Karmaveer Bhaurao Patil College, Vashi
Autonomous College
Affiliated to University of Mumbai
Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of Course	Computer Science
2	Eligibility for Admission	B.Sc. (IT)/ B.Sc. (CS)/ B.Sc. (Maths)/ B.Sc. (Phy)/B.E.(Comp)/B.E.(IT)
3	Passing marks	40
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	P.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic year	2021-2022

AC- / /
Item No-

Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI
(AUTONOMOUS COLLEGE)
Sector-15- A, Vashi, Navi Mumbai - 400 703

Syllabus for M.Sc. I Computer Science
Program: M.Sc. Computer Science (Honours)
Course: M.Sc. I Computer Science

(Choice Based Credit System with effect from the academic year 2021-2022)

Preamble

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

- Bring a new approach to syllabus, not a revision of the existing syllabus.
- Create a unique identity for MSc in Comp Science distinct from similar degrees in other related subjects.
- Recommend provision for specialization in MSc Computer Science degree.
- 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.
- Focus, as far as possible, only on open source software.

This 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 three core compulsory courses, one Skill Enhancement Course and one Discipline Specific Elective course in semester I. Semester II also proposes three core compulsory courses, one Skill Enhancement Course and one Discipline Specific Elective course. From Semester II elective in Discipline Specific Elective has two tracks of courses based on a recent and emerging area. It is expected that a student continues to take that track for each elective in semester III and specializes in one of those in semester IV.

In order to give an impetus to research among students, one of the courses in the semester I gives an overview on how to do research in Computer Science. Provision for case study in the practical course of the elective in the semester II is an attempt to translate that theory into practice. It is assumed that, with this background, a student can take up a challenging research project in semester III and semester IV.

We thank all the industry experts, senior faculties and our colleagues in the department of Computer Science of different colleges as well as BOS members who have given their valuable comments and suggestions, which we tried to incorporate.

Scheme of examination for Each Semester:

Continuous Internal Evaluation: 40 Marks (Common Test-20 Marks & 20 Marks for- Mini Projects, Presentation, Online Course, Case Study, Assignment, Analysis In Statistics, Report Writing, Interviews, Paper Review, Surprise Test, Research Paper, Data Analysis).

Semester End Examination: 60 Marks will be as follows-

I.	**Theory:** The Semester End Examination for theory course work will be conducted as per the following scheme.	
	Each theory paper shall be of two and half hour duration.	
	All questions are compulsory and will have internal options.	
	Q – I	From Unit – I (having internal options.) 12 M
	Q – II	From Unit – II (having internal options.)12 M
	Q – III	From Unit – III (having internal options.)12 M
	Q – IV	From Unit – IV (having internal options.)12 M
	Q – V	Questions from all the FOUR Units with equal weightage of marks allotted to each Unit. 12 M
II.	Practical	The Semester End Examination for practical course will be conducted as per the following scheme.

Sr. No.	**Particulars of Semester End Practical Examination**	**Marks**
1	Laboratory Work	40
2	Journal	05
3	Viva	05
	TOTAL	**50**

M.Sc. Computer Science Syllabus
Choice Based Credit, Grading and Semester System
Academic year 2021-2022
SEMESTER - I

CODE	COURSE TYPE	SUBJECT	SCHEME OF INSTRUCTION (PERIOD PER WEEK)		SCHEME OF EXAMINATION (MAX MARKS)			NO. OF CREDITS
			TH	LAB	CIA	SEE	TOTAL	
PGCS101	CORE	Analysis of Algorithms	4	4	40	60	100	4
PGCS102	CORE	Advanced Networking Concepts	4	4	40	60	100	4
PGCS103	CORE	Advanced Database Systems	4	4	40	60	100	4
PGCS104	Skill Enhancement Course	Advanced Python Programming	3	2	40	60	100	3
PGCS105	Discipline Specific Elective - I	Embedded and IOT Technology	4	4	40	60	100	4
PGCS106	Discipline Specific Elective - I	Image Processing and Pattern Recognition	4	4	40	60	100	4
PGCSP101	Core Subject Practical	PGCS101		4			50	2
PGCSP102	Core Subject Practical	PGCS102		4			50	2
PGCSP103	Core Subject Practical	PGCS103		4			50	2
PGCSP104	Skill Enhancement Subject Practical	PGCS104		2			50	1
PGCSP105	Discipline Specific Elective - I Subject Practical **OR**	PGCS105		4			50	2
PGCSP106	Discipline Specific Elective - I Subject Practical	PGCS106		4			50	2
						TOTAL	750	28

SEMESTER - II

CODE	COURSE TYPE	SUBJECT	SCHEME OF INSTRUCTION (PERIOD PER WEEK)		SCHEME OF EXAMINATION (MAX MARKS)			NO. OF CREDITS
			TH	LAB	CIA	SEE	TOTAL	
PGCS201	CORE	Research in Computing	4	4	40	60	100	4
PGCS202	CORE	Business Intelligence and Big Data Analytics-I (Business Intelligence)	4	4	40	60	100	4
PGCS203	CORE	Social Network Analysis	4	4	40	60	100	4
PGCS204	Skill Enhancement Course	Data visualization using R	3	2	40	60	100	3
PGCS205	Discipline Specific Elective - II	Cyber and Information Security-I (Network Security)	4	4	40	60	100	4
PGCS206	Discipline Specific Elective - II	Machine Intelligence-I (Fundamentals of Machine Intelligence)	4	4	40	60	100	4
PGCSP201	Core Subject Practical	PGCS201		4			50	2
PGCSP202	Core Subject Practical	PGCS202		4			50	2
PGCSP203	Core Subject Practical	PGCS203		4			50	2
PGCSP204	Skill Enhancement Subject Practical	PGCS204		2			50	1
PGCSP205	Discipline Specific Elective - I Subject Practical **OR**	PGCS205		4			50	2
PGCSP206	Discipline Specific Elective - I Subject Practical	PGCS206		4			50	2
						TOTAL	750	28

Note: TH-Theory, CIA- Continuous Internal Assessment, SEE-Semester End Examination.

