hadoop and the Hadoop Ecosystem.	1,2	BT Level III, IV Apply draw conclusions
CO4	Describe graphs and streaming data in Spark.	1,2	BT level III, IV and V
CO5	Understands the Hive, Sqoop, and Pig Technology.	1,2	BT Level III, IV Apply draw conclusions
CO6	Understands Map-Reduce Technology and its applications.	1,2	BT level III, IV and V

Practical-I: Big Data		Paper Code: RJSPCSP401 Credits:02
1	Installing and setting environment variables for Working with Apache Hadoop.	
2	Implementing Map-Reduce Program for Word Count problem.	
3	Download and install Spark. Create Graphical data and access the graphical data using Spark.	
4	Write a Spark code for the given application and handle error and recovery of data.	
5	Write a Spark code to Handle the Streaming of data.	
6	Install Hive and use Hive Create and store structured databases.	
7	Install HBase and use the HBase Data model Store and retrieve data.	
8	Perform importing and exporting of data between SQL and Hadoop using Sqoop.	
9	Write a Pig Script for solving counting problems.	
10	Use Flume and transport the data from the various sources to a centralized data store.	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV MAJOR (CORE) SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Big Data
COURSE CODE	:	RJSPCSP401
CREDITS	:	02
DURATION	:	20 HOUR

LEARNING OBJECTIVES	
1	Understand Big Data and its analytics in the real world.
2	Explain and Analyze the Big Data using Map-reduce programming.
3	Demonstrate the graph algorithms and live streaming data in Spark

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Analyze the Big Data framework like Hadoop and NOSQL to efficiently store and process Big Data to generate analytics.	1	BT Level III, IV Apply draw conclusions
CO2	Design of Algorithms to solve Data Intensive Problems using Map Reduce Paradigm.	1,2	BT level III, IV and V Apply, analyze, and evaluate
CO3	Design and Implementation of Big Data Analytics using pig and spark to solve data intensive problems and to generate analytics.	1,2	BT level III, IV and V Apply, analyze and evaluate
CO4	Implement Big Data Activities using Hive, Hbase, Sqoop-flume,pig etc.	1,2	BT level III, IV and V Apply, analyze and evaluate

SEMESTER IV (THEORY)		L	Cr
Paper-II: Operation Research	Paper Code: RJSPCS402	20	2
UNIT I		10	
Linear Programming, Graphical Method, Simplex Method			
1	1. Linear Programming Formulating the problem, Constructing a mathematical model, 2. Graphical Method Graphical solution, 3. Simplex Method The standard form of linear programming problems, Basic feasible solutions, Simplex algorithm, Artificial variables, Big M and two phase method, Solution to Problems based on Degeneracy, Alternative optima, Unbounded solution, Infeasible solutions.		
UNIT II		10	
Transportation Problem, Assignment Problem, Sequence Problem			
1	1. Transportation Problem Starting solutions. North-west corner Rule –least cost methods – Vogel's approximation method, MODI Method 2. Assignment Problem Assignment Problem, Hungarian method. 3. Sequence Problem Two machines n jobs , three machines n jobs, n machines m jobs		

Suggested References:

1. Operation Research, R D Sharma

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV MAJOR (CORE) SUBJECT THEORY
TITLE OF THE SUBJECT/COURSE	:	Operation Research
COURSE CODE	:	RJSPCS402
CREDITS	:	02
DURATION	:	20 LECTURES

LEARNING OBJECTIVES	
1	Study formulation, analysis and solving science, engineering and business problems.
2	Study mathematics and mathematical modelling using computers to forecast the implications of various choices.
3	Study the selection of the best alternatives from the available choices.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Apply Operations research methodology to a broad range of problems in business and industry	1,2	BT Level II, III
CO2	Use mathematics and mathematical modelling using computers to forecast the implications of various choices.	1,2	BT Level III, IV
CO3	Solve optimization problems. Think of new methods for solving optimization problems.	1,2	BBT Level III, IV, V

