DEPARTMENT OF
COMPUTER SCIENCE & ENGINEERING

PG CURRICULUM (2022-23 SESSION ONWARDS)

A. PROPOSED CREDITS BREAK-UP FOR M.TECH. PROGRAMME (2022-23 ONWARDS)

CURRICULAR COMPONENTS		Credits
I.	Program Core Courses (PCC)	18
II.	Departmental Elective Courses (DEC)	6
III.	Institute Open Elective Courses	3
IV.	Design of Experiments & Research Methodology	3
V.	Seminar and Report Writing	2
VI.	Engineering Mathematics	3
VII.	Soft Computing / Soft Skills & Management	3
VIII.	Industrial Tour	0
IX.	Research and Publication Ethics	2
X.	Dissertation / Industry Project	32
Grand Total		**72**

B. Proposed Semester wise PG Scheme to be implemented w.e.f. 2022-23 session

SEMESTER-I		
S. No.	**Courses**	**Credits**
1.	Program Core Course (PCC-I)	3
2.	Program Core Course (PCC-II)	3
3.	Program Core Course (PCC-III)	3
4.	Department Elective Course (DEC-I)	3
5.	Design of Experiments & Research Methodology (CB) / Engineering Mathematics (NCB)	3
6.	Soft Computing / Soft Skills & Management	3
Total		**18**

SEMESTER-II		
S. No.	**Courses**	**Credits**
1.	Program Core Course (PCC-IV)	3
2.	Program Core Course (PCC-V)	3
3.	Program Core Course (PCC-VI)	3
4.	Department Elective Course (DEC-II)	3
5.	Open Elective	3
6.	Engineering Mathematics (CB) / Design of Experiments & Research Methodology (NCB)	3
7.	Industrial Tour	0
Total		**18**

SEMESTER-III		
S. No.	**Courses**	**Credits**
1.	Seminar and Report Writing	2
2.	Research and Publication Ethics	2
3.	Dissertation - I	14
Total		**18**

SEMESTER-IV		
S. No.	**Courses**	**Credits**
1.	Dissertation-II	18
Total		**18**

Total Credits = 18 + 18 + 18 + 18 = 72

Note:

* Industrial Tour will be held in winter vacation after 1st semester and it will be recorded in 2nd semester

** In the first and second semester, at least one of the Program Core Courses should have laboratory component.

Abbreviation

CB : Circuital Branches (CSE, CSIS, Electrical, VLSI, Healthcare, Energy System)

NCB: Non-circuital branches (Aerospace, Environmental, Transportation, Water Resources, Structural, Mechanical, IMM & Production)

C. TEACHING SCHEME

First Year

Semester I

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 1101	Advanced Data Structures and Algorithms	2	0	2	3	PCC-I
2.	CSR 1102	Artificial Intelligence and Data Analysis	2	0	2	3	PCC-II
3.	CSR 1103	Special Topics in Wireless and Mobile Networks	2	0	2	3	PCC-III
4.	CSR 1201 to CSR 1211	Department Elective Course-I	2	0	2	3	DEC-I
5.	CSR 1001	Design of Experiments & Research Methodology (CB) / Engineering Mathematics (NCB)	2	0	2	3	DERM Maths
6.	SCR 1001 / SMR 1001	Soft Computing / Soft Skills & Management	2	0	2	3	
					Total Credits	18	

CB : Circuital Branches (CSE, CSIS, Electrical, VLSI, Healthcare, Energy System)
NCB: Non-circuital branches (Aerospace, Environmental, Transportation, Water Resources, Structural, Mechanical, IMM & Production)

Department Elective Course - I (DEC-I)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 1201	Cloud Computing	2	0	2	3
2.	CSR 1202	Explainable Artificial Intelligence	2	0	2	3
3.	CSR 1203	Natural Language Processing	2	0	2	3
4.	CSR 1204	Cryptography and Network Security	2	0	2	3
5.	CSR 1205	Big Data Analytics	2	0	2	3
6.	CSR 1206	Human and Computer Interaction	2	0	2	3
7.	CSR 1207	Information Retrieval	2	0	2	3
8.	CSR 1208	Data warehouse and data mining	2	0	2	3
9.	CSR 1209	Computer Vision	2	0	2	3
10.	CSR 1210	Cluster and Grid Computing	2	0	2	3
11.	CSR 1211	Cloud Native Services	2	0	2	3

Semester II

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 1104	Distributed & High Performance Computing	2	0	2	3	PCC-IV
2.	CSR 1105	Software Testing Techniques	2	0	2	3	PCC-V
3.	CSR 1106	Advanced IOT	2	0	2	3	PCC-VI
4.	CSR 1251 to CSR 1261	Department Elective Course-II	2	0	2	3	DEC-II
5.	CSR 3001 to CSR 3005	Open Elective	2	0	2	3	OE
6.	CSR 1001	Engineering Mathematics (CB) / Design of Experiments & Research Methodology (NCB)	2	0	2	3	Maths DERM
7.	CSR 4001	Industrial Tour				0	
					Total Credits	18	

CB : Circuital Branches (CSE, CSIS, Electrical, VLSI, Healthcare, Energy System)
NCB: Non-circuital branches (Aerospace, Environmental, Transportation, Water Resources, Structural, Mechanical, IMM & Production)

Department Elective Course - II (DEC-II)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 1251	Wireless Sensor Networks	2	0	2	3
2.	CSR 1252	Data Science	2	0	2	3
3.	CSR 1253	Logic and Functional Programming	2	0	2	3
4.	CSR 1254	Bioinformatics	2	0	2	3
5.	CSR 1255	Intelligent Systems	2	0	2	3
6.	CSR 1256	Advanced Computer Networks	2	0	2	3
7.	CSR 1257	Advanced Machine Learning	2	0	2	3
8.	CSR 1258	Blockchain and Cryptocurrency	2	0	2	3
9.	CSR 1259	Software Defined Networks	2	0	2	3
10.	CSR 1260	Recommender System	2	0	2	3
11.	CSR 1261	Container Micro Services	2	0	2	3