Detailed syllabus of Semester – I

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** I	
Subject : **Analysis of Algorithms**			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS101	**Analysis of Algorithms** **(Credits : 4 Lectures/Week: 4)**	
	Expected Course Outcomes : After successful completion of this course, students will be able to: 1. Apply the algorithms and design techniques to solve problems. 2. Compare two or more algorithms in terms of time and space complexity on growth functions. 3. Evaluate Algorithms using Dynamic Programming approach, Greedy strategy and Minimum spanning trees (MST) method. 4. Apply the concept of Lower Bound on RSA public-key cryptosystem NP-Completeness and Approximation algorithms.	
Unit I:	**Design strategies** The Role of Algorithms in Computing: Algorithms as a technology. Getting Started: Insertion sort, Analyzing algorithms, Designing algorithms. Growth of Functions: Asymptotic notation, Standard notations and common functions. Divide-and-Conquer: The maximum-subarray problem, Strassen's algorithm for matrix multiplication, The substitution method for solving recurrences. Probabilistic Analysis and Randomized Algorithms: The hiring problem, Indicator random variables, Randomized algorithms.	**15 L**
Unit II:	**Advanced Design and Analysis Techniques** Dynamic Programming: Rod cutting, Elements of dynamic programming, longest common subsequence. Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Huffman codes.	**15 L**
Unit III:	Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search. Minimum Spanning Trees: Growing a minimum spanning tree, Algorithms of Kruskal and Prim. Single-Source Shortest Paths: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Dijkstra's algorithm.	**15 L**
Unit IV:	**Number-Theoretic Algorithms and NP –** Completeness Elementary number-theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder	**15 L**

	theorem, Powers of an element, The RSA public-key cryptosystem NP-Completeness: Polynomial time, Polynomial-time verification, NP-completeness and reducibility, NP-complete problems. Approximation Algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, subset-sum problem.	

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).

Links:

1) https://www.tutorialspoint.com/design_and_analysis_of_algorithms/analysis_of_algorithms.htm
2) https://www.geeksforgeeks.org/analysis-of-algorithms-set-1-asymptotic-analysis/
3) https://mcdtu.files.wordpress.com/2017/03/introduction-to-algorithms-3rd-edition-sep-2010.pdf

Sr. No.	List of Practical Experiments on PGCSP101
1.	Write a program to implement insertion sort and find the running time of the algorithm.
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 Huffman's code algorithm
6.	Write a program to implement Kruskal's algorithm.
7.	Write a program to implement Dijkstrass's algorithm
8.	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.
9.	Write a program to verify (i) Euclid's theorem (ii) Fermat's theorem.
10.	Write a program to implement greedy set cover algorithm to solve set covering problem

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** I	
Subject : Advanced Networking Concepts			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS102	**Advanced Networking Concepts** **(Credits : 4 Lectures/Week: 4)**	Lectures
	Expected Course Outcomes : After successful completion of this course, students will be able to: 1. Identify the different types of network topologies, protocols, virtualization technologies primer and central service access.. 2. Examine the layers of the OSI model and TCP/IP application of manet, Ad Hoc networks, Routing protocols and Transmission techniques 3. Determine the different types of network devices and their functions within a network 4. Illustrate the basic concepts of Sensor networks, and how they can be used to assist in network design and implementation.	
Unit I	**Networking** Internet and Intranet, Protocol layer and their services, Network Applications like Web, HTTP, FTP and Electronic Mail in the Internet, Domain Name System, Transport-Layer Services, Multiplexing and Demultiplexing, UDP, TCP, TCP Congestion Control, Network Layer, Virtual Circuit and Datagram Networks, Need of Router, The Internet Protocol (IP), Routing Algorithms, Routing in the Internet.	**15 L**
Unit II	**Network Virtualization** Need for Virtualization, The Virtual Enterprise, Transport Virtualization-VNs, Central Services Access: Virtual Network Perimeter, A Virtualization Technologies primer: theory, Network Device Virtualization, Data-Path Virtualization, Control-Plane Virtualization, Routing Protocols.	**15 L**
Unit III	**Adhoc Networking** Introduction, application of MANET, challenges, Routing in Ad hoc networks, topology & position based approaches, Routing protocols: topology based, position based, Broadcasting, Multicasting, & Geocasting, Wireless LAN, Transmission techniques, MAC protocol issues, Wireless PANs, The Bluetooth technology.	**15 L**
Unit IV	**Wireless Sensor networks:**	**15 L**

	Need and application of sensor networks, sensor networks design considerations, empirical energy consumption, sensing and communication range, design issues, localization scheme, clustering of SNs, Routing layer, Sensor networks in controlled environment and actuators, regularly placed sensors, network issues, RFID as passive sensors.	

Text book:

- Computer Networking: A Top-Down Approach 6th edition, James F. Kurose, Keith W. Ross, Pearson (2012).
- Network Virtualization, Victor Moreno, Kumar Reddy, Cisco Press (2006).
- Ad Hoc and Sensor Networks: Theory and Applications 2nd edition; Carlos de Morais Cordeiro, Dharma Prakash Agrawal, World Scientific Publishing Company; 2 edition (2011)

Reference book:

- TCP/IP Protocol Suite 4 edition, Behrouz Forouzan, McGraw-Hill Science (2009)
- Mobile Ad Hoc Networks: Current Status and Future Trends, Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, CRC Press(2011)
- Fundamentals of Sensor Network Programming: Applications and Technology, S.
- Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley-IEEE Press (2010).

Links:

1) https://sites.google.com/site/avicodes/notes/advance-computer-network
2) https://web.eecs.umich.edu/~zmao/eecs589/notes/lec1_6.pdf

Sr. No.	**List of Practical Experiments on PGCSP102**
1.	Create a network with three routers with RIPv2 and each router associated network will have minimum three PC. Show connectivity
2.	Create a network with three routers with OSPF and each router associated network will have minimum three PC. Show connectivity
3.	Create a network with three routers with BGP and each router associated network will have minimum three PC. Show connectivity.
4.	Configure DHCP server and client for DHCP service.
5.	Create virtual PC based network using virtualization software and virtual NIC
6.	Create network cloud and hosts
7.	Create simple Adhoc network
8.	Create MANET simulation for AODVUU Network
9.	Create Single mobile network
10.	Create wireless network in OMNET++
Note: Practical experiments require software tools like INET Framework for OMNeT++ or NS2, Cisco packet tracer 5.3 or higher, virtualization tools-VMware/virtual Box/ virtualPC	