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER IV (THEORY)		L	Cr
Paper-III: NO SQL	Paper Code: RJSPCS403A	20	2
UNIT I		10	
Introduction to NoSQL and Interfacing with NoSQL Data Stores			
1	Basics Introduction to NoSQL: Characteristics of NoSQL, NoSQL Storage types, Advantages and Drawbacks, NoSQL Products Interfacing and interacting with NoSQL: Storing Data in and Accessing Data from MongoDB, Redis, HBase and Apache Cassandra, Language Bindings for NoSQL Data Stores		
2	Understanding the storage architecture: Working with Column Oriented Databases, HBase Distributed Storage Architecture, Document Store Internals, Understanding Key/Value Stores in Memcached and Redis, Eventually Consistent Non-relational.		
3	Databases Performing CRUD operations: Creating Records, Accessing Data, Updating and Deleting Data.		
UNIT II		10	
Querying, Indexing, and Data Management in NoSQL Databases			
1	Querying NoSQL Stores: Similarities Between SQL and MongoDB Query Features, Accessing Data from Column-Oriented Databases Like HBase, Querying		
2	Redis Data Stores Indexing and Ordering Data Sets: Essential Concepts Behind a Database Index, Indexing and Ordering in MongoDB, ouchDB and Apache Cassandra		
3	Managing Transactions and Data Integrity: RDBMS and ACID, Distributed ACID Systems, Upholding CAP, Consistency Implementations Using NoSQL in The Cloud: Google App Engine Data Store, Amazon SimpleDB		

Suggested References:

1. SQL & NoSQL Databases, Andreas Meier · Michael Kaufmann, Springer Vieweg, 2019
2. Professional NoSQL by Shashank Tiwari, Wrox-John Wiley & Sons, Inc, 2011
3. SQL & NoSQL Databases, Andreas Meier · Michael Kaufmann, Springer Vieweg, 2019
4. NoSQL: Database for Storage and Retrieval of Data in Cloud, Ganesh Chandra Deka, CRC Press, 2017
5. Demystifying NoSQL by Seema Acharya, Wiley, 2020

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV ELECTIVE SUBJECT THEORY
TITLE OF THE SUBJECT/COURSE	:	NO SQL
COURSE CODE	:	RJSPCS403A
CREDITS	:	02
DURATION	:	20 LECTURES

LEARNING OBJECTIVES	
1	Basic understanding of databases, SQL concepts, and familiarity with programming languages like Java or Python.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Understand NoSQL characteristics, storage types, and advantages/drawbacks.	1,2	BT Level II,V
CO2	Interface and interact with MongoDB, Redis, HBase, and Apache Cassandra effectively.	1,2	BT Level I, III, IV
CO3	Perform CRUD operations proficiently, including data creation, access, update, and deletion.	1,2	BT Level I, III, IV
CO4	Apply indexing and ordering concepts in NoSQL databases like MongoDB, CouchDB, and Cassandra.	1,2	BT Level IV, V, VI
CO5	Manage transactions and ensure data integrity in NoSQL, including distributed ACID systems	1,2	BT Level I, II, V

Practical 3A: NO SQL		Paper Code: RJSPCSP403A Credits: 02
1	Setting up and Exploring MongoDB a) Install MongoDB on your local machine or lab server. b) Create a new MongoDB database and collection. c) Insert sample data into the collection. d) Retrieve and display data from the collection using MongoDB queries.	
2	Interacting with Redis a) Install Redis on your lab server or local machine. b) Store and retrieve data in Redis using various data structures like strings, lists, and sets. c) Implement basic Redis commands for data manipulation and retrieval	
3	Working with HBase a) Set up an HBase cluster in a lab environment. b) Create an HBase table and define column families. c) Insert sample data into the table. d) Perform CRUD operations and retrieval of data in HBase.	
4	Apache Cassandra Operations a) Install and configure Apache Cassandra in a lab environment. b) Create a key space and define a table schema. c) Insert data into the table. d) Perform CRUD operations and query data from Apache Cassandra	
5	Querying MongoDB and HBase a) Write and execute MongoDB queries to retrieve specific data from a collection. b) Perform queries on HBase tables using HBase shell commands.	
6	Redis Data Manipulation a) Use Redis commands to manipulate and modify data stored in different data structures. b) Retrieve specific data using Redis query operations	
7	Implementing Indexing in MongoDB a) Create an index on a specific field in a MongoDB collection. b) Measure the impact of indexing on query performance.	

