II विद्या विनयेन शोभते II

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: Masters in Science (M. Sc.)

SYLLABUS

(Approved in the Academic council meeting held on--------)

M.Sc.-I Computer Science

Revised as per
Choice Based Credit & Grading System (60:40)
w. e. f. Academic Year 2022-23

MASTERS IN SCIENCE (M. Sc.)

Programme Outcomes

After completion of M.Sc. programme students will acquire

Sr. No.	After completion of M.Sc. program students will acquire	Graduate Attribute
PO1	An ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge
PO2	An ability to demonstrate proficiency in various instrumentation, modern tools, advanced techniques and ICT to meet industrial expectations and research outputs.	Disciplinary knowledge/Digital literacy
PO3	An ability to identify problems, formulates, and proves hypotheses by applying theoretical knowledge and skills relevant to the discipline.	Problem-solving
PO4	An ability to articulate thoughts, research ideas, information, scientific outcomes in oral and in written presentation to a range of audience.	Communication skills
PO5	A capacity for independent, conceptual and creative thinking, analysis and problem solving through the existing methods of enquiry.	Problem solving
PO6	Skills required for cutting edge research, investigations, field study, documentation, networking, and ability to build logical arguments using scholarly evidence.	Research skills
PO7	An ability to portray good interpersonal skills with ability to work collaboratively as part of a team undertaking a range of different team roles	Teamwork
PO8	The ability to understand ethical responsibilities and impact of scientific solutions in global, societal and environmental context and contribute to the sustainable development	Moral and ethical awareness/ multicultural competence
PO9	An ability to demonstrate leadership, to take action and to get others involved.	Leadership
PO10	An openness to and interest in, life-long learning through directed and self-directed study	Self-directed learning
PO11	An ability to translate the knowledge and demonstrate the skills required to be employed and successful professional development.	Life-long learning

Masters in Science (Computer)
Syllabus for Semester I and II

Preamble:

M.Sc. in Computer Science is a two-year post-graduate programme with the objective to develop human resources with core competence in various thrust areas of Computer Science. It will provide students with opportunities to develop and hone core competency in the field of computer science and encourage them to make a mark in the much sought-after IT industry.

The Syllabus of this Course creates a unique identity for M.Sc. in Comp Science distinct from similar degrees in other related subjects, focuses on core Computer Science subjects, incorporate advanced and most recent trends, Identify and nurture research temper among students, Offer provision for internship with industry and Focus, as far as possible, only on open-source software

The syllabus for the semester I and semester II has tried to initiate steps to meet these goals. By extending the syllabus to semester III and semester IV, it is assumed that these goals will be met to a larger extent. The syllabus proposes to have four core compulsory courses in Semester I and Semester II. UNIT -1 of Paper I of Semester - I and Semester - II are ABILITY ENHANCEMENT UNITS and UNIT- 4 of all papers of Semester - I and Semester - II is SKILL ENHANCEMENT UNIT. Semester III and Semester IV proposes electives courses based on a recent and emerging area. Inclusion of Project as part of the internal assessment is an attempt to translate theory into practice. It is assumed that, with this back ground, a student can take up challenging research project in the semester III and semester IV and will be better fit for industry as he or she will have strong foundation on fundamentals and exposure to advanced and emerging trends.

We thank all the members of BOS in Computer Science; who have given their valuable comments and suggestions, which we tried to incorporate. Thank you to all stakeholders who provided feedback and suggested changes as well as University of Mumbai. Thanks to one and all who have directly or indirectly helped in this venture.

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO	Description After completing Master's Degree in Computer Science learners will be able to:
PSO 1	Understand the core and advanced subjects of Computer Science and its logical application to solve real-life case studies using Emerging technologies
PSO 2	Identify, analyze, and solve research based interdisciplinary computational problems
PSO 3	Get exposure to modern software tools and lifelong learning for professional development

Semester – I

[Under CBCS Scheme]

Course	Course Type	Course code	Hrs/ week	Internal assessment	Semester-end examination	Total	Credits
Analysis of algorithm and Research Computing	Core	PCS1ARC	4	40	60	100	4
Design and Implementation of Modern Compilers	Core	PCS1DMC	4	40	60	100	4
Advanced Database Management System	Core	PCS1ADS	4	40	60	100	4
Robotics	Core	PCS1ROB	4	40	60	100	4
Practical of PCS1ARC+ PCS1DMC	Core	PCS1PPR1	4	--	100	100	4
Practical of PCS1ADS+ PCS1ROB	Core	PCS1PPR2	4	--	100	100	4

Semester – II

[Under CBCS Scheme]

Course	Course Type	Course code	Hrs/ week	Internal assessment	Semester-end examination	Total	Credits
Cloud Computing-I	Core	PCS2CL1	4	40	60	100	4
Natural Language Processing	Core	PCS2NLP	4	40	60	100	4
Business Intelligence and Big Data Analytics – I (Business Intelligence)	Core	PCS+2BI1	4	40	60	100	4
Machine Intelligence(Fundamentals of Machine Intelligence)	Core	PCS2MIN	4	40	60	100	4
Practical of PCS2CL1+ PCS2NLP	Core	PCS2PPR1	4	--	100	100	4
Practical of PCS2BI1+ PCS2MIN	Core	PCS2PPR2	4	--	100	100	4