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** I	
Subject : Advanced Database Systems			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS103	**Advanced Database Systems** **(Credits : 4 Lectures/Week: 4)**	
	Expected Course Outcomes After successful completion of this course, students would be able to 1. Develop knowledge and understanding of the underlying principles of Distributed Database Management System there Architecture and design strategies in detail with XML. 2. Evaluate the proper functions of transaction management using ACID properties, Deadlock management, database reliability and parallel query Evaluation . 3. Explain the concept of NoSQL Basics & Accessing Data from MongoDB. 4. Describe the Gaining Proficiency With NoSQL,MongoDB Query ,HBase,RDBMS and ACID.	
Unit I	**Enhanced Database Models** Object–Oriented Databases: Need of Object-oriented databases, Complex Data Types, Structured Types and Inheritance, ObjectIdentity and Reference, ODL and OQL, Implementing O-R Features, Persistent Programming Languages, Object-Oriented versus ObjectRelational, Example of Object oriented and object relational database implementation, comparison of RDBMS, OODBMS, ORDBMS XML Databases: Structured Semi structure and unstructured data, XML hierarchical tree data model, Documents DTD and XML schema, XML Documents & Database, XML query and transformation, Storage of XML data, Xpath. XQuery, Join and Nesting Queries, XML database applications. Spatial Databases: Types of spatial data, Geographical Information Systems (GIS), Conceptual Data Models for spatial databases, Logical data models for spatial databases: Raster and vector model. Physical data models for spatial databases: Clustering methods (space filling curves), Storage methods (R-tree). Query	**15 L**

	processing. Temporal Databases: Time ontology, structure, and granularity, Temporal data models, Temporal relational algebra.	
Unit II	**Cooperative Transaction Model** :Parallel and Distributed Databases: Architecture of parallel databases, Parallel query evaluation, Parallelizing individual operations, Sorting Joins Distributed Databases: Concepts, Data fragmentation, Replication and allocation techniques for distributed database design, Query processing, Concurrency control and recovery in distributed databases, Architecture and Design: Centralised versus non centralized Databases, Homogeneous and Heterogeneous DDBMS, Functions and Architecture, Distributed database design, query processing in DDBMS, Distributed concurrency management, deadlock management, Distributed Commit Protocols: 2 PC and 3 PC, Concepts of replication servers. Mobile Database: Overview, Features, Advantages and Disadvantages, Mobile databases in Android System	**15 L**
Unit III	**Learning the NoSQL 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 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 Databases Performing CRUD operations: Creating Records, Accessing Data, Updating and Deleting Data	**15 L**
Unit IV	**Gaining Proficiency With NoSQL** Querying NoSQL Stores: Similarities Between SQL and MongoDB Query Features, Accessing Data from Column-Oriented Databases Like HBase, Querying Redis Data Stores Indexing And Ordering Data Sets: Essential Concepts Behind a Database Index, Indexing and Ordering in MongoDB, ouchDB and Apache Cassandra 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	**15 L**

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).

Links:

1) http://aries.ektf.hu/~hz/pdf-tamop/pdf-xx/Radvanyi-hdbms-eng2.pdf
2) https://www.studyyaar.com/index.php/learning-program/7-advanced-database-management-system

Sr. No.	**Practical Course on PGCSP103**
Note: All the Practical's should be implemented using NoSQL Link: https://www.oracle.com/database/technologies/nosql-databaseserver-downloads.html	
1.	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.
2.	Create an XML database and demonstrate insert, update and delete operations on these tables. Issue queries on it.
3.	Demonstrate distributed databases environment by dividing given global conceCreate a table that stores spatial data and issue queries on it. ptual schema, into vertical and Horizontal fragments and place them on different nodes. Execute queries on these fragments.
4.	Create a table that stores spatial data and issues queries on it.
5.	Create a temporal database and issue queries on it.
6.	Demonstrate the Accessing and Storing and performing CRUD operations in 1. MongoDB 2. Redis
7.	Demonstrate the Accessing and Storing and performing CRUD operations in 1. HBase 2. Apache Cassandra
8.	Demonstrating MapReduce in MongoDB to count the number of female (F) and male (M) respondents in the database.
9.	Demonstrate the indexing and ordering operations in 1. MongoDB 2. CouchDB 3. Apache Cassandra
10.	Demonstrate the use of data management and operations using NoSQL in the Cloud.

Class: M.Sc CS Part I	**Branch**: Computer Science	**Semester:** I

Subject : Advanced Python Programming			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS104	Advanced Python Programming **(Credits : 4 Lectures/Week: 4)**	
	Expected course Outcome After successful completion of this course, students would be able to 1. Explain fundamental understanding of the Python programming language. 2. Describe common Python functionality and features used for data science. 3. Illustrate the Object-oriented Programming concepts in Python. 4. Visualize and describe DataFrame structures for cleaning and processing data.	
Unit I	**LIST MANIPULATION**:Introduction to Python List· Creating List· Accessing List· Joining List· Replicating List· List Slicing, list comprehension **TUPLES** Introduction to Tuple· Creating Tuples· Accessing Tuples· Joining Tuples· Replicating Tuples· Tuple Slicing· **DICTIONARIES** Introduction to Dictionary· Accessing values in dictionaries· Working with dictionaries· Properties· **Set and Frozeset:** Introduction to Set and Frozenset,Creating Set and Frozenset, Accessing and Joining, Replicating and Slicing **Regular Expressions:** Match function, Search function, Grouping, Matching at Beginning or End, Match Objects , Flags	**15 L**
Unit II	**Object-Oriented Programming**: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism. **Functional Programming**: Iterators, Generators, Decorators **Files and Working with Text Data:** Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, The Pickle Module, Reading and Writing CSV Files, Python os and os.pathModules, JSON and XML in Python, Processing HTML Files, Processing Texts in Natural Languages	**15 L**
Unit III	**Working with Tabular Numeric Data(Numpy with Python)**: NumPy Arrays Creation Using *array()* Function, Array Attributes, NumPy Arrays Creation with Initial Placeholder Content, Integer Indexing, Array Indexing,	**15 L**

	Boolean ArrayIndexing, Slicing and Iterating in Arrays, Basic Arithmetic Operations on NumPy Arrays, Mathematical Functions in NumPy, Changing the Shape of an Array, Stacking and Splitting of Arrays, Broadcasting in Arrays. **Working with Data Series and Frames:** Pandas Data Structures, Reshaping Data, Handling Missing Data, Combining Data, Ordering and Describing Data, Transforming Data, Taming Pandas File I/O **Plotting**: Basic Plotting with PyPlot, Getting to Know Other Plot Types, Mastering Embellishments, Plotting with Pandas	