8	Data Storage in Redis a) Implement caching functionality using Redis as a cache store. b) Store and retrieve data from Redis cache using appropriate commands.
9	Using Google App Engine Data Store a) Create a project in Google App Engine and set up the Data Store. b) Store and retrieve data from the Data Store using the provided API
10	Amazon SimpleDB Data Management Task 1: Set up an Amazon SimpleDB domain for data storage. Task 2: Store and retrieve data from the SimpleDB domain using appropriate commands or APIs

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV ELECTIVE SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	NO SQL
COURSE CODE	:	RJSPCSP403A
CREDITS	:	02
DURATION	:	20 HOUR

LEARNING OBJECTIVES	
1	Setting, Exploring & interacting with Redi
2	Performing operations & querying DB, Data manipulation
3	Indexing, Using GoogleApp Engine & Amazon SimpleDB

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Setting up and Exploring MongoDB, Interacting with Redis & working with HBase	1,2	BT Level II, V
CO2	Apache Cassandra Operations, Querying MongoDB and HBase, Redis Data Manipulation	1,2	BT Level I, III, IV
CO3	Implementing Indexing in MongoDB, Data Storage in Redis	1,2	BT Level I, III, IV
CO4	Using Google App Engine Data Store Amazon SimpleDB Data Management	1,2	BT Level IV, V, VI

SEMESTER IV (THEORY)		L	Cr
Paper-IV: Robotics		20	2
Paper Code: RJSPCS403B			
UNIT I		10	
INTRODUCTION TO ROBOTICS & CONTROL TECHNIQUES AND IMPLEMENTATION IN ROBOTICS			
1	Introduction to Robotics: What is a Robot? Definition, History of Robots: Control Theory, Cybernetics, Grey Walter Tortoise, Analog Electronic Circuit, Reactive Theory, Braitenberg Vehicle, Artificial Intelligence, Vision Based Navigation, Types of Robot Control. Robot Components: Embodiment, Sensors, States, Action, Brains and Brawn, Autonomy, Arms, Legs, Wheels, Tracks, and What really drives them effectors and actuators: Effector, Actuator, Passive and Active Actuation, Types of Actuators, Motors, Degree of freedom Locomotion: Stability, Moving and Gaits, Wheels and Steering, Staying on the path. Manipulators: End effectors, Teleoperation, why is manipulation hard?		
2	Sensors: Types of Sensors, Levels of Processing, Passive and Active sensors, Switches, Light sensors, Resistive position sensor. Ultrasonic and Sonar sensing, Specular Reflection, Laser Sensing, Visual Sensing, Cameras, Edge Detection, Motion Vision, Stereo Vision, Biological Vision, Vision for Robots. Feedback or Closed Loop Control: Example of Feedback Control Robot, Types of feedback control, Feed forward or Open loop control.		
UNIT II		10	
CONTROL ARCHITECTURES IN ROBOTICS, ARTIFICIAL INTELLIGENCE AND IT'S USAGE IN ROBOTICS			
1	Algorithms, Architecture, The many ways to make a map, What is planning, Cost of planning, Reactive systems, Action selection, Subsumption architecture, How to sequence behavior through the world. Hybrid control, Behavior based control and Behavior Coordination, Behavior Arbitration.		
2	Artificial Intelligence and it's usage in Robotics When the Unexpected Happens: An Example: Emergent Wall-Following Components of Emergence, Expect the Unexpected, Predictability of Surprise, Good vs. Bad Emergent Behavior, Architectures and Emergence. Navigation. Reinforcement Learning, Supervised Learning, Learning by Imitation/From Demonstration, Learning and Forgetting. The Future of Robotics.		

Suggested References:

1. The Robotics Primer by Maja J Mataric, MIT press Cambridge, Massachusetts, London, England (2007).
2. A First course in Artificial Intelligence, Deepak Khemani, Tata McGraw Hill Education (India) private limited (2013).
3. Artificial Intelligence: A Modern Approach, 3e, Stuart Jonathan Russell, Peter Norvig, Prentice Hall Publications (2010).
4. Artificial Intelligence Illuminated, Ben Coppin, Jones and Bartlett Publishers Inc (2004)
5. Artificial Intelligence A Systems Approach, M Tim Jones, Firewall media, New Delhi (2008)
6. Artificial Intelligence -Structures and Strategies for Complex Problem Solving., 4/e, George Luger, Pearson Education (2002).