Examination Scheme

I. Continuous Internal Examination: 40 Marks

Marks	**Group Project*/ Individual Project**	**Presentation and write-up**	**Practical Skills**	**Open book test**	**Quiz**
5	Hypothesis/Topic of the project	Presentation skill	Demonstration of skill	**High order thinking questions (HOTS)**	**Quiz on application of subject in real life**
5	Actual laboratory work/Field work	Knowledge	Viva		
5	Result/output	Quality of ppt	Report		
5	Dissertation/Report	Writing skill	Problem solving ability		

II. External Examination: 60 Marks

- There shall be five questions each of 12 marks.
- All questions shall be compulsory with internal options.
- Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Question	Based on	Marks
Q.1	Unit I	12
Q.2	Unit II	12
Q.3	Unit III	12
Q.4	Unit IV	12
Q.5	Unit I,II,III,IV	12

III. Practical Examination: 50 Marks

Sr. No.	Particulars of External	Marks
1	Laboratory Work	40
2	Journal	05
3	Viva	05
	TOTAL	50

Course Description	
Semester	**I**
Course Name	**Analysis of Algorithm and Research Computing**
Course Code	**PCS1ARC**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives

1. Understand designing and backtracking techniques of an algorithm.
2. Understand analysis techniques, number theoretic and Np completeness aspects of an algorithm.
3. Analyze various research problems and ways to solve specific problems.
4. Develop an approach towards research and implementation in the form of a research paper.

Course Outcomes

1. Describe designing and advanced strategies of an algorithm.
2. Discuss the analysis techniques, number theoretic and NP completeness perspectives of an algorithm.
3. Discover a research problem and find a way to solve a specific research problem.
4. Create a research paper with professional skills.

Course Code: PCS1ARC	**Course Title** **Analysis of Algorithm and Research Computing**	**Credits 04**
Unit I	**Design and Advanced design strategies** The Role of Algorithms in Computing: Algorithms as a technology. Analyzing algorithms, Designing algorithms. Growth of Functions: Standard notations and common functions. Divide-and-Conquer: The maximum-subarray problem, Probabilistic Analysis and Randomized Algorithms: The hiring problem, Indicator random variables, Randomized algorithms. Dynamic Programming: Rod cutting, Elements of dynamic programming Greedy Algorithms: An activity-selection problem,	**15L**

	Elements of the greedy strategy. Backtracking algorithm: 8 queen problem.	
Unit II	**Analysis Techniques , Number-Theoretic Algorithms and NP – Completeness** Elementary Graph Algorithms: Representations of graphs, Minimum Spanning Trees: Growing a minimum spanning tree, Algorithms of Kruskal. Single-Source Shortest Paths: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Dijkstra‘s algorithm. Elementary number-theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, NP-Completeness: Polynomial time, Polynomial-time verification, NP-completeness and reducibility, NP-complete problems.	**15L**
Unit III	**Introduction of Research** Meaning of research, objectives of research, types of research, research approaches, significance of research, research methods versus methodology, research methods vs methodology, research and scientific method, research process, Criteria of good research, Problems encountered by researchers in India. What is research Problem? Selecting the problem, techniques involved in defining a problem, Different research designs: Exploratory research studies, Descriptive and Diagnostic Research Studies, Hypothesis testing research studies. Sample design, quantitative and qualitative data, experiments and surveys, data preparation, Degree of freedom, standard error.	**15L**

Unit IV	**Research Computing** Interpretation and report: Techniques of Interpretation, Precautions of interpretation, Significance of report writing, Different steps in writing report, Layout of research report, types of reports, oral presentation, Mechanics of research writing, Precautions for writing research report and conclusion, accuracy, confusion matrix, sensitivity and specificity, ROC curve, t-test. Research paper: What is research paper, Understand assignment, Choose a research paper topic, conduct preliminary research, Develop a thesis statement, create research paper outline, draft of research paper: introduction, a compelling body, the conclusion, the second draft, revision process, research paper checklist.	**15L**
	Text book: • Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, PHI Learning Pvt. Ltd-New Delhi (2009) • Researching Information Systems and Computing, Brinoy J Oates, Sage Publications India Pvt Ltd (2006)	
	References: • Algorithms, Sanjoy Dasgupta, Christos H. Papadimitriou, Umesh Vazirani, McGraw-Hill Higher Education (2006). • Grokking Algorithms: An illustrated guide for programmers and other curious people, MEAP, Aditya Bhargava, http://www.manning.com/bhargava • Research Methodology, Methods and Techniques, Kothari, C.R.,1985, third edition, New Age International (2014) • Basic of Qualitative Research (3rd Edition), Juliet Corbin & Anselm Strauss, Sage Publications (2008). • Research Methodology, third edition by C. R. Kothari, Gaurav Garg	

Practical Course on Analysis of Algorithm & Research Computing	
Sr. No	**List of Practical Experiments on Analysis of Algorithm and Research Computing**
1	Write a program to implement the Rod Cutting problem.
2	Write a program to implement a merge sort algorithm. Compare the time and memory complexity.
3	Given an array of numbers of length l. Write a program to generate a random permutation of the array using (i) permute-by-sorting () and (ii) permute-by-cyclic ().
4	Write a program to implement Longest Common Subsequence (LCS) algorithm.
5	Write a program to implement Kruskal's algorithm.
6	Write a program to implement Dijkstrass's algorithm.
7	Write a program to implement Euclid's algorithm to implement gcd of two non-negative integers a and b. Extend the algorithm to find x and y such that gcd(a,b) = ax+by. Compare the running time and recursive calls made in each case.
8	Write a program to verify (i) Euclid's theorem (ii) Fermat's theorem.
9	Write a program to implement greedy set cover algorithm to solve set covering problem.
10	Write a research paper.