Open Elective (OE)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 3001	Data Science	2	0	2	3
2.	CSR 3002	Internet of Things	2	0	2	3
3.	CSR 3003	Machine Learning	2	0	2	3
4.	CSR 3004	Software Project Management	2	0	2	3
5.	CSR 3005	Mobile Computing	2	0	2	3

Second Year

Semester III

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 5001	Seminar and Report Writing	2	0	0	2	Seminar
2.	RPR 6001	Research and Publication Ethics				2	RPE
3.	CSR 7001	Dissertation-I	0	0	28	14	Dissertation
					Total Credits	18	

Semester IV

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 8001	Dissertation-II	0	0	36	18	Dissertation
					Total Credits	18	

D. LIST OF COURSES

I. List of Program Core Courses (PCC) – 18 credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	CSR 1101	Advanced Data Structures and Algorithms	2	0	2	3	PCC-I
2.	CSR 1102	Artificial Intelligence and Data Analysis	2	0	2	3	PCC-II
3.	CSR 1103	Special Topics in Wireless and Mobile Networks	2	0	2	3	PCC-III
Semester II							
4.	CSR 1104	Distributed & High Performance Computing	2	0	2	3	PCC-IV
5.	CSR 1105	Software Testing Techniques	2	0	2	3	PCC-V
6.	CSR 1106	Advanced IOT	2	0	2	3	PCC-VI
					Total Credits	18	

II. List of Department Elective Courses (DEC) – 6 credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							

1.	CSR 1201 to CSR 1211	Department Elective Course – I (DEC-I)	2	0	2	3	DEC-I
Semester II							
2.	CSR 1251 to CSR 1261	Department Elective Course – II (DEC-II)	2	0	2	3	DEC-II
					Total Credits	6	

Department Elective Course - I (DEC-I)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 1201	Cloud Computing	2	0	2	3
2.	CSR 1202	Explainable Artificial Intelligence	2	0	2	3
3.	CSR 1203	Natural Language Processing	2	0	2	3
4.	CSR 1204	Cryptography and Network Security	2	0	2	3
5.	CSR 1205	Big Data Analytics	2	0	2	3
6.	CSR 1206	Human and Computer Interaction	2	0	2	3
7.	CSR 1207	Information Retrieval	2	0	2	3
8.	CSR 1208	Data warehouse and data mining	2	0	2	3
9.	CSR 1209	Computer Vision	2	0	2	3
10.	CSR 1210	Cluster and Grid Computing	2	0	2	3
11.	CSR 1211	Cloud Native Services	2	0	2	3

Department Elective Course - II (DEC-II)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 1251	Wireless Sensor Networks	2	0	2	3
2.	CSR 1252	Data Science	2	0	2	3
3.	CSR 1253	Logic and Functional Programming	2	0	2	3
4.	CSR 1254	Bioinformatics	2	0	2	3
5.	CSR 1255	Intelligent Systems	2	0	2	3
6.	CSR 1256	Advanced Computer Networks	2	0	2	3
7.	CSR 1257	Advanced Machine Learning	2	0	2	3
8.	CSR 1258	Blockchain and Cryptocurrency	2	0	2	3
9.	CSR 1259	Software Defined Networks	2	0	2	3
10.	CSR 1260	Recommender System	2	0	2	3
11.	CSR 1261	Container Micro Services	2	0	2	3

III. List of Open Elective Courses – 3 credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester II							
1.	CSR 3001 to	Open Elective	2	0	2	3	OE

	CSR 3005						
					Total Credits	3	

*Open Elective courses will not be offered to M.Tech. (CSE) students

Open Elective – I (OE-I)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 3001	Data Science	2	0	2	3
2.	CSR 3002	Internet of Things	2	0	2	3
3.	CSR 3003	Machine Learning	2	0	2	3
4.	CSR 3004	Software Project Management	2	0	2	3
5.	CSR 3005	Mobile Computing	2	0	2	3

IV. List of Other Courses – 45 credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	CSR 1001	Design of Experiments & Research Methodology (CB) / Engineering Mathematics (NCB)	2	0	2	3	DERM Maths
2.	SCR 1001 / SMR 1001	Soft Computing / Soft Skills & Management	2	0	2	3	
Semester II							
3.	CSR 1001	Engineering Mathematics (CB) / Design of Experiments & Research Methodology (NCB)	2	0	2	3	Maths DERM
4.		Industrial Tour	0	0	0	0	
Semester III							
5.	CSR 5001	Seminar and Report Writing	2	0	0	2	Seminar
6.	RPR 6001	Research and Publication Ethics				2	RPE
7.	CSR 7001	Dissertation - I	0	0	28	14	Dissertation
Semester IV							
8.	CSR 8001	Dissertation-II	0	0	36	18	Dissertation
					Total Credits	45	

M.Tech. (CSE) Program Educational Objectives (PEOs)

- **PEO 1:** To develop professionals with strong theoretical fundamentals and practical skills.
- **PEO 2:** To enable graduates to acquire research and development competence to sustain in academia, research and industry.
- **PEO 3:** To keep abreast with latest area & research in Computer Science and Engineering and its applications in all allied areas.