TEXT BOOKS:

1) Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
2) Haltermanpython Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010
3) Introduction to Python Programming**.** Gowrishankar S., Veena A. CRC Press, Taylor & Francis Group, 2019

References:

1) Python for Everybody: Exploring Data Using Python 3. Charles R Severance, 2016

ONLINE RESOURCES:

https://www.w3schools.com/python
https://docs.python.org/3/tutorial/index.html
https://www.python-course.eu/advanced_topics.php

Sr. No.	**Practical Course on PGCSP104** **(Credits : 4 Lectures/Week: 3)**
1.	a. Program with a function that takes two lists L1 and L2 containing integer numbers as parameters. The return value is a single list containing the pair wise sums of the numbers in L1 and L2 b. Program to read the lists of numbers as L1, print the lists in reverse order without using reverse function.
2.	Program to find max and min of a given tuple of integers.
3.	Write a program that combine lists L1 and L2 into a dictionary.
4.	Program to find union, intersection, difference, symmetric difference of given two sets.
5.	Write a program for searching, splitting and replacing things based on pattern matching using regular expression.
6.	Write programs to parse text files, CSV, HTML, XML and JSON documents and extract relevant data. After retrieving data check any anomalies in the data, missing values etc.
7.	Write programs for reading and writing binary files
8.	a. Program to implement the inheritance b. Program to implement the polymorphism
9.	Write programs to create numpy arrays of different shapes and from different sources, reshape and slice arrays, add array indexes, and apply arithmetic, logic, and aggregation functions to some or all array elements
10.	Write programs to use the pandas data structures: Frames and series as storage containers and for a variety of data-wrangling operations, such as: ● Single-level and hierarchical indexing ● Handling missing data ● Arithmetic and Boolean operations on entire columns and tables

	• Database-type operations (such as merging and aggregation) • Plotting individual columns and whole tables • Reading data from files and writing data to files
Datasets For this laboratory, appropriate publicly available datasets, can be studied and used. Example: MNIST (http://yann.lecun.com/exdb/mnist/), UCI Machine Learning Repository(https://archive.ics.uci.edu/ml/datasets.html), Kaggle(https://www.kaggle.com/datasets) Twitter Data	

Class: M.Sc CS Part I	**Branch**: Computer Science	**Semester:** I	
Subject : Embedded and IOT Technology			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS105	Embedded and IOT Technology **(Credits : 4 Lectures/Week: 4)**	
	Expected course Outcome After successful completion of this course, students would be able to 1) Design and executive projects in IoT with Automatic Identification and Data Capture. 2) Describe the basic components and functionalities of an Embedded System including its hardware. 3) Design case studies in IoT and replicate the same for more detailed analysis of the IoT development.	
Unit I	Embedded System Basics Introduction to Embedded Systems, Design of Embedded Systems, Memory Architecture, Input/Output. Basic electronics: Semiconductors, Transistors, BJT, Flip Flops, Resistors, Capacitors, CMOS, MOSFET, FPGA, Relays. Microcontrollers, UART Communications, SPI-peripherals interface, I2C communication, Wireless Sensor Network (WSN)	**15 L**
Unit II	Basics of IOT Introduction IoT:Evolution of the IoT concept, vision and definition of IoT, basic characteristics of IoT, distinguish the IoT from other related technologies, IoT enablers, IoT architectures, pros and cons of IoT, IoT architecture concepts for specific IoT applications. IoT Building Blocks -Hardware and Software:The basic IoT building blocks, smart thing components and capabilities, basics	**15 L**

	of Packet Tracer with reference to IoT, basics of IoT gateway, Cloud, and analytics Sensing Principles and Wireless Sensor Network:Sensor fundamentals and classification of sensors, physical principles of some common sensors, basics of WSNs, WSN architecture and types, layer-level functionality of WSN protocol stack.	
Unit III	**Advanced IOT Technologies IoT Gateway:** IoT architecture domains, IoT gateway architecture, IoT gateway functionalities, IoT gateway selection criteria, IoT gateway and edge computing, edge computing-based solution for specific IoT applications IoT Protocol Stack:Mapping of IoT protocols to layered IoT architecture, functionality of infrastructure, service discovery, and application layer protocols of IoT protocol stack IoT Cloud and Fog Computing:Components of IoT Cloud architecture, usage of application domains of IoT Cloud platforms, layered architecture of Fog computing, distinguish Fog computing from other related terms IoT Applications:Main applications of IoT, Implementation details of various IoT application domains	**15L**
Unit IV	**Security, Communication and Data analytics in IOT** IoT Security: Security constraints in IoT systems, security requirements of IoT systems, IoT attacks, security threats at each layer of IoT architecture, design secure IoT system for specific application Social IoT: Nature of social relationships among IoT Devices, functionality of different components of social IoT architecture, social aspects of smart devices in IoT applications Packet Tracer and IoT: Basics of Packet Tracer and Blockly programming language, design simple IoT projects in Packet Tracer.	**15L**

TEXT BOOK:

1. Introduction to Embedded Systems – Cyber physical systems Approach Edward Ashford Lee &SanjitArunkumarSeshia Second Edition — MIT Press — 2017
2. Enabling the Internet of Things Fundamentals, Design and Applications by Muhammad Azhar Iqbal, Sajjad Hussain, Huanlai Xing, Muhammad Ali Imran Wiley Pub.1stEdition 2021.

REFERENCE BOOKS:

1. Introduction Embedded Systems by K.V. Shibu Second Edition McGraw Hills–2017
2. Build your own IoT Platform Develop a Fully Flexible and Scalable Internet 33 of Things Platform in 24 Hours by Anand Tamboli 2019 Apress.