Module/ Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	Designing strategies of an algorithm	15h	1	1	2
2	Analysis techniques of an algorithm	15h	2	1	2
3	Discover a research problem	15h	3	2	3
4	Create a research paper	15h	4	3	4

Course Description	
Semester	**I**
Course Name	**Design and Implementation of Modern Compiler**
Course Code	**PCS2DMC**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives

1. Apply the basic concepts and methods of Compiler Design.
2. Understand the Structure of Compilers.
3. Improving designing and optimization of source programs.
4. Explore concepts of converting source program to target program.

Course Outcomes

1. Describe the Phases of Compiler.
2. Explain step by step transformation of source code to target code.
3. Explain Methods for Code Optimization.
4. Evaluate data flow, logic flow, liveness of variables through the program.

Course Code PCS2BI1	**Course Title** **Design and Implementation of Modern Compiler**	**Credits 04**
Unit I	**Introduction to Compilers** 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, Context-free grammars, Derivations and Parse trees, Parsers, Shift-reduce parsing, Operator-precedence parsing, Top- down parsing, Predictive parsers.	**15 L**
Unit II	**Automatic Construction of Efficient Parsers** LR parsers, The canonical collection of LR(0) items, Constructing SLR parsing tables, Constructing canonical LR parsing tables,	**15 L**

	Constructing LALR parsing tables, Using ambiguous grammars, An automatic parser generator, Implementation of LR parsing tables, Constructing LALR sets of items.	
Unit III	**Advanced syntax analysis and basic semantic analysis** Syntax-directed translation schemes, Implementation of syntax-directed translators, Initial introduction to the ongoing Tiger compiler, bindings for the Tiger compiler, type- checking expressions, type-checking declarations, activation records, stack frames, frames in the Tiger compiler, translation to intermediate code, intermediate representation trees, translation into trees, declarations, basic blocks and traces, taming conditional branches, liveness analysis, solution of dataflow equations, liveness in the Tiger compiler, interference graph construction	**15 L**
Unit-IV	**Dataflow analysis and loop optimization** The principle sources of optimization, Loop optimization: The DAG representation of basic blocks, Dominators, Reducible flow graphs, Depth-first search, Loop-invariant computations, Induction variable elimination, Some other loop optimizations. Dataflow Analysis: intermediate representation for flow analysis, various dataflow analyses, transformations using dataflow analysis, speeding up dataflow analysis, alias analysis.	**15 L**

Text book:

- Compilers: Principles, Techniques and Tools 2nd edition, Alfred V. Aho , Monica
- S. Lam , Ravi Sethi , Jeffrey D. Ullman , Pearson (2011)
- Modern Compiler Implementation in Java, Second Edition, Andrew Appel and Jens Palsberg, Cambridge University Press (2004).

Reference:

- Principles of Compiler Design, Alfred Aho and Jeffrey D. Ullman, Addison Wesley (1997).
- Compiler design in C, Allen Holub, Prentice Hall (1990)

Sr. No.	List of Practical Experiments on Design and Implementation of Modern Compiler
1	Write a program to convert the given NDFA to DFA.
2	Write a program to convert the given Right Linear Grammar to Left Linear Grammar form.
3	Write a program to illustrate the generation on SPM for the input grammar.
4	Write a program to illustrate the generation on OPM for the input operator grammar
5	Implement a simple program analyzer and interpreter for the straight-line programming language
6	Add semantic actions to your parser to produce abstract syntax for the MiniJava language together with a PrettyPrintVisitor
7	Design a set of visitors, which translate a MiniJava program into intermediate representation trees
8	Implement the translation to Assem instructions for your favorite instruction set (let μ stand for Sparc, Mips, Alpha, Pentium, etc.) using maximal munch.
9	Write a code to generate the DAG for the input arithmetic expression.
10	Write a program to demonstrate loop unrolling and loop splitting for the given code sequence containing loop.

Module/ Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	**Introduction to Compilers**	**15h**	**1**	**1**	**2**
2	**Automatic Construction of Efficient Parsers**	**15h**	**2**	**2**	**3**
3	**Advanced syntax analysis and basic semantic analysis**	**15h**	**3**	**2**	**5**
4	**Dataflow analysis and loop optimization**	**15h**	**4**	**3**	**5**

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Course Description	
Semester	**I**
Course Name	**Advanced Database Systems**
Course Code	**PCS1ADS**
Eligibility for the Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives

This course will help the students to acquire the theoretical foundation of Database Management Systems. It includes concepts relating to various advanced database models, and concepts like database mining and warehousing. This course also describes in major details about the advanced concepts of relation database management systems. The course also provides sample database management system architecture. Thus, this is an advanced course, which will further develop the knowledge and skill acquired by the students at the basic level.

Course Outcomes

After completing the course, Student will be able to

1. Describe the concept of distributed database systems.
2. Analyze database management in a centralized and distributed environment.
3. Illustrate data modeling and database development processes for object-oriented, Temporal, and Spatial databases.
4. Explain the use of deductive, active, and multimedia databases.