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV ELECTIVE SUBJECT THEORY
TITLE OF THE SUBJECT/COURSE	:	Robotics
COURSE CODE	:	RJSPCS403B
CREDITS	:	02
DURATION	:	20 LECTURES

LEARNING OBJECTIVES	
1	This course introduces fundamental concepts in robotics.
2	The objective of the course is to provide an introductory understanding of robotics.
3	Students will be exposed to a broad range of topics in robotics with emphasis on basics of manipulators, coordinate transformation and kinematics, trajectory planning, control techniques, sensors and devices, and robot applications.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Undertake kinematics analysis of robot manipulators.	1	BT Level II Identify, locate
CO2	Understand the importance of robot dynamics.	1	BT Level II Identify, locate
CO3	Have an understanding of the functionality and limitations of robot actuators and sensors.	1, 2	BT Level III, IV Apply, evaluate
CO4	Understand and be able to apply a variety of techniques to solve problems in areas such as robot control and navigation.	2	BT Level II, III Identify, locate and apply
CO5	Describe different mechanical configurations of robot manipulators.	1, 2	BT Level II, III Identify, locate and apply

Practical 3B: Robotics		Paper Code: RJSPCSP403B Credits: 02
1	Write a program to move the robot left, right & forward using gears.	
2	Write a program to make a robot move in a square pattern.	
3	Write a program to show the circular motion of robot using gears	
4	Write a program to make a robot move in a square pattern.	
5	Write a program to perform the circular motion of a robot using an arch function with gears.	
6	Write a program to perform the circular motion of a robot using an arch function without using gears.	
7	Write a program for line following the robot.	
8	Write a program for line follower robots with different images.	
9	Write a program for line follower robot (White Black)	
10	Write a program for a path finding robot.	
11	Write a program for a pathfinding robot but in a different image.	
12	Write a program for obstacle resistance using touch sensor	
13	Write a program to create a robot with ultrasonic sensor	
14	Write a program to create a torch-following robot.	
15	Write a program to create a shadow-following robot.	

COURSE OUTCOMES (COs) M.Sc. COMPUTER SCIENCE

SEMESTER	:	IV ELECTIVE SUBJECT PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	Robotics
COURSE CODE	:	RJSPCSP403B
CREDITS	:	02
DURATION	:	20 HOUR

LEARNING OBJECTIVES	
1	To develop the student's knowledge in various robot structures and their workspace.
2	To make the students understand various robot motions.
3	To make the students understand configuring sensors with robot

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Understand design, construction, operation, and use of robots.	1,2	BT Level II
CO2	Understand different motions of robot	1,2	BT Level II, III
CO3	Understand working of robot with sensor	1	BT Level II, III

SEMESTER IV		L	Cr
Paper - V: Research Project	Paper Code: RJSPCS505	2	10

Scheme of Examinations

1. Two Internals of 20 marks each. Duration 30 min for each for 4 credit courses where as one internal of 20 marks (30 Min).
 - CIA 1: 20 Marks Duration 30 Min
 - CIA 2: 20 Marks Duration 30 Min
2. One External (Semester End Examination) –
 - 60 marks. Duration: 2.5 Hours (For 4 credit courses)
 - 30 marks. Duration: 1 Hour 15 Min (For 2 credit courses)
3. One Practical at the end of Semester each of 50 marks.
4. Minimum marks for passing Semester End Theory and Practical Exam are 40 %.
5. Students must appear for at least one of the two Internal Tests to be eligible for the Semester End Examination.
6. For any KT examinations, there shall be ODD-ODD/EVEN-EVEN pattern followed.
7. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of MSc Computer-Science or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of M.Sc. Computer- Science as per the minimum requirements.
8. In case of loss of journal, a candidate must produce a certificate from the Head of the department /Institute that the practical's for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.
9. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation of Practical's 50 marks (RJSPCSP301, RJSPCSP302, RJSPCSP303, RJSPCSP304A, RJSPCSP304B, RJSPCSP401, RJSPCSP403A, RJSPCSP403B)

Course Semester End Examination in Semester III and IV

Courses With 4 Credits

(RJSPCS301, RJSPCS302, RJSPCS303, RJSPCS401)

Question	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSIS	TOTAL MARKS-Per unit
Unit 1	07	02	03	12
Unit 2	07	02	03	12
Unit 3	07	02	03	12
Unit 4	07	02	03	12
Short notes from topics covering all the units	07	02	03	12
-TOTAL-Per objective	35	10	15	60
% WEIGHTAGE	58	17	25	100%

Courses With 2 Credits

(RJSPCSP304A, RJSPCSP304B, RJSPCSP402, RJSPCSP403A, RJSPCSP03B)

Question	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSIS	TOTAL MARKS-Per unit
Unit 1	06	02	02	10
Unit 2	06	02	02	10
Short notes from topics covering all the units	06	02	02	10
-TOTAL-Per objective	18	06	06	30
% WEIGHTAGE	60	20	20	100%

Continuous Evaluation of components which require adequate duration for completion of the task, observation and interpretation: 25%

Course end Practical Evaluation of skills of students in terms of skill, analysis, interpretation and conclusion.