M.Tech. (CSE) Program Outcomes (POs)

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Detailed Syllabus

Semester I

Semester I

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 1101	Advanced Data Structures and Algorithms	2	0	2	3	PCC-I
2.	CSR 1102	Artificial Intelligence and Data Analysis	2	0	2	3	PCC-II
3.	CSR 1103	Special Topics in Wireless and Mobile Networks	2	0	2	3	PCC-III
4.	CSR 1201 to CSR 1211	Department Elective Course-I	2	0	2	3	DEC-I
5.	CSR 1001	Design of Experiments & Research Methodology (CB) / Engineering Mathematics (NCB)	2	0	2	3	DERM Maths
6.	SCR 1001 / SMR 1001	Soft Computing / Soft Skills & Management	2	0	2	3	
					Total Credits	18	

CB : Circuital Branches (CSE, CSIS, Electrical, VLSI, Healthcare, Energy System)
NCB: Non-circuital branches (Aerospace, Environmental, Transportation, Water Resources, Structural, Mechanical, IMM & Production)

Department Elective Course - I (DEC-I)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 1201	Cloud Computing	2	0	2	3
2.	CSR 1202	Explainable Artificial Intelligence	2	0	2	3
3.	CSR 1203	Natural Language Processing	2	0	2	3
4.	CSR 1204	Cryptography and Network Security	2	0	2	3
5.	CSR 1205	Big Data Analytics	2	0	2	3
6.	CSR 1206	Human and Computer Interaction	2	0	2	3
7.	CSR 1207	Information Retrieval	2	0	2	3
8.	CSR 1208	Data warehouse and data mining	2	0	2	3
9.	CSR 1209	Computer Vision	2	0	2	3
10.	CSR 1210	Cluster and Grid Computing	2	0	2	3
11.	CSR 1211	Cloud Native Services	2	0	2	3

Course Name	**:**	**Advanced Data Structures & Algorithms**
Course Code	**:**	**CSR 1101**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of course	**:**	**Program Core Course – I (PCC-I)**

Course Objectives:	
1.	To choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem. To understand the necessary mathematical abstraction to solve problems. To familiarize students with advanced paradigms and data structure used to solve algorithmic problems. To come up with analysis of efficiency and proofs of correctness
2.	To understand different classes of problems. To analyze and compare multiple algorithms for same problem. To introduce students with recent development in area of algorithmic design.

Total No. of Lectures – 28
Total No. of Lab hrs. – 28

Sr No.	**Course contents**	**Number of Lectures**
1.	**Dictionaries and hashing:** Definition, Dictionary Abstract Data Type, Implementation of Dictionaries, Double Hashing, Rehashing, Extendible Hashing.	3
2.	**Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	3
3.	**Text Processing:** Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, Compressed Trees, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	5
4.	**Trees:** Red Black Trees, 2-3 Trees, B-Trees, Splay Trees **LOWER BOUND THEORY AND COMPELXITY CLASSES**	3
5.	**Graph Algorithms:** Bellman-Ford shortest path, Floyd Warshall shortest path, Topological sorting, Euler Path and Circuit	4
6.	**Approximation Algorithms** One Way of Coping with NP Hardness. Introduction to Randomized Algorithms, Approximation Algorithms, Parallel Algorithms	5
7.	**Amortized Analysis:** Aggregation method, Accounting method, Potential method, The disjoint set union problem.	3
8.	**Parallel algorithm and External Memory algorithm:** Pointer Jumping and Parallel Prefix. Tree Contraction	2

Sr No.	**Lab contents**	**Number of Hours**
1.	Project related to applications of hashing techniques	4
2.	Small text Processing application to compare different string processing algorithms	4
3.	Build application using tree data structures	6
4.	Practical comparison of regular and Fibonacci heaps	3
5.	String matching with errors	2
6.	Lossless data compression with suffix trees	4
7.	Discovering shortest routes between Indian railroad stations	5

Bibliography:

Sr No.	Book Detail	Year of Publication
1.	Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 4th Edition, Pearson	2014
2.	M T Goodrich, Roberto Tamassia, Algorithm Design and Applications, John Wiley	2014
3.	Bradley N. Miller, David L. Ranum, Problem Solving with Algorithms and Data Structures Using Python, Franklin, Beedle & Associates	2011
4.	Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithms", Prentice Hall of India.	2009
5.	Brassard, Bratley, "Fundamentals of algorithms", Prentice Hall of India.	1996
6.	Knuth, "The Art of Computer Programming", Vol. I-III, Pearson Education.	2008
7.	Kleinberg and Tardos, "Algorithm Design", Pearson Addison-Wesley	2011

Available MOOCS:

1. http://nptel.ac.in/courses/106106133/
2. https://www.edx.org/course/data-structures-fundamentals-uc-san-diegox-algs201x
3. https://www.coursera.org/learn/advanced-algorithms-and-complexity
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-854j-advanced-algorithms-fall-2005/

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Develop algorithms for text processing applications	Create
2	Evaluate, compare and design efficient solution for a given problem and implement latest paradigms in algorithm design	Apply and Evaluate
3	To understand suitable data structures and know about algorithms for computational geometry	Understanding and Knowledge
4	Understand the implementation of symbol table using hashing techniques.	Understand
5	Develop and analyze algorithms for red-black trees, B-trees and Splay trees	Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	3	1	2
2	2	1	3
3	2	-	3
4	2	1	1
5	3	1	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Artificial Intelligence and Data Analysis**
Course Code	**:**	**CSR 1102**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Program Core Course – II (PCC-II)**

Course Objectives:
1. To cover modern paradigms of AI for real world problem solving 2. To introduce the methods for data preparation and understanding multivariate data by summarizing it through statistical methods and graphical methods.

Total No. of Lectures: 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction:** Introduction to AI, Intelligent Agents, Problem solving, ethics in AI	4
2	**Knowledge, Reasoning and Planning:** Logical Agents, Planning and acting in real world, Current trends in Knowledge Representation and Reasoning	5
3	**Learning, Communicating, Perceiving and Acting:** Learning from examples, Learning by advice, explanation based learning, learning in problem solving, Communication, Natural Language Processing, Computer Vision	4
4	**Introduction to Exploratory Data Analysis and Preprocessing** Exploratory Data Analysis (EDA): Definition, Motivation, Steps in data exploration, Data Types, Data Type Portability Preprocessing: Introduction to Missing data, Traditional methods for dealing with missing data, Maximum Likelihood Estimation: Basics, Missing data handling, Improving the accuracy of analysis	5
5	**Data Summarization, Data Visualization and Outlier Analysis** Statistical data elaboration, 1-D Statistical data analysis, 2-D Statistical data analysis, N-D Statistical data analysis Introduction to Outlier Analysis, Extreme Value Analysis, Clustering based, Distance Based and Density Based outlier analysis	5
6	**Feature Subset Selection and Dimensionality Reduction** Feature selection algorithms: filter methods, wrapper methods and embedded methods, Forward selection, backward elimination Introduction to dimensionality reduction techniques, Principal Component Analysis	5