Course Code : PCS1ADS	Course Title Advanced Database Systems	Credits 04
Unit I	**Distributed Database Concepts** Definition of Distributed databases and Distributed Database Management System (DDBMS), Distributed transparent system. DDBMS Architecture: DBMS standardization, Global, Local, External, and Internal Schemas, Architectural models for DDBMS. Distributed database design: Design problem of distributed systems, Design, strategies (top-down, bottom-up), Fragmentation, Allocation and replication of fragments. Query Processing Overview, Query Optimization.	**15L**
Unit II	**Transaction Processing in Distributed databases and Parallel databases:** Transaction Management: Definition and examples, formalization of a transaction, ACID properties, classification of transaction. Concurrency Control: definition, execution schedules, examples, locking based algorithms, timestamp ordering algorithms, deadlock management. DBMS reliability: Definitions and Basic Concepts, Local Recovery Management, In-place update, out-of-place update, Distributed Reliability Protocols, Two phase commit protocol, Three phases commit protocol. Parallel Database System: Definition of Parallel Database Systems. Parallel query evaluation: Speed up and scale up, Query Parallelism: I/O Parallelism (Data Partitioning) Intra-query Parallelism, Inter –Query Parallelism, Intra Operation Parallelism, Inter Operation Parallelism.	**15L**

Unit III	**Object Oriented, Temporal and Spatial Databases:** Object Oriented Database: Object Identity, Object structure, Type Constructors, Encapsulation of Operations, Methods, Persistence, Type and Class Hierarchies, Inheritance, Complex Objects, Object-oriented DBMS, Languages and Design: ODMG Model, Object Definition Languages (ODL), Object Query Languages (OQL). Temporal and Spatial Database: Introduction to Temporal Database: Time ontology, structure, and granularity, Temporal data models, Temporal relational algebras. Introduction to Spatial Database: Definition, Types of spatial data, Geographical Information Systems (GIS), Conceptual Data Models for spatial databases, Logical data models for spatial databases: rastor and vector model. Physical data models for spatial databases: Clustering methods (space filling curves), Storage methods (R-tree). Query processing.	**15L**
Unit IV	**Deductive, Active, Multimedia and XML Databases** Deductive Database: Introduction to recursive queries, Datalog Notation, Clause Form and Horn Clauses, Interpretation of model: Least Model semantics, The fixed point operator, safe Datalog program, recursive query with negation. Active Database: Languages for rule specification: Events, Conditions, Actions. XML and Database: Structure of XML Data, XML Document Schema, Querying and Transformation, Storage of XML Data. Introduction to multimedia database systems.	**15L**

	Text book: • Distributed Database; Principles & Systems By Publications, Stefano Ceri and Giuseppo Pelagatti,, McGraw-Hill International Editions (1984) • Database Management Systems, 3rd edition, Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill (2002). • Fundamentals of Database Systems, 6thEdition, Elmasri and • Navathe, Addison. Wesley (2003). • Unifying temporal data models via a conceptual model, C.S. Jensen, M.D. Soo, and R.T. Snodgrass: Information Systems, vol. 19, no. 7, pp. 513-547, 1994. • Spatial Databases: A Tour by Shashi Shekhar and Sanjay Chawla, Prentice Hall, 2003 (ISBN 013-017480-7) • Principles of Multimedia Database Systems, Subramanian V. S. Elsevier Publishers, 2013	
	References: • Principles of Distributed Database Systems; 2nd Editied By M. Tamer Ozsu and Patrick Valduriez, Person Education Asia. · Database System Concepts, 5th edition, Avi Silberschatz , Henry F. Korth , S. Sudarshan: McGraw-Hill (2010) • Database Systems: Concepts, Design and Applications, 2nd edition, Shio Kumar Singh, Pearson Publishing, (2011). • Multi-dimensional aggregation for temporal data. M. Böhlen, J. Gamper, and C.S. Jensen. In Proc. of EDBT-2006, pp. 257-275, (2006). • Moving objects databases (chapter 1 and 2), R.H. Güting and M. Schneider: Morgan Kaufmann Publishers, Inc., (2005) • Advanced Database Systems, (chapter 5, 6, and 7), Zaniolo et al.: Morgan Kaufmann Publishers, Inc., (1997)	

Practical Course on Advanced Database Systems	
Sr No	**List of Practical Experiments on Advanced Database Systems**
1	For a given a global conceptual schema, divide the schema into vertical fragments and Place the replication of the global conceptual schema on different nodes and execute queries that will demonstrate a distributed database environment.
2	Create different types that include attributes and methods. Define tables for these types by adding a sufficient number of tuples. Demonstrate insert, update and delete operations on these tables. Execute queries on them
3	For a given global conceptual schema, divide the schema into horizontal fragments and place them on different nodes. Execute queries on these fragments that will demonstrate distributed databases environment.
4	Place the replication of global conceptual schema on different nodes and execute queries that will demonstrate distributed databases environment.
5	Create a nested table and insert a sufficient number of tuples and execute queries
6	Create a table with multimedia attribute and issue queries on it.
7	Create a temporal database and issue queries on it.
8	Create a table that stores spatial data and issue queries on it.
9	Formulate a database using active rules with row and statement levels.
10	Create an XML database and demonstrate insert, update and delete operations on these tables. Issue queries on it.