Sr. No.	**Practical Course on PGCSP105** **(Credits : 4 Lectures/Week: 3)**
Note: - The following set of practicals should be implemented in CodeVisionAVR, Proteus8, Cisco Packet Tracer, Keli V5, Python Link: -Python:https://www.python.org/downloads/ CodeVisionAVR :https://www.codevision.be/ Proteus8:https://www.labcenter.com/downloads/ Cisco Packet Tracer:https://www.netacad.com/courses/packet-tracer Keli V5: https://www.keil.com/download/	
1.	Design and implement basics embedded circuits 1. Automatic Alarm system- Alarm should get tigger by senor 2. Timer based buzzer 3. Sensor based Counting device

2.	Demonstrate communication between two embedded devices using UART port
3.	Built an IoT system to send ticket before entering the bus.
4.	Demonstrate an IoT based game which can be played between two player who are physically at a considerable distance.
5.	Develop a IoT application which will record the movement and orientation of your phone and give the data back to the PC
6.	Develop an IoT application that will raise an alarm whenever with going to rain outside based on the weather prediction data.
7.	Deploy an IoT application which will alert you by beeping or vibrating your phone whenever you get someone call your name.
8.	Develop an IoT application for monitoring water levels in tanks and automatically start the motor to fill the tank if the level goes below the critical level.
9.	Develop an IoT module to which measure the intensity of light and send the same to your PC/ Phone
10.	Develop an IoT application for Motion detection

Class: M.Sc CS Part I	**Branch**: Computer Science	**Semester:** I	
Subject : Image Processing and Pattern Recognition			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS106	Image Processing and Pattern Recognition **(Credits : 4 Lectures/Week: 4)**	
	Expected course Outcome After successful completion of this course, students would be able to 1) Define the fundamental concepts of a digital image processing system.. 2) Analyze images in the frequency domain using various transforms. 3) Evaluate the techniques for image enhancement and image restoration. 4) Develop image patterns using statistical patterns**.**	
Unit I	**Introduction to digital image processing:** Digital image representation, Digital image processing: Problems and applications, Elements of visual perception, Sampling and quantization, relationships between pixels. **Two-dimensional System:**Fourier transform and Fast Fourier Transform, Other image transforms and their properties: Cosine transform, Sine transform, Hadamard transform, Haar transform.	**15 L**
Unit II	**Image Restoration:** Image Restoration-Constrained and unconstrained restoration Wiener filter , motion blur remover, geometric and radiometric	**15 L**

	correction Image data compression-Huffman and other codes transform compression, predictive compression two tone Image compression, block coding, run length coding, and contour coding.	
Unit III	**Segmentation Techniques:** Segmentation Techniques-thresh holding approaches, region growing, relaxation, line and edge detection approaches, edge linking, supervised and unsupervised classification techniques, remotely sensed image analysis and applications, Shape Analysis – Gestalt principles, shape number, moment Fourier and other shape descriptors, Skeleton detection, Hough trans-form, topological and texture analysis, shape matching.	**15L**
Unit IV	**Pattern Recognition:** Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test. **Statistical Pattern Recognition:** Bayesian Decision Theory, Classifiers-k-NN classifier, Normal density and discriminant functions, Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods – Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM),Gaussian mixture models.	**15L**

Text book:

- R. C. Gonzalez and P. Wintz, "Digital Image Processing", Second Edition, Addison-Wesley Publishing, 1987.
- K. Castlemann. "Digital Image Processing", Prentice Hall of India Ltd., 1996.
- A. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt. Ltd., 1995.
- Digital Image Processing – Ganzalez and Wood, Addison Wesley, 1993.
- Pattern Classification – R.O. Duda, P.E. Hart and D.G. Stork, Second Edition John Wiley, 2006

References:

- Digital Picture Processing – Rosenfeld and Kak, vol.I & vol.II, Academic,1982
- Computer Vision – Ballard and Brown, Prentice Hall, 1982
- An Introduction to Digital Image Processing – Wayne Niblack, Prentice Hall, 1986
- Pattern Recognition and Machine Learning – C. M. Bishop, Springer, 2009.
- Pattern Recognition – S. Theodoridis and K. Koutroumbas, 4th Edition, Academic Press,2009

Sr. No.	**Practical Course on PGCSP106** **(Credits : 4 Lectures/Week: 3)**
1.	To study the Image Processing concept. (image acquisition, image storage, image processing and display)
2.	To obtain histogram equalization image from original image histogram.
3.	To Implement smoothing or averaging filters in spatial domain.

4.	Write a program for opening and closing of the image.
5.	Write a program to fill the region of interest for the image.
6.	Write a program to perform an edge detection algorithm.
7.	Write a program of sharpening images using gradient masks.
8.	Write Program for morphological operation: erosion and dilation.
9.	Write a Program for DCT/IDCT to express the finite sequence.
10.	Implement the k-NN classifier for an unknown image and for a general K value.

Detailed syllabus of semester – II

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** II	
Subject : Research in Computing			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS201	Research in Computing **(Credits : 4 Lectures/Week: 4)**	
	Expected Course Outcomes After successful completion of this course, students would be able to 1) Develop analytical skills by applying scientific methods. 2) Review the existing research article on Machine learning & Business analytics 3) Survey the specific research areas in the field of Computer Science. 4) Test & validate the proposed methodology on research problems.	

Unit I	**Introduction:** Role of Business Research, Information Systems and Knowledge Management, Theory Building, Organization ethics and Issues	**12L**
Unit II	**Beginning Stages of Research Process:**Problem definition, Qualitative research tools, Secondary data research	**12 L**
Unit III	**Research Methods and Data Collection:** Survey research, communicating with respondents, Observation methods, Experimental research	**12 L**
Unit IV	**Measurement Concepts, Sampling and Field work:** Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size	**12 L**
Unit-V	**Data Analysis and Presentation:** Editing and Coding, Basic Data Analysis, Univariate Statistical Analysis and Bivariate Statistical analysis and differences between two variables. Multivariate Statistical Analysis.	**12 L**

Text book:

1. Business Research Methods, William G.Zikmund, B.J Babin, J.C. Carr,Atanu Adhikari, M.Griffin, 8th Edition. 2016.
2. Business Analytics, Albright Winsto, 5th Edition,2015
3.Research Methods for Business Students Fifth Edition, Mark Saunders, 2011.
4.Multivariate Data Analysis, Hair, Pearson, 7th Edition, 2014.