Total no. of hours: 28

List of Experiments:		**Number of turns**
1	Implement various problem solving techniques	6
2	Implement various techniques of knowledge representation and planning	6
3	Implement various preprocessing techniques for handling missing values	4
4	Implement various data visualization and outlier handling techniques	6
5	Implement feature selection and dimensionality reduction techniques	6

Sr. No.	Name of Book/ Authors/ Publisher	Year of publication
1	S. RUSSEL, P. NORVIG, "Artificial Intelligence: A Modern Approach", Pearson, 3rd Edition.	2015
2	E. RICH, K. KNIGHT, S. B. NAIR, "Artificial Intelligence", McGraw Hill Education, 3rd Edition	2017
3	Inge Koch, "Analysis of Multivariate and High dimensional data", Cambridge University Press	2014
4	Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC press	2015

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs42/preview
2. https://www.coursera.org/learn/introduction-to-ai
3. https://onlinecourses.swayam2.ac.in/cec20_cs10/preview

Course Outcomes: At the end of the course, students will be able to:	
1	Develop an understanding of modern concepts in AI and where they can be used
2	Design, implement and apply novel AI techniques based on emerging real-world Requirements
3	Handle missing data in the real world data sets by choosing appropriate methods
4	Summarize data using statistical methods and visualize the data using graphs and plots
5	Analyse and choose appropriate feature selection and dimensionality reduction

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	1	1
CO5	2	1	1

1-Low, 2-Medium, 3-High

Course Name	**Special Topics in Wireless and Mobile Networks**
Course Code	**CSR 1103**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Program Core Course – III (PCC-III)**

Course Objectives:

1. To introduce the fundamentals of the wireless and mobile networks
2. To learn the architecture and issues related to wireless LAN, PAN and WAN and mobility issues
3. To understand the functioning of different types of wireless networks including mobile adhoc and sensor networks and security issues

Course Contents: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	**Wireless and Mobile networking fundamentals** Wireless transmission and networking, Multiple Access Technologies- CDMA, FDMA, TDMA, Cellular architecture, Frequency reuse, Channel assignment strategies, Spread spectrum Technologies	6
2.	**Wireless LAN, PAN, WAN** Wireless LANs - IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node Problems, Wireless PANs - Bluetooth AND Zigbee, Introduction to Wireless Sensors, Introduction to Vehicular Adhoc Networks Wireless WANs – 2G, 3G, 4G, 5G, 6G, Protocols for digital cellular systems such as GSM, EDGE, GPRS, UTMS	6
3.	**Mobile network and transport layer** Mobile IP, DHCP, traditional TCP, classical TCP improvements, support for mobility	6
4.	**Ad hoc & Sensor Networks** Adhoc network routing protocols - Destination sequenced distance vector algorithm, Cluster based gateway switch routing, Ad hoc on-demand routing, Location aided routing, Zonal routing algorithm. Sensor networks - fundamentals, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS	6
5.	**Security in wireless and mobile Networks** Vulnerabilities, Security techniques, Wi-Fi Security, IEEE 802.11x and IEEE 802.11i standards, DoS in wireless communication	4

List of experiments:		**No. of Turns**
1.	Understanding and configuring several networking devices such as routers, computers, cables, wireless router, access points etc.	2
2.	Measuring signal power strength, throughput, and delays of a wireless network	2
3.	Experiments for ad hoc routing in a multi-hop wireless network and experiments for a network of wireless sensor nodes and motes.	4
4.	Discovering devices, building ad hoc net, increasing the coverage of the wireless net, using static or mobile nodes, etc.	2
5.	Simulation of various mobile and wireless network protocols, evaluate and analyse network performance	4

Suggested Books:

Sr. No.	Name of books / Author/ Publisher
1.	Schiller J., Mobile Communications, Addison Wesley
2.	Stallings W., Wireless Communications and Networks, Pearson Education
3.	Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc
4.	Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc
5.	Pandya Raj, Mobile and Personal Communications Systems and Services, PHI

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_ee66/preview
2. https://www.coursera.org/lecture/wireless-communications/6-3-mobile-network-qxAtk

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Understand the concepts and characteristics of wireless signals and transmission channels	Understanding
2	List the various types of multiple radio access techniques, and be able to apply in cellular and underlying propagation and performance analysis	Explain, Apply
3	Design the wireless LAN and identify the various design issues of WLAN and its architecture	Create
4	Demonstrate the working principles of various mobile networks and their security issues	Knowledge
5	Distinguish the characteristics, working principles and design issues of various wireless networks	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	3
2	2	2	3
3	3	3	3
4	3	2	3
5	3	2	3

1-Low, 2-Medium, 3-High

Course Name	**Cloud Computing**
Course code	**CSR 1201**
L T P	**2 0 2**
Credits	**3**
Type of course	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. Understand the concepts, processes and practices for secure information within Cloud infrastructures
2. Learn basic Cloud types and delivery models.
3. Understand risk and compliance for each Cloud type and service delivery model

Course Contents: **Total no. of lectures: 28**

Introduction: Cloud-definition, benefits, usage scenarios, History of Cloud Computing – Cloud Architecture – Types of Clouds – Business models around Clouds – Major Players in Cloud Computing – issues in Clouds – Eucalyptus – Nimbus – Open Nebula, CloudSim, Risks Involved in Cloud Computing. 4 hrs

Cloud Services: Types of Cloud services: Software as a service – Platform as a Service – Infrastructure as a Service – database as a Service – Monitoring as a Service – Communication as services. Service providers – Google, Amazon, Microsoft Azure, IBM, Salesforce. 4 Hrs

Collaborating Using Cloud Services: Email Communication over the Cloud – CRM Management – Project Management – Event Management – Task Management – Calendar – Schedules – Word Processing – Presentation – Spreadsheet – Databases – Desktop – Social Networks and Groupware, Work Loan Management in Cloud. 4Hrs