Module/ Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	Distributed Database Concepts	15h	1	1	1
2	Transaction Processing in Distributed databases and Parallel databases	15h	2	3	2,3
3	Object Oriented, Temporal and Spatial Databases:	15h	3	3	2,3
4	Deductive, Active, Multimedia and XML Databases	15h	4	2	1,2

Course Description	
Semester	**I**
Course Name	**Robotics**
Course Code	**PCS1RBT**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives

1. Understand the working principles of physical components of robotic system
2. Learn the internal and external perceptions of the robot based on different types of sensors
3. To impart the knowledge about planning, mapping, and navigation of robot
4. Provide hands-on practice to build actual robot

Course Outcomes

1. Describe the concepts of robotics and its components
2. Analyze the internal and external perceptions of the robot based on different types of sensors
3. Evaluate the planning, mapping, and navigation of robots
4. Construct a robot using Raspberry Pi

Course Code: PCS1RBT	Course Title Robotics	Credits 4
Unit I	**Introduction to Robotics:** What is a Robot? Definition, History of Robots: Control Theory, Cybernetics, Grey Walter Tortoise, Analog Electronic Circuit, Reactive Theory, Braitenberg's 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 Actuator, Motors, Degree of freedom Locomotion: Stability, Moving and Gaits, Wheels and Steering, Staying on the path. Manipulators: End effectors, Teleoperation, Why is manipulation hard? Sensors: Types of Sensors, Levels of Processing, Passive and Active sensors, Switches, Light sensors, Resistive position sensor.	**15 L**
Unit II	**Sonar, Lasers and Cameras:** 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.	**15 L**
Unit III	**Languages for Programming Robot:** Algorithm, 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 world, hybrid control, Behavior based control and Behavior Coordination, Behavior Arbitration, Distributed mapping, Navigation and Path planning.	**15 L**
Unit-IV	**Building Robots With Raspberry Pi and Python:** Hardware components of Raspberry pi, installation of Raspberry pi, Building Robot- ,Required Components, Assembling robot, Robot Movement-H-bridge, Programme Robot with predefined route, Line following using	**15 L**

	TCRT5000 sensor , Avoiding Obstacles-Ultrasonic sensors for analog object detection,HC-SR04 working and mounting, Measuring short distance

References

1. The Robotics Primer by Maja J Matarić, MIT press Cambridge, Massachusetts, London, England (2007).
2. Learn Robotics With Raspberry Pi , Matt Timmons –Brown

Practical Course on Robotics	
Sr. No.	**List of Practical Experiments on Robotics**
Perform following practical's using Robosim and JGameGrid	
1	Write a program to create a robot (i) With gear (ii) Without gear and move it forward, left, right
2	Write a program to create a robot with a two motor and move it forward, left, right
3	Write a program to do a square using a while loop, doing steps with a for loop, to change directions based on condition, controlling motor speed using switch case
4	Write a program to create a robot with light sensors to follow a line
5	Write a program to create a robot that does a circle using 2 motors
6	Write a program to create a path following robot
7	Write a program to register obstacles
Perform following practical's using Raspberry Pi	
8	Build and assemble a robot using Raspberry Pi
9	Implement Line following using TCRT5000 sensor
10	Implement Object detection using HC-SR04 sensor

Module/ Unit	**Course Description**	**Hrs**	**CO No.**	**PSO No.**	**PO No.**
1	Introduction to Robotics	15h	1	1	1
2	Sonar, Lasers and Cameras	15h	2	3	2
3	Languages for Programming Robot	15h	3	3	2
4	Building Robots With Raspberry Pi and Python	15h	4	2	6

Semester II

Course Description	
Semester	**II**
Course Name	**Cloud Computing**
Course Code	**PCS2CLD**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives:

1. To provide comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, and architecture
2. To analyze different cloud computing platforms for implementing solutions
3. To expose the students to frontier areas of Cloud Computing Management services
4. To make students aware of security threats in cloud computing

Course Outcomes: Learners will be able to

1. Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
2. Identify problems, and explain, analyze, and evaluate various cloud computing platforms for the solution
3. Implement different types of Service Oriented Architecture systems
4. Analyze the issues in Resource provisioning and Security governance in clouds

Course Code: PCS2E1A	Course Title **Cloud Computing-I**	Credits 04
Unit I	**Introduction** Introduction, Roots of Cloud Computing: From mainframe to Cloud, Benefits of Cloud Computing SOA, Web services, Web 2.0, Mashups, Grid computing, Utility computing, Hardware virtualization, Essentials of Cloud characteristics, Challenges, Cloud economics, Role of Networks in Cloud Computing: Cloud types and service models.	**15L**
Unit II	**Cloud Platforms:** Features of Cloud and Grid Platforms: Cloud Capabilities and Platform Features, Traditional Features Common To Grids and Clouds, Data Features and Databases, Programming and Runtime Support. Parallel and Distributed Programming Paradigms: Parallel Computing and Programming Paradigms, MapReduce, Twister and Iterative MapReduce, Hadoop Library from Apache. **Examples:** Openstack, Opennimbus, Eucalyptus Primary Cloud Service models, GAE, AWS, and Azure: Public Clouds and Service Offerings, Google App Engine (GAE), Amazon Web Service (AWS), Microsoft Windows Azure	**15L**
Unit III	**Management of cloud services** Reliability, availability, and security of services deployed from the cloud. Performance and scalability of services, tools, and technologies used to manage cloud services deployment; Cloud Economics: Cloud Computing infrastructures available for implementing cloud-based services. Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat)	**15L**