References:

Links:

1)http://www.library.auckland.ac.nz/subject-guides/med/pdfs/Hindex%20and%20impact%20factors.pdf

2)www.openintro.org/stat/down/OpenIntroStatFirst.pdf

Sr. No.	**Practical Course on PGCSP201**	
1	**A**	Write a program for obtaining descriptive statistics of data.
	B	Import data from different data sources (from Excel,csv, mysql, sql server, oracle to R/Python/Excel)
2	**A**	Design a survey form for a given case study, collect the primary data and analyze it
	B	Perform suitable analysis of given secondary data.
3	**A**	Perform testing of hypothesis using one sample t-test.
	B	Perform testing of hypothesis using two sample t-test.
	C	Perform testing of hypothesis using paired t-test.
4	**A**	Perform testing of hypothesis using chi-squared goodness-of-fit test.
	B	Perform testing of hypothesis using chi-squared Test Of Independence
5		Perform testing of hypothesis using Z-test.
6	**A**	Perform testing of hypothesis using one-wayANOVA.
	B	Perform testing of hypothesis using two-wayANOVA.
	C	Perform testing of hypothesis using multivariateANOVA (MANOVA).
7	**A**	Perform the Random sampling for the given data and analyse it.
	B	Perform the Stratified sampling for the given data and analyse it.
8		Compute different types of correlation.
9	**A**	Perform linear regression for prediction.
	B	Perform polynomial regression for prediction.

10	**A**	Perform multiple linear regression.
	B	Perform Logistic regression.

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** II	
Subject : Business Intelligence and Big Data Analytics (Business Intelligence)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS202	**Elective II- Business Intelligence and Big Data Analytics (Business Intelligence)** **(Credits : 4 Lectures/Week: 4)**	
	Expected Course Outcomes After successful completion of this course, students would be able to 1. Explain the operational and decision support system. 2. Evaluate the impact of use and information using knowledge discovery in databases and KDD process models. 3. Summarize the data mining concepts with the help of Apriori algorithm, lift conviction and trees. 4. Construct data models and prototypes needed to gain stakeholder support to achieve business objectives.	
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**	**15 L**

	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.	

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

References:

- 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).

Links:

1) **http://www.vssut.ac.in/lecture_notes/lecture1428550844.pdf**
2) **https://lecturenotes.in/subject/32/data-mining-and-data-warehousing-dmdw**

Sr. No.	Practical of PGCSP202
1.	Create tables using different applications.
2.	Develop an application to design a warehouse by importing various tables from external sources
3.	Develop an application to creating a fact table and measures in a cube
4.	Develop an application to create dimension tables in a cube and form star schema.
5.	Develop an application to create dimension tables in a cube and form snowflake schema
6.	Develop an application to create a dimension table from Parent-Child schema.
7.	Develop an application to demonstrate operations like roll-up, drill-down, slice, and dice.
8.	Develop an application to demonstrate processing and browsing data from a cube.
9.	Develop an application to pre process data imported from external sources.
10.	Create association rules by considering suitable parameters.

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** III
Subject: Social Network Analysis		

Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	__	40
	Semester End Practical Examination	2	50
	Total	__	150

Course: PGCS203	**Social Network Analysis (Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Course Outcomes : After successful completion of this course, students will be able to: 1. Represents social network relationships through graph theory 2. Analyse the social network relationship and ties between different egos networks using a page ranking algorithm. 3. Compare different Similarity and dissimilarity distance measuring approaches 4. Understand and analyse two mode Bi-partite data structures.	
Unit I	**Introduction to social network analysis (SNA)** Introduction to networks and relations- analyzing relationships to understand people and groups, binary and valued relationships, symmetric and asymmetric relationships, multimode relationships, Using graph theory for social networks analysis- adjacency matrices, edge-lists, adjacency lists, graph traversals and distances, depth-first traversal, breadth-first traversal paths and walks, Dijkstra's algorithm, graph distance and graph diameter, social networks vs. link analysis, ego-centric and socio-centric density.	**15 L**
Unit II	**Networks, Centrality and centralization in SNA** Understanding networks- density, reachability, connectivity, reciprocity, group-external and group-internal ties in networks, ego networks, extracting and visualizing ego networks, structural holes, Centrality- degree of centrality, closeness and betweenness centrality, local and global centrality, centralization and graph centers, notion of importance within network, Google pagerank algorithm, Analyzing network structure bottom-up approaches using cliques, N-cliques, N-clans, K-plexes, K-cores, F-groups and top-down approaches using components, blocks and cut-points, lambda sets and bridges, and factions.	**15 L**
Unit III	**Measures of similarity and structural equivalence in SNA** Approaches to network positions and social roles- defining equivalence or similarity, structural equivalence, automorphic equivalence, finding equivalence sets, brute force and Tabu search, regular equivalence, equivalence of distances: Maxsim, regular equivalence, Measuring similarity/dissimilarity- valued relations, Pearson correlations covariance and cross-products, Understanding clustering-	**15 L**

	agglomerative and divisive clusters, Euclidean, Manhattan, and squared distances, binary relations, matches: exact, Jaccard, Hamming,	
Unit IV	**Two-mode networks for SNA** Understanding mode networks- Bi-partite data structures, visualizing two-mode data, quantitative analysis using two-mode Singular value decomposition (SVD) analysis, two-mode factor analysis, two-mode correspondence analysis, qualitative analysis using two-mode core-periphery analysis, two-mode factions analysis, affiliation and attribute networks.	**15 L**

Text book:

- Introduction to Social Network Methods: Robert A. Hanneman, Mark Riddle, University of California, 2005 [Published in digital form and available at http://faculty.ucr.edu/~hanneman/nettext/index.html].
- Social Network Analysis for Startups- Finding connections on the social web: MaksimTsvetovat, Alexander Kouznetsov, O'Reilly Media, 2011.
- Social Network Analysis- 3rd edition, John Scott, SAGE Publications, 2012.

Reference book:

- Exploratory Social Network Analysis with Pajek, Second edition: Wouter de Nooy, Andrej Mrvar, Vladimir Batagelj, Cambridge University Press, 2011.
- Analyzing Social Networks, Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications, 2013.
- Statistical Analysis of Network Data with R: Eric D. Kolaczyk, GáborCsárdi, Springer, 2014.
- Network Analysis: Methodological Foundations, (Editors) UlrikBrandes, Thomas Erlebach. Springer, 2005.
- Models and Methods in Social Network Analysis: (Editors) Peter J. Carrington, John Scott,Stanley Wasserman, Cambridge University Press, 2005.