Virtualization for Cloud: Need for Virtualization – Pros and cons of Virtualization – Types of Virtualization – System Vm, Process VM, Virtual Machine monitor – Virtual machine properties – Interpretation and binary translation, HLL VM – Hypervisors – Xen, KVM, VMWare, Virtual Box, Hyper-V. Collaborating via Web - Based Communication Tools - Evaluating Web Mail Services – Evaluating Web Conference Tools – Collaborating via Social Networks and Groupware - Collaborating via Blogs and Wikis. 8Hrs

Security, Standards and Applications: Security in Cloud: Issues in information Security, Security Models, Cloud security challenges – Software as a Service, Common Standards: The Open Cloud Consortium – The Distributed Management Task Force – Standards for application Developer – Standards for Messaging – Standards for Security, End user access to cloud computing, Mobile Internet devices and the cloud. 8 Hrs

Lab Work:

Sr. No.	List of Experiments	Number of Turns
1.	Installation & configuration of Hadoop	2
2.	Using Hadoop for counting word frequency with map reduce	1
3.	Service deployment research & uses over cloud- Google app & Amazon web services	3

4	Performance evaluation of services over cloud- Google App &Amazon Web Services	2
5.	Design and deploy a private cloud using open source tools	1
6	Project work for Design of cloud environment using open source	5

TEXT BOOKS, AND/OR REFERENCE MATERIAL

1. K Jayaswal, J Kallakurchi, DJ Houde, and D Shah, "Cloud Computing Black Book" 1st edition, 2018.
2. Z Mahmood and R puttini, "Cloud Computing Concepts Technology & Architecture", 1st edition, 2014
3. John Rittinghouse and James Ransome, Cloud Computing, Implementation, Management and Strategy, CRC Press, 2010.
4. David E. Y. Sarna Implementing and Developing Cloud Application, CRC press 2011.

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. https://www.coursera.org/specializations/cloud-computing
3. https://www.edx.org/learn/cloud-computing

COURSE OUTCOMES

After the course completion, the student will be able to

CO1. Understand cloud computing models and architecture.

CO2. Understand security implications in cloud computing.

CO3. Analyse the operation, implementation and performance of cloud computing systems, and the relative merits and suitability of each for complex data-intensive applications.

CO4. Analyse the migration risks and cost in Cloud Computing.

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

Course Outcomes	**Programme Outcomes**		
	PO1	PO2	PO3
CO1	1	-	1
CO2	-	-	2
CO3	1	-	3
CO4	2	-	1

Course Name	**Explainable Artificial Intelligence**
Course code	**CSR 1202**
L T P	**2 0 2**
Credits	**3**
Type of course	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. To learn the concept of Explainable AI and related techniques.
2. To learn the evaluation of machine learning models using various XAI techniques.
3. To understand various performance evaluation metrics as well as open source tools for application specific implementation.

Pre-requites: Python Programming, Probability and Distributions, Machine learning

Course Contents: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Introduction to XAI: definition, black-box models, transparency, interpretable machine learning and explanations, trust and acceptance; Decision Making and Decision Support System (DSS): history of DSS, principles of intelligence and cognition, probabilistic decision theory, problem of understanding context; Importance of Interpretability, Taxonomy of Interpretability Methods, Scope of Interpretability, Evaluation of Interpretability, Properties of Explanations, Human-friendly Explanations Ethical, Legal and Social issues of explainable AI.	5
2.	Explanation Methods and Transparent Machine Learning Algorithms: Global vs. Local explainability, Ante-hoc and Post-hoc interpretability; Ante-Hoc: GAM, S-HOG, decision trees, decision rules, Hybrid models, iML (interactive Machine Learning); Post-Hoc: LIME (Local Interpretable Model Agnostic Explanations), SHAP, BETA (Black Box Explanation through Transparent Approximation), LRP (Layer-wise Relevance Propagation); Making neural networks neutral, explanation interfaces, visual explanations.	9
3.	Example based Explanations: Counterfactual Explanations, Adversarial Examples, Prototypes and Criticisms, Influential Instances. Performance measures: confusion matrix, ROC, AOC; Hypothesis testing and estimating, Comparison of machine learning algorithms, Measuring beyond accuracy (simplicity, scalability, interpretability, learnability), Visual explanations: setting up of Python environment, transparent models and RuleFit, Partial dependency plots.	9
4.	Case Studies, Examples and Applications of XAI: Autonomous vehicles, Healthcare and medicine, Manufacturing and Marketing, Fraud detection, Insurance. XAI Challenges and Future: properties of Explanation, Categories of Explanation; Formalization of Explanation Techniques and Evaluations, Adoption of Interpretable Techniques, Human-Machine Collaboration, Collective Intelligence from Multiple Disciplines, Responsible AI (RAI), XAI and Security, Causality and XAI	5

Lab Work:	**No. of labs: 14**
Each lab sessions will be aimed to implement explanation methods and machine learning models under different categories through programming paradigms and tools, and open-source platforms like Python, R, and SQL, Jupyter notebooks, RStudio IDE, IBM Watson Studio	

SUGGESTED BOOKS:

Text books:

1. Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning by Uday Kamath and John Liu, 2021

2. Interpretable Machine Learning by Christoph Molnar, Lulu.com, 2020
3. Hands-On Explainable AI (XAI) with Python by Denis Rothman, Packt Publishing, 2020

Reference books:

1. Interpretable Machine Learning with Python by Serg Masis, Packt Publishing, 2021

Available MOOCS:

1. https://nptel.ac.in/courses/106105077
2. https://www.classcentral.com/course/linkedin-learning-learning-xai-explainable-artificial-intelligence-30590
3. https://www.coursera.org/lecture/detect-mitigate-ethical-risks/explainable-ai-zVudJ

Couse Outcomes and Blooms Level mapping:

	Description	Blooms level of taxonomy
1	**Understand** the concepts within Explainable AI and interpretable machine learning	Understanding
2	**Describe** the comprehension of current techniques for generating explanations from black-box machine learning methods	Apply
3	**Implement** and demonstrate post-hoc and ante-hoc explainability models for various example applications	Create
4	**Study** the current ethical, social and legal challenges related to Explainable AI	Knowledge
5	**Compare** and critically assess the Explainable AI methods	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

Course Outcomes (COs)	Program Outcomes (POs)		
	PO1	PO2	PO3
CO1	3	1	1
CO2	3	1	2
CO3	3	2	2
CO4	2	-	2
CO5	2	3	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Natural Language Processing**
Course Code	**:**	**CSR 1203**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of course	**:**	**Department Elective Course – I (DEC-I)**

Course Objectives:

The main objectives of this course are:	
1	To understand the language structure and tools that are available to efficiently study and analyse large collections of texts
2	To gain knowledge for various tasks related to language processing, information extraction and machine translation.