Unit IV	**Security in Cloud Computing** Introduction, Global Risk and Compliance aspects in cloud environments and key security terminologies, Technologies for Data security, Data security risk, Cloud computing and identity, Digital identity and access management, Content level security, Security-As-A-Cloud Service	**15L**

Text book:

- Rajkumar Buyya, "Cloud computing principles and paradigms", Wiley
- Gautam Shroff, Enterprise Cloud Computing, Cambridge
- Rajkumar Buyya, "Mastering Cloud computing", McGraw Hill
- Tim Mather, Subra K, Shahid L.,Cloud Security and Privacy, Oreilly, ISBN-13 978-81-8404-815-5
- Distributed and cloud computing from parallel processing to the internet of things by Kai Hwang, Geoffry C. Fox, and Jack J. Dongarra

References:

- Kai Hwang, Jack Dongarra, Geoffrey Fox: Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, MK Publishers, 2012. 2.
- Michael Miller, Cloud Computing: Web-Based Applications that change the Way you work and collaborate Online, Pearson Publication, 2012.
- Dr. Kumar Saurabh,"Cloud Computing", Wiley Publication

Course Code: PCS2PR2	**Practical Experiments on Cloud Computing**
	List of Practical Experiments on Cloud Computing
1	Develop Applications using Google AppEngine
2	Implement MapReduce and Hadoop
3	Implement private cloud with Xen server
4	Creating a Failover Cluster using Failover Cluster Manager
5	Implement private cloud with Exi server
6	Installation and Configuration of virtualization using KVM
7	Study and implement Cloud Security management with Two-Factor Authentication
8	Study and implementation of Single-Sing-On
9	Managing Hyper-V environment with SCVVM 2012
10	Using Data Protection Manager for Backup and Recovery

Module/ Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	Introduction	15h	1	1	1
2	Cloud Platforms	15h	2	2	2
3	Management of cloud services	15h	3	3	3
4	Security in Cloud Computing	15h	4	2	8

Course Description	
Semester	**II**
Course Name	**Natural Language Processing**
Course Code	**PCS2NLP**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course objectives:

1. To understand natural language processing and to learn how to apply basic algorithms in this field
2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics
3. To design and implement applications based on natural language processing
4. To implement various language Models

Course outcomes: On successful completion of the course, the learner should:

1. Have a broad understanding of the field of natural language processing
2. Have a sense of the capabilities and limitations of current natural language technologies,
3. Be able to model linguistic phenomena with formal grammar
4. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP
5. Be able to apply NLP techniques to design real-world NLP applications such as machine translation, text categorization, text summarization, information extraction, etc.

Course Code: PCS2NLP	Course Title	Credits
	Natural Language Processing	**04**
Unit I	**Introduction to NLP** Introduction to NLP History of NLP, Generic NLP system, levels of NLP, Knowledge in Speech and language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP	**15L**
Unit II	**Word Level Analysis** An Outline of English Syntax Words- The Elements of Simple Noun Phrases Verb Phrases and Simple Sentences Noun Phrases Revisited Adjective Phrases Adverbial Phrases, Grammars and Sentence Structure What Makes a Good Grammar A Top-Down Parser A Bottom-Up Chart Parser Top-Down Chart Parsing Finite State Models and Morphological Processing Grammars and Logic Programming Parsing tools such as Stanford Parser. N –Grams- N-gram language model, N-gram for spelling correction.	**15L**
Unit III	**Syntax Analysis** Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank), Rule-based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	**15L**
Unit IV	**Semantic Analysis** Lexical Semantics, Attachment for the fragment of English- Sentences, Noun phrases, Verb phrases, Prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Word Sense Disambiguation (WSD) Applications: Named Entity Recognition, Information retrieval, Question answers system, Machine translation. **Sentiment Analysis**	**15L**

	What is Sentiment Analysis, Types of Sentiment Analysis, Importance of Sentiment Analysis, Challenges of Sentiment Analysis.	

Text Books:

1. Daniel Jurafsky, James H. Martin ―Speech and Language Processing‖ Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, ― Foundations of Statistical Natural Language Processing ―, MIT Press, 1999.
3. D. Jurafsky, J. H. Martin, "Speech and Language Processing", Pearson Education, 2002.

Reference Books:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. https://monkeylearn.com/sentiment-analysis
3. Daniel M Bikel and Imed Zitouni ― Multilingual natural language processing applications‖ Pearson, 2013
4. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) ― The Handbook of Computational Linguistics and Natural Language Processing ― ISBN: 978-1-118
5. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
6. Brian Neil Levine, An Introduction to R Programming
7. Niel J le Roux, Sugnet Lubbe, A step by step tutorial: An introduction into R application and programming
8. Christopher D. Manning, Hinrich Schutze, Foundations of Statistical Natural Language Processing, The MIT Press, Cambridge, Massachusetts, 1999.