Research Project Evaluation Scheme

Course Code	Unit	Topic Headings	Credits	L/Week
RJSPCS403B	Paper Title: Research Project		10	1

Project and submission of Dissertation wherever mentioned

Dept of _____ Course Code _____ Date _____

UID No _____ Roll No _____ Marks _____ / 250

Name of the Student: _____

Assessment Grid: Place one tick in each appropriate row. Overall marks should reflect the positions of ticks in the individual rows. In boxes that have more than one set of marks, cancel out the marks that are not applicable and circle the correct marks.

Project Work & Report (Parameters)	Marks	80 - 100% Excellent	60 – 80% Good	40 – 60% Satisfactory	20 – 40% Average
Project Work Done Laboratory Skills Required	50				
Complication of Project Work Done as Suggested 1. Survey of Literature 2. Objectives Proposed 3. Materials & Methods 4. Results & Discussions 5. General Conclusions	100				
Preparation Of Manuscripts	50				
Presentation & Viva	50	8 – 10 / 10	6 – 8 / 10	4 – 6 / 10	2 – 4 / 10

COMPUTER SCIENCE

Mapping of the courses to employability / entrepreneurship / skill development

Class	Course Name	Course Code	Unit No. And topics focusing on Employability / Entrepreneurship / Skill development	Employability / Entrepreneurship / Skill development
MSC SEM III				
MSC	Compiler	RJSPCS301	Employability Unit 1: 1. Structure of a compiler 2. Lexical Analysis Phase 3. Grammars Unit 2: 1. Parsers 2. Construction of parser Unit 3: 1. Syntax directed Translation 2. Intermediate code and its type Unit 4: 1. Loop Optimization 2. Some more Optimization Techniques	Employability in the field of ML & researching
MSC	Cyber Forensics and Laws	RJSP CS302	Employability Unit1: Computer Forensic Fundamental Unit2: Data backup and Recovery and Network forensics Unit 3: Cyber Laws Unit 4: Information Technology Act 2000	Employability in the field of Security, Cyber forensic
MSC	ARVR	RJSPCS303	Skill Enhancement Unit1: Introduction & Graphics ForVR Unit2: VR Geometrical Concepts, Virtualization & Transformation Unit 3: Introduction to AR & AR Hardware Unit 4: AR Software's & Techniques	Employability in the field of Augmented & Virtual Reality , Gaming, Simulations

MSC	Natural Processing Language	RJSPCS304A	Employability Unit 1: 1. Introduction to Natural Language Processing (NLP) and Language Modelling 2. Morphology & Parsing in NLP Unit 2: 1. Semantic and Word Embedding Semantics 2. NLP Applications and Case Studies	Employability in the field of NLP analyst, sentiment analyst, speech recognition
MSC	Data Visualization	RJSPCS304B	Skill Enhancement Unit 1: Data Visualization using Python Data Visualization using Plotly Unit 2: Data Visualization using PowerBI Data Visualization using Tableau	Employability in the Data Science, Graphic Design, Data Visualization Developer
MSC SEM IV				
MSC	Big Data	RJSPCS401	Employability Unit 1: Big Data and Hadoop Unit 2: Map Reduce and HBASE Unit 3: Spark Framework and Applications Unit 4: Tools for Data Analytics	Employability in the Machine Learning Engineer, Business Intelligence
MSC	Operation Research	RJSPCS402	Employability Unit 1: 1. Linear Programming 2. Graphical Method 3. Simplex Method Unit 2: 1. Transportation Problem 2. Assignment Problem 3. Sequence Problem	Employability in the field of Business, Finance, Industrial Engineering

MSC	NO SQL	RJSPCS403A	Entrepreneurship Unit1: Introduction to NoSQL and Interfacing with NoSQL Data Stores Unit 2: Querying, Indexing, and Data Management in NoSQL Databases	Employability in the field of Data Engineer, Data Scientist,
MSC	Robotics	RJSPCS403B	Entrepreneurship Unit1: Introduction To Robotics & Control Techniques And Implementation In Robotics Unit 2: Control Architectures In Robotics, Artificial Intelligence And It's Usage In Robotics	Employability in the field of Robotics Engineering, Robotics Technician, Automation,