Course Contents:

Lecture wise breakup		**Number of Lectures**
1	INTRODUCTION NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. Brief review of Regular Expressions, Finite Automata and Morphological Parsing.	4
2	N-Gram Language Models The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models. Part of Speech Tagging and Sequence Labeling: Lexical syntax. Hidden Markov Models, Viterbi algorithm.	6
3	SYNTACTIC PARSING Grammar Rules, Treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs.	6
4	SEMANTIC ANALYSIS Lexical semantics and word-sense disambiguation. Logical Representations of Sentence Meaning, Semantic Role Labeling, Discourse Coherence	5
5	INFORMATION EXTRACTION AND MACHINE TRANSLATION Named Entity Recognition, Coreference Resolution, Relation Extraction. Basic issues in Machine Translation. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.	7

Lab work

Sr No	**Lab Contents**	No. of Hours
1	To explore tools for automatic language processing, information extraction and machine translation	8
2	Implementation with N grams, POS tagging, Hidden Markov Model, statistical and probabilistic parsing, semantic role labeling	20

References

Sr No	Book detail	Year of Publication
1	Speech and Language Processing by Daniel Jurafsky and James H Martin., 3rd ed draft. Available online https://web.stanford.edu/~jurafsky/slp3/	
2	Natural Language understanding by James Allen, Pearson Education	2008
3	NLP: A Paninian Perspective by Akshar Bharati, Vineet Chaitanya, and Rajeev Sangal, Prentice Hall	1995
4	Meaning and Grammar by G. Chirchia and S. McConnell Ginet, MIT Press	2000
5	Natural Language Processing and Information Retrieval by T.Siddiqui, U.S. Tiwary, OUP.	2008

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs56/preview
2. https://www.coursera.org/specializations/natural-language-processing

Course Outcomes: At the end of the course, students will be able to:	
1	To understand the challenges of language processing, information extraction and translation.
2	To apply natural language concepts for various language based applications
3	To analyse the language constructs for language processing
4	To evaluate the language based techniques for processing applications
5	To design solutions for natural language processing, information extraction and translation

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	PO1	PO2	PO3
CO1	2	2	1
CO2	2	2	1
CO3	3	2	1
CO4	2	1	1
CO5	3	2	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Cryptography & Network Security**
Course Code	**:**	**CSR 1204**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of course	**:**	**Department Elective Course – I (DEC-I)**

Course Objectives:

The main objectives of this course are:	
1	To understand basic design principals of symmetric and asymmetric cryptography and learn how standard cryptanalytic attacks work and thereby how to avoid common design flaws.
2	To gain knowledge of the technologies and security tools for deployment and maintenance of a secure network.

Course Contents

Lecture wise breakup		**Number of Lectures**
1	Introduction - Security mindset, Computer Security Concepts (CIA), Threats, Attacks and Assets.	2
2	Cryptographic Protocols - Introduction to Protocols, Communications using Symmetric Cryptography, Substitution Ciphers and Transposition Cipher, Block Cipher, Stream Cipher, Modes of Operation, Symmetric and Asymmetric cryptography	3
3	Cryptographic Techniques - Key Length & Management: Symmetric Key Length, Public-Key Key Length, Comparing Symmetric and Public- Key Key Length, Generating Keys, Algorithms: DIFFIE-HELLMAN, RSA, DES. Elliptic Curve Cryptosystems	7
4	Practical Cryptography –Encryption, authentication, hashing, Symmetric and Asymmetric cryptography, Digital Signatures and Certificates	2
5	Network Security and Protocol Standards – Network security issues, sniffing, IP Spoofing, Common threats, E-mail security, Secure Socket Layer (SSL), Transport Layer Security (TLS), SSH, IPSEC, Pretty Good Privacy (PGP), Intruders, Virus, Worms, Firewalls-need and features of firewall, Types of firewall, Intruder Detection Systems.	8
6	Application Layer Protocol Attacks and Defense mechanisms: DNS spoofing attacks, DNS cache poisoning attacks, organization activity finger printing using DNS, SMTP vulnerability and Hacking Exploits, Mails relays, SMTP Security and Controls, HTTP hacking, Buffer Overflow Attacks, SQL Injection, Cross Side Scripting HTTP security and controls	6

Lab work

Sr No	**Lab Contents**	**No. of Hours**
1	Implementation of key exchange, symmetric and asymmetric algorithms, signature schemes.	14
2	Practical Use of Network Security Tools, Email Header Analysis, Packet sniffing, configuration of network security equipment such as firewall, routers, IDS, Wireless Access Points. Explore security solutions for Web application vulnerabilities.	14

References

Sr No	Book detail	Year of Publication
1	Introduction to Modern Cryptography by Jonathan Katz and Yehuda Lindell, CRC Press	2014
2	Cryptography and Network Security by William Stallings, Prentice Hall. ISBN 0-13-187316-4	2006
3	Handbook of Applied Cryptography by Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, CRC Press	2000
4	Applied Cryptography: Protocols, Algorithms and Source Code in C by Bruce Schneier, John Wiley and Sons	2017
5	Cryptography Theory and Practice by Douglas R. Stinson: 3rd ed., Chapman & Hall/CRC.	2006
6	Security Engineering by Ross Anderson, Wiley, 2nd ed Available online: http://www. cl.cam.ac.uk/~rja14/book.html.	
7	Security in Computing by C.P. Pfleeger, S.L. Pfleeger, J. Margulies, Prentice Hall, 5th ed.	2015
8	Secure Programming HOWTO by David Wheeler. Available online: https://www. dwheeler.com/secure-programs/.	