Course Code: PCS2PR1	Course Title
	Practical Course on Natural Language Processing
Note: - The following set of practicals can be performed using any Python Libraries for NLP such as NLTK, spaCy, genism: Link:-https://www.python.org/downloads/	
Sr. No.	**List of Practical Experiments on Natural Language Processing**
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

Module /Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	Introduction to NLP	15h	1	1	1
2	Word Level Analysis	15h	2	2	3
3	Syntax Analysis	15h	3	2	3
4	Semantic Analysis	15h	4	2	3

Course Description	
Semester	**II**
Course Name	**Business Intelligence and Big data Analytics**
Course Code	**PCS2BI1**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives

1. Apply the basic concepts and methods of business analytics
2. Understand the basic concepts of Business Data Warehouse
3. Improving strategic decision-making by designing Data Warehouse model.
4. To explore data mining concepts and solutions.

Course Outcomes

1. Describe the concepts of Business Intelligence
2. Explain business Data Warehouse
3. Build business Data Warehouse
4. Evaluate data mining process and Association analysis

Course Code: PCS2BI1	**Course Title**	**Credits 04**
	Business Intelligence and Big Data Analytics	
Unit I	**Introduction to Business Intelligence:** Operational and Decision Support System, Data-Information-Knowledge- Decision making-Action cycle. Basic definitions-Business Intelligence; Data warehousing, Business Intelligence architecture, Use and benefits of Business Intelligence. Knowledge Discovery in Databases: KDD process model, Data Pre-processing: Cleaning: Missing Values; Noisy Values; Inconsistent values; redundant values. Outliers, Integration, transformation, reduction, Discretization: Equal Width Binning; Equal Depth Binning,Normalization, Smoothing	**15 L**

Unit II	**Introduction to Business Data Warehouse:** Definition of Data warehouse, Logical architecture of Data Warehouse, Data Warehouse model- Enterprise warehouse; Data Marts; Virtual warehouse. Populating business Data Warehousing: data integration and extract, transform, load (ETL).	**15 L**
Unit III	**Designing Business Data Warehouse:** OLTP and OLAP systems, Designing business information warehouse: Principles of dimensional modeling, Data cubes, Data cube operations, data cube schemas.	**15 L**
Unit-IV	**Introduction to Data Mining:** Data mining definitions and process: business and data understanding. Association Analysis: Definition of association rule, General issues: Support; Confidence; Lift; Conviction, Frequent Item sets: APriori Algorithm; Issues with APriori Algorithm, Data structures: Hash tree and FP tree.	**15 L**

Text book:

- Business Intelligence (2nd Edition), Efraim Turban, Ramesh Sharda, Dursun Delen, David King, Pearson (2013)
- Business Intelligence for Dummies, Swain Scheps, Wiley Publications (2008).
- Building the Data Warehouse, Inmon: Wiley (1993).
- Data Mining: Introductory and Advanced Topics, Dunham, Margaret H, Prentice Hall (2006)
- Data Mining: Practical Machine Learning Tools and Techniques,Second Edition, Witten, Ian and Eibe Frank, Morgan Kaufmann (2011)

Reference:

- Business Intelligence Road Map, Larissa T. Moss, Shaku Atr, Addison-Wesley

- Data Modeling Techniques for Data Warehousing by IBM; International Technical Support Organization, Chuck Ballard, Dirk Herreman, Don Schau, Rhonda Bell, Eunsaeng Kim, Ann Valencic:http://www.redbooks.ibm.com
- Data Mining: Concepts and Techniques, The Morgan Kaufmann Series in Data Management Systems, Han J. and Kamber M. Morgan Kaufmann Publishers, (2000).
- Data Mining with Microsoft SQL Server 2008, MacLennan Jamie, Tang ZhaoHui and Crivat Bogdan, Wiley India Edition (2009).

Sr. No.	List of Practical Experiments on Business Intelligence & Big Data Analytics (Business Intelligence)
1	Import the legacy data from different sources such as (Excel , SqlServer, Oracle etc.) and load in the target system. (You can download sample database such as Adventureworks, Northwind, foodmart etc.)
2	Perform the Extraction Transformation and Loading (ETL) process to construct the database in the Sqlserver.
3	a. Create the Data staging area for the selected database. b. Create the cube with suitable dimension and fact tables based on ROLAP, MOLAP and HOLAP model.
4	a.Create the ETL map and setup the schedule for execution. b. Execute the MDX queries to extract the data from the datawarehouse.
5	a. Import the datawarehouse data in Microsoft Excel and create the Pivot table and Pivot Chart. 57 b. Import the cube in Microsoft Excel and create the Pivot table and Pivot Chart to perform data analysis.
6	Apply the what – if Analysis for data visualization. Design and generate necessary reports based on the datawarehouse data
7	Develop an application to pre process data imported from external sources.
8	Create association rules by considering suitable parameters.
9	Write a program in Python based on Hash Tree

10	Write a program in Python based on FP Tree

The BI tools such as Tableau / Power BI / BIRT / R / Excel or any other can be used.

Module/ Unit	**Course Description**	Hrs	CO No.	PSO No.	PO No.
1	Introduction to Business Intelligence	15h	1	1	2
2	Introduction to Business Data Warehouse	15h	2	1	1
3	Designing Business Data Warehouse	15h	3	2	5
4	Introduction to Data Mining	15h	4	3	6

Course Description	
Semester	**II**
Course Name	**Machine Intelligence**
Course Code	**PCS2MI1**
Eligibility for Course	**B.Sc.**
Credit	**4**
Hours	**60**

Course Objectives:

1. To be able to formulate machine learning problems corresponding to different applications
2. To understand various machine learning algorithms along with their advantages and disadvantages
3. To be able to apply machine learning algorithms to solve problems of moderate complexity.