Links:

1) http://www.faculty.ucr.edu/~hanneman/nettext/C11_Cliques.html
2) https://www.safaribooksonline.com/library/view/social-network-analysis/9781449311377/ch04.html

Sr. No.	**Practical of PGCSP203**
1.	Write a program to compute the following for a given a network: (i) number of edges, (ii) number of nodes; (iii) degree of node; (iv) node with lowest degree; (v)the adjacency list; (vi) matrix of the graph.
2.	Perform following tasks: (i) View data collection forms and/or import onemode/ two-mode datasets; (ii) Basic Networks matrices transformations
3.	Compute the following node level measures: (i) Density; (ii) Degree; (iii) Reciprocity; (iv) Transitivity; (v) Centralization; (vi) Clustering.
4.	For a given network find the following: (i) Length of the shortest path from a given node to another node; (ii) the density of the graph; (iii) Draw egocentric network of node G with chosen configuration parameters.
5.	Write a program to distinguish between a network as a matrix, a network as an edge list, and the network as a sociogram (or “network graph”) using 3 distinct networks representatives of each.

6.	Write a program to exhibit structural equivalence, automatic equivalence, and regular equivalence from a network.
7.	Create sociograms for the persons-by-persons network and the committee-by committee network for a given relevant problem. Create one-mode network and two-node network for the same.
8.	Perform SVD analysis of a network.
9.	Identify ties within the network using two-mode core periphery analysis.
10.	Find "factions" in the network using two-mode faction analysis.
Note: One may use programming languages like R, Python, Pajeketc and open software/tools like (i) EGONet; (ii) Ora; (iii) Netlogo; (iv) Pajek; and (v) NetDraw; to do the practical experiments.	

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** II	
Subject : Data visualization using R			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	__	40
	Semester End Practical Examination	2	50
	Total	__	150

Course: PGCS204	**Data visualization using R** **(Credits : 4 Lectures/Week: 3)**	
	Expected Course Outcomes After successful completion of this course, students would be able to : 1. Explain basic programming language concepts using R 2. Differentiate between different R data structures such as: string, number, vector, matrix, data frame, factor, date and time object 3. Collect detailed information raw data using R profiler 4. Visualize your data using base R graphics	
Unit I	**Overview of R :**History and Overview of R- Basic Features of R-Design of the R System- Installation of R- Console and Editor Panes- Comments- Installing and Loading R Packages- Help Files and Function DocumentationSaving Work and Exiting R- Conventions- R for Basic Math- Arithmetic- Logarithms and ExponentialsE-Notation- Assigning Objects- Vectors- Creating a Vector- Sequences, Repetition, Sorting, and Lengths- Subsetting and Element Extraction- Vector-Oriented Behaviour	**15 L**
Unit II	**Matrices And Arrays:** Defining a Matrix – Defining a Matrix- Filling Direction- Row and Column Bindings- Matrix DimensionsSubsetting- Row,	**15 L**

	Column, and Diagonal Extractions- Omitting and Overwriting- Matrix Operations and Algebra- Matrix Transpose- Identity Matrix- Matrix Addition and Subtraction- Matrix MultiplicationMatrix Inversion-Multidimensional Arrays- Subsets, Extractions, and Replacements	
Unit III	**Non-numeric Values :**Logical Values- Relational Operators- Characters- Creating a String- Concatenation- Escape SequencesSubstrings and Matching- Factors- Identifying Categories- Defining and Ordering Levels- Combining and Cutting Lists And Data Frames:Lists of Objects-Component Access-Naming-Nesting-Data Frames-Adding Data Columns and Combining Data Frames-Logical Record Subsets-SomeSpecial,Values-Infinity-NaN-NA-NULLAttributes-Object-Class-Is-Dot Object-Checking Functions-As-Dot Coercion Functions	**15 L**
Unit IV	**Basic Plotting:**Using plot with Coordinate Vectors-Graphical Parameters-Automatic Plot Types-Title and Axis LabelsColor-Line and Point Appearances-Plotting Region Limits-Adding Points, Lines, and Text to an Existing Plot-ggplot2 Package-Quick Plot with ggplot-Setting Appearance Constants with Geoms-- READING AND WRITING FILES- R-Ready Data Sets- Contributed Data Sets- Reading in External Data Files- Writing Out Data Files and Plots- Ad Hoc Object Read/Write Operations	**15 L**

TextBook:

1. https://www.cs.upc.edu/~robert/teaching/estadistica/rprogramming.pdf
2. Tilman M.Davies,"THE BOOK OF R - A FIRST PROGRAMMING AND STATISTICS" Library of Congress Cataloging-in-Publication Data,2016

References:

1. Wickham, H. & Grolemund, G. (2018). for Data Science. O'Reilly: New York. Available
2. Steven Keller, "R Programming for Beginners", CreateSpace Independent Publishing Platform 2016
3. Kun Ren ,"Learning R Programming", Packt Publishing,2016

Links:

- **https://r4ds.had.co.nz/**

Sr. No.	Practical of PGCSP204
1.	1.Develop the R program for Basic Mathematical computation –Square, Square root, exponential etc. 2. Create an object X that stores the value then overwrite the object in by itself divided by Y. Print the result to the console. 3. Create and store a sequence of values from x to y that progresses in steps of 0.3
2.	Create and store a three-dimensional array with six layers of a 4 X 2 matrix, filled with a decreasing sequence of values between 4.8 and 0.1 of the appropriate length
3.	Extract and store as a new object the fourth- and first-row elements, in that order, of the second column only of all layers of (1).
4.	1.Confirm the specific locations of elements equal to 0 in the 10 X 10 identity matrix I10 2.Store this vector of 10 values: foo <- c(7,5,6,1,2,10,8,3,8,2).Then, do the following: i. Extract the elements greater than or equal to 5, storing the result as bar. ii. Display the

	vector containing those elements from foo that remain after omitting all elements that are greater than or equal to 5.
5.	Store the string "Two 6-packs for $12.99". Then do the following: i. Use a check for equality to confirm that the substring beginning with character 5 and ending with character 10 is "6-pack". ii. Make it a better deal by changing the price to $10.99
6.	Create a list that contains, in this order, a sequence of 20 evenly spaced numbers between -4 and 4; a 3 X 3 matrix of the logical vector c(F,T,T,T,F,T,T,F,F) filled column-wise; a character vector with the two strings "don" and "quixote"; and a factor vector containing the observations c("LOW","MED","LOW","MED","MED","HIGH"). Then, Extract row elements 2 and 1 of columns 2 and 3, in that order, of the logical matrix.
7.	Create and store this data frame as dframe with the fiiels of person,sex,funny in your R workspace.Append the two new records. 3. Write a single line of code that will extract from mydataframe just the names and ages of any records where the individual is female and has a level of funniness equal to Med OR High
8.	Create a database with the fields of weight,height and sex then create a plot of weight on the x-axis and height on the y-axis. Use different point characters or colors to distinguish between males and females and provide a matching legend. Label the axes and give the plot a title.
9.	Create a plot using ggplot2 for the same database consisting of weight on the x-axis and height on the y-axis. Use different point characters or colors to distinguish between males and females and provide a matching legend. Label the axes and give the plot a title.
10.	Write R code that will plot education on the x-axis and income on the y-axis, with both x- and y-axis limits fixed to be [0;100]. Provide appropriate axis labels. For jobs with a prestige value of less than or equal to 80, use a black * as the point character. For jobs with prestige greater than 80, use a blue @.