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2. https://www.coursera.org/lecture/managing-network-cybersecurity/cryptography-and-network-security-w9SuJ

Course Outcomes: At the end of the course, students will be able to:	
1	Understand the cryptographic principles
2	Apply the basic rules of public key and symmetric encryption for practical cryptographic problems
3	Demonstrate the design and use of hash functions, digital signatures, and key distribution with a wide range of key types.
4	To evaluate various security issues and understand solutions for it.
5	To design/develop/ implement the security solution for a given application

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	PO1	PO2	PO3
CO1	1	2	1
CO2	2	2	1
CO3	2	2	1
CO4	2	1	1
CO5	3	2	2

1-Low, 2-Medium, 3-High

Course Name	**Big Data Analytics**
Course Code	**CSR 1205**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. To study the programming aspects of cloud computing with a view to rapid prototyping of complex applications.
2. To understand the basic technologies and specialized aspects of big data including big data application, and big data analytics.
3. To study different types Case studies on the current research and applications of the Hadoop and big data in industry**.**

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Hadoop Distributed File System Basics, Running Example Programs and Benchmarks, Hadoop MapReduce Framework, Map Reduce Programming	6
2.	Essential Hadoop Tools, Hadoop YARN Applications, Managing Hadoop with Apache Ambari, Basic Hadoop Administration Procedures	7
3.	Business Intelligence Concepts and Application, Data Warehousing, Data Mining, Data Visualization, Decision Trees, Regression, Artificial Neural Networks, Cluster Analysis, Association Rule Mining	8
4.	Text Mining, Naïve-Bayes Analysis, Support Vector Machines, Web Mining, Social Network Analysis	7

SUGGESTED BOOKS

Text books:

1. Douglas Eadline,"Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1stEdition, Pearson Education, 2016. ISBN-13: 978-9332570351

Reference books:

1. Tom White, “Hadoop: The Definitive Guide”, 4th Edition, O’Reilly Media, 2015.ISBN-13: 978-9352130672

2. Eric Sammer,"Hadoop Operations: A Guide for Developers and Administrators",1 stEdition, O'Reilly Media, 2012.ISBN-13: 978-9350239261

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2. https://www.coursera.org/specializations/big-data

Lab Practical:

1. Perform setting up and Installing Hadoop in its three operating modes.

i. Standalone.
ii. Pseudo distributed.
iii. Fully distributed.

2. Use web based tools to monitor your Hadoop setup.
3. Implement the following file management tasks in Hadoop:
   i. Adding files and directories
   ii. Retrieving files
   iii. Deleting files
   Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command line utilities.
4. Write a Map Reduce program that mines weather data. Hint: Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce, since it is semi structured and record-oriented.
5. Use Hive to create, alter, and drop databases, tables, views, functions, and indexes.

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Student must be Able to **understand** the building blocks of Big Data.	Understanding
2	Student must be able to **apply** the programming aspects of cloud computing (map Reduce etc)	Apply
3	Student must be able to **understand** the specialized aspects of big data with the help of **different** big data applications	Understanding and Analyze
4	Student must be able to **represent** the analytical aspects of Big Data	Evaluate and Analyze
5	Student must be **know** the recent research trends related to Hadoop File System, MapReduce and Google File System etc	Knowledge

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	1
2	3	2	-
3	2	3	--
4	1	2	1
5	1	2	--

1-Low, 2-Medium, 3-High

Course Name	**Human Computer Interaction**
Course code	**CSR 1206**
L T P	**2 0 2**
Credits	**3**
Type of course	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. To learn the foundations and guidelines of Human Computer Interaction.
2. To become familiar with the design technologies for individuals and persons with disabilities.
3. To be aware of mobile HCI.

Course Contents: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	The Human: I/O channels – Memory – Reasoning and problem solving; The Computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms. - Case Studies	5
2.	Interactive Design: Basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process: Software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules: principles, standards, guidelines, rules. Evaluation Techniques – Universal Design	7
3.	HCI Models: Cognitive models: Socio-Organizational issues and stakeholder requirements – Communication and collaboration models- Hypertext, Multimedia and WWW.	8
4.	Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. - Case Studies	8

List of Practicals

Sr. No.	Course Content	No. of hours (28)
1.	Design a system based on user cantered approach.	2
2.	Understand the principles of good screen design.	2
3.	Redesign existing Graphical User Interface with screen complexity.	4
4.	Implementation of Different kinds of Menues	4
5.	Implementation of Different Kinds of Windows	8
6.	Design a system with proper guidelines for icons	8

Suggested readings:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction‖, 3rd Edition, Pearson Education, 2004 (UNIT I, II & III)
2. Brian Fling, ―Mobile Design and Development‖, First Edition, O'Reilly Media Inc., 2009 (UNIT – IV)
3. Bill Scott and Theresa Neil, ―Designing Web Interfaces‖, First Edition, O'Reilly, 2009. (UNIT-V)

Available MOOCS:

1. https://nptel.ac.in/courses/106103115
2. https://www.edx.org/professional-certificate/gtx-human-computer-interaction
3. https://www.coursera.org/courses?query=human%20computer%20interaction
4. https://www.udacity.com/course/human-computer-interaction--ud400

Couse Outcomes:

Sr. No	Description	Blooms level of taxonomy
CO1	Design effective dialog for HCI	Understanding
CO2	Design effective HCI for individuals and persons with disabilities.	Knowledge, Apply
CO3	Assess the importance of user feedback.	Analyze
CO4	Explain the HCI implications for designing multimedia/ ecommerce/ e-learning Web sites.	Evaluate
CO5	Creation of HCI based software tools	Create