Course Outcomes:

1. Identify basic concepts and types of learning from data
2. Describe dimensionality reduction technique for attribute reduction
3. Create ensemble models using different Machine Learning techniques
4. Build probabilistic and unsupervised learning models for handling unknown patterns

Course Code: PCS2MI1	Course Title	Credits 04
	Machine Intelligence	
Unit I	**Learning-Standard Linear methods:** Statistical Learning: What Is Statistical Learning, Assessing Model Accuracy. Linear Regression: Simple Linear Regression, Multiple Linear Regressions, Other Considerations in the Regression Model, The Marketing Plan, Comparison of Linear Regression with K-Nearest Neighbors. Classification: An Overview of Classification, Why Not Linear Regression? , Logistic Regression, Linear Discriminant Analysis, ,A Comparison of Classification Methods.	**15 L**
Unit II	**Selection and improvements of linear learning methods:** Resampling Methods: Cross-Validation, The Bootstrap. Linear Model Selection and Regularization: Subset Selection, Shrinkage Methods, Dimension Reduction Methods, Considerations in High Dimensions.	**15 L**
Unit III	**Non-Linear Learning methods:** Polynomial Regression, Step Functions, Basis Functions, Regression Splines, Smoothing Splines, Local Regression, Generalized Additive Models, Tree-Based Methods: The Basics of Decision Trees. Bagging, Random Forests, Boosting.	**15 L**
Unit-IV	**Support Vector machines, Principle Component Analysis and Clustering:** Support Vector Machines: Maximal Margin Classifier. Support Vector Classifiers: Support Vector Machines, SVMs with More than Two Classes Relationship to Logistic Regression. Unsupervised Learning: The Challenge of Unsupervised Learning, Principal Components Analysis, Clustering, Methods: K-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering.	**15 L**

Text book:

- An Introduction to Statistical Learning with Applications in R: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer 2013.
- The Elements of Statistical Learning: Data Mining, Inference, and Prediction (Second Edition) : Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer (2008).

Reference:

- Introduction to Machine Learning (Second Edition): Ethem Alpaydın, The MIT Press (2010).
- Pattern Recognition and Machine Learning: Christopher M. Bishop, Springer (2006)
- Bayesian Reasoning and Machine Learning: David Barber, Cambridge University Press (2012)
- Machine Learning: The Art and Science of Algorithms that Make Sense of Data: Peter Flach, Cambridge University Press (2012) Machine Learning for Hackers: Drew Conway and John Myles White, O'Reilly (2012)
- Machine Learning in Action: Peter Harrington, Manning Publications (2012).
- Machine Learning with R: Brett Lantz, Packt Publishing (2013)
- https://class.coursera.org/ml-005/lecture/preview
- https://github.com/josephmisiti/awesome-machine-learning.

Sr. No.	List of Practical Experiments on Machine Intelligence (Fundamentals of Machine Intelligence)
1	Implement simple linear regression model on a standard data set and plot the least square regression fit. Comment on the result. [One may use inbuilt data sets like Boston, Auto etc]
2	Implement multiple regression model on a standard data set and plot the least square regression fit. Comment on the result. [One may use inbuilt data sets like Carseats, Boston etc].
3	Fit a classification model using following: (i) logistic regression (ii) Linear Discriminant Analysis (LDA) and (iii) Quadratic Discriminant Analysis (QDA)

	on a standard data set and compares the results. [Inbuilt datasets like Smarket, Weekly, Auto, Boston etc may be used for the purpose].
4	Fit a classification model using K Nearest Neighbour (KNN) Algorithm on a given data set. [One may use data sets like Caravan, Smarket, Weekly, Auto and Boston].
5	Use bootstrap to give an estimate of a given statistic. [Datasets like Auto, Portfolio and Boston etc may be used for the purpose].
6	For a given data set, split the data into two training and testing and fit the following on the training set: (i) Linear model using least squares (ii) Ridge regression model (iii) Lasso model (iv) PCR model (v) PLS model Report test errors obtained in each case and compare the results. [Data sets like College, Boston etc may be used for the purpose].
7	For a given data set, perform the following: (i) Perform the polynomial regression and make a plot of the resulting polynomial fit to the data. (ii) Fit a step function and perform cross validation to choose the optimal number of cuts. Make a plot of the fit to the data. [Use data set like Wage for the purpose].
8	For a given data set, do the following: (i) Fit a classification tree (ii) Fit a regression tree [One may choose data sets like Carseats, Boston etc for the purpose].
9	For a given data set, split the dataset into training and testing. Fit the following models on the training set and evaluate the performance on the test set: (i) Boosting (ii) Bagging (iii) Random Forest [Data sets like Boston may be used for the purpose].
10	Fit a support vector classifier for a given data set. [Data sets like Car, Khan, Boston etc may be used for the purpose].
11	Perform the following on a given data set: (i) Principal Component Analysis (ii) Hierarchical clustering. [Data set like NC160, USArrests etc may be used for the purpose].

Note: The above practical experiments require the R Software

Module /Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	Learning-Standard Linear methods:	15h	1	1	1
2	Selection and improvements of linear learning methods:	15h	2	2	2
3	Non-Linear Learning methods:	15h	3	1	1
4	Support Vector machines, Principle Component Analysis and Clustering:	15h	4	2	2