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** II	
Subject : Cyber and Information Security (Network Security)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS205	**Elective I- Cyber and Information Security (Network Security)** **(Credits : 4 Lectures/Week: 4)**	
	Expected Course Outcomes : After successful completion of this course, students will be able to:	

	1. Identify when attacks are happening inside networks 2. Collect evidence of network intrusions 3. Test networks and systems for vulnerabilities 4. Prepare for defend against network attacks	
Unit I	**Computer Security** Principles of Security, Different Attacks: malicious and non-malicious program, Types of Computer Criminals. Protected objects and methods of protection. Memory address protection: Fence, Relocation, Base/Bound Registers, Tagged Architecture, Segmentation, Paging, Directory, access control list. Database Security: Security requirements, Integrity, Confidentiality, Availability, Reliability of Database, Sensitive data, Multilevel database, Proposals for multilevel security.	**15 L**
Unit II	**Network Security** Different types of network layer attacks, Firewall (ACL, Packet Filtering, DMZ, Alerts and Audit Trials) – IDS,IPS and its types (Signature based, Anomaly based, Policy based, Honeypot based). Web Server Security: SSL/TLS Basic Protocol-computing the keys- client authentication-PKI as deployed by SSL Attacks fixed in v3- Exportability-Encoding-Secure Elect How concepts of Security apply in the cloud, User authentication in the cloud; How the cloud provider can provide this- Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security-storage considerations, backup and recovery-Virtualization System Vulnerabilities, security management standards- SaaS, PaaS, IaaS availability management- access control- Data security and storage in cloud. ronic Transaction (SET), Kerberos	**15 L**
Unit III	**Cloud Security** How concepts of Security apply in the cloud, User authentication in the cloud; How the cloud provider can provide this- Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security-storage considerations, backup and recovery-Virtualization System Vulnerabilities, security management standards- SaaS, PaaS, IaaS availability management- access control- Data security and storage in cloud.	**15 L**
Unit IV	**Mobile Security:** Mobile system architectures, Overview of mobile cellular systems, GSM and UMTS Security & Attacks, Vulnerabilities in Cellular Services, Cellular Jamming Attacks & Mitigation, Security in Cellular VoIP Services, Mobile application security. Securing Wireless Networks: Overview of Wireless Networks, Scanning and Enumerating 802.11 Networks, Attacking 802.11 Networks, Bluetooth Scanning and Reconnaissance, Bluetooth Eavesdropping, Attacking & Exploiting Bluetooth, Zigbee Security & Attacks	**15 L**
Text book: ● Security in Computing 4th edition, Charles P. Pfleeger, Charles P. Pfleeger, Shari Lawrence Pfleeger, Prentice Hall; 4th edition (2006) ● Mobile and Wireless Security and Privacy, Kia Makki, Peter Reiher, Springer, (2007). ● Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory and practice), Tim Mather, Subra Kumaraswamy, Shahed Latif., O'Reilly Media; 1 edition (2009).		
References:		

- Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley (2010)
- Network Security, Charlie Kaufman, Radia Perlam, Mike Speciner, Prentice Hall, 2nd Edition (2002)
- Cryptography and Network Security 3rd edition, Atul Kahate, Tata McGraw Hill Education Private Limited (2013)
- Network Security, Charlie Kaufman, Radia Perlam, Mike Speciner, Prentice Hall, 2nd Edition (2002)
- Cryptography and Network Security: Principles and practice 6th edition, William Stallings, Pearson Education (2013).

Links:

1) **https://elearning.dei.unipd.it/pluginfile.php/17665/mod_resource/content/1/slides.pdf**
2) **http://www.vssut.ac.in/lecture_notes/lecture1428550736.pdf**

Sr. No.	Practical of PGCSP205
1.	Write a program to store username and password in an encrypted form in a database to implement integrity lock.
2.	Write SQL query to retrieve sensitive information from less sensitive queries
3.	Write SQL query to create a view to implement the concept of views and commutative filter in distributed databases.
4.	Write a program to implement SSL.
5.	Write a program to send an encrypted email.
6.	Write a program to digitally sign MIME to create an ‘opaque’ signature.
7.	Write a program to generate DSA SSH key.
8.	Write a program to implement multilevel security.
9.	Write a program to Demonstrates how to encrypt and decrypt the content of an XML node using 128-bit CBC AES encryption

Class: M.Sc Part I	**Branch**: Computer Science	**Semester:** II	
Subject : Machine Learning			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS206	Elective II - Machine Learning(Fundamentals of Machine Learning) (Credits : 4Lectures/Week: 3)	
	Expected Course Outcomes : After successful completion of this course, students will be able to: 1. Discuss Classification, regression, and conditional probability estimation. 2. Explain resampling methods with Linear models and nonlinearity using kernel methods.. 3. Identify the Machine Learning model to choose for each type of problem. 4. Predict the output by applying Clustering & Classification algorithm.	
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).

References:

- 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)

LINKS:

- https://class.coursera.org/ml-005/lecture/preview
- https://github.com/josephmisiti/awesome-machine-learning.

Sr. No.	Practical of PGCSP206
11.	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]
12.	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].
13.	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].
14.	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].
15.	Use bootstrap to give an estimate of a given statistic. [Datasets like Auto, Portfolio and Boston etc may be used for the purpose].
16.	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].
17.	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].
18.	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].
19.	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].

20.	Fit a support vector classifier for a given data set. [Data sets like Car, Khan, Boston etc may be used for the purpose]
21.	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.	