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	1	-	1
2	1	1	1
3	1	2	3
4	1	1	1
5	2	2	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Information Retrieval**
Course Code	**:**	**CSR 1207**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. To understand the theoretical basis behind the standard models of IR: Boolean retrieval model, Vector space model, etc
2. To understand the difficulty of representing and retrieving documents, images, speech, etc. and be able to implement, run and test a standard IR system
3. To provide inclusive details about various Query Evaluation methods for retrieval

Course Contents: Total No. Lectures: 28

Sr. No.	Course contents	No. of Lectures
1	The impact of the web on Real World and data Science Basic IR Models: Boolean and vector-space retrieval models; ranked retrieval; The term vocabulary and postings lists, Dictionaries	05
2	Text-similarity metrics; TF-IDF (term frequency/inverse document frequency) weighting; cosine similarity Text Index construction and compression, Pre-processing and File Organization, Stop words, stemming, thesauri, File (Text) organization (invert, suff), Text statistics (properties)	06
3	Tolerant Retrieval: Wild card queries, Permuterm index, Bigram index, Spelling correction, Edit distance, Term Weighting and Vector Space Model	06
4	Evaluation metrics, Precision, Recall, F-measure, Normalized recall, Evaluation problems	05
5	Query evaluation costs , Query optimization -- equivalent expressions, transformation of query Query Expansion Relevance feedback, Rocchio algorithm, Probabilistic relevance feedback, Query Expansion and its types, Query drift	04
6	Web search engines, Link structure and analysis, and social search	02

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	To implement various IR models and have a comparative analysis of the same	3
2	To implement Compression of inverted indexes for fast query evaluation	2
3	To implement tokenization, stop word elimination, lemmatization and stemming	3
4	To build an inverse index out of IR model	3
5	Apply various evaluation parameters to improve the queries.	3

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Introduction to Information Retrieval by Christopher D. Manning, Cambridge	2019
2	Natural Language Processing And Information Retrieval by *Tanveer Siddiqui and U. S. Tiwary*	2019

Available MOOCS:

1. https://www.coursera.org/learn/text-retrieval
2. https://www.udemy.com/course/python-webscraping-for-information-retrieval-and-analytics/

Course Outcomes:

At the end of the course, students will be able to:	
1.	Understand the main concepts, challenges behind the standard models of IR
2.	Understand the strategies used in IR, in particular the retrieval models currently used.
3.	Correlate the concepts and various components of Information Retrieval (IR) systems
4.	Understand the reasons for the evaluation strategies developed for the tasks covered
5.	Implement, run and test a standard IR system

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	-	-	1
CO2	2	-	1
CO3	2	-	2
CO4	2	1	2
CO5	3	1	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Data Warehouse & Data Mining**
Course Code	**:**	**CSR 1208**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. Students should understand fundamentals of data mining tools.
2. They should be able to Understand and implement classical models and algorithms in data warehouses and data mining.
3. They should learn to Characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering and various applications

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	INTRODUCTION to Data Warehouse: Introduction to Data Ware House, Differences between operational data base systems and data Ware House, Data Ware House characteristics, Data Ware House Architecture and its components, Extraction-Transformation-Loading, Multi-Dimensional Data Modeling, Schema Design, star and snow-Flake Schema, Fact Constellation, Fact Table, Measures; Dimension Table characteristics; Query tools and Applications , OLAP Operations, , OLAP Server Architecture-ROLAP, MOLAP and HOLAP	6
2	Introduction to Data Mining: Introduction, What is Data Mining, Definition, Applications , KDD,Challenges, Data Mining Tasks, Data objects, data visualization and techniques. Data Preprocessing- Data Cleaning, data integration, Missing Data, , Data reduction, data transformation Data discretization Concept Hierarchy Generation	6
3	ASSOCIATION RULE MINING Mining frequent patterns : basic concept, frequent itemset mining methods, Association Rule Mining, Apriori, Mining Various Kinds of Association Rules	5
4	CLASSIFICATION: basic concepts . Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines , Classification Using Frequent Patterns , Associative Classification – Lazy Learners –Model evaluation and selection Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods	5
5	CLUSTERING : Cluster Analysis and its Various Techniques :– A Categorization of Major Clustering Methods – Partitioning Methods, k-Means: Hierarchical methods , Agglomerative – Density-Based Methods – Grid-Based Methods , outlier detection	4
6	APPLICATIONS AND TRENDS IN DATA MINING Data Mining Trends and Research Frontiers, Mining Complex Data Types Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences , Mining Graphs and Networks Other Methodologies of Data Mining Data Mining Applications , Data Mining in Science and Engineering, Data Mining and Society ,Privacy, Security, and Social Impacts of Data Mining , Data Mining Trends	2

List of Experiments:		**Number of Turns**
1	Briefly describe about Data mining Tools	2
2	Explore different types of data visualization	2

3	Perform the basic pre-processing operations on data relation such as removing an attribute and filter attribute bank data	1
4	Program on data reduction techniques	2
5	Program to Mining frequent pattern in the given Data Set is using Algos	2
6	To predict the most probable class on each instance based on training set using Baeye's Theorem/ and other classification methods like knn etc	2
7	Program to mine using clustering techniques like kmeans, Agglomerative etc	2
8	program to demonstrate the use of data mining technology in various applications	1

Suggested Books:		
Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Data Mining-Concepts and Techniques- Jiawei Han, Micheline Kamber	Latest edition
2	Data Warehousing, Data Mining and OLAP by Alex Berson and Stephen J. Smith	Latest edition
3	Introduction to Data Mining, Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, Pearson Education	Latest edition
4	Data Mining Techniques, Arun K Pujari , Universities Press.	Latest edition
5	K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India	

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2. https://www.coursera.org/specializations/data-warehousing
3. https://www.edx.org/learn/data-warehouse

Course Outcomes: At the end of the course, students will be able to:	
1	Understand the functionality of the various data mining and data warehousing component schema, star,snowflake, data preprocessing
2	analyze various techniques of data mining: Association, classification, Clustering etc and usage in research
3	Describe different methodologies used in data mining and data ware housing.and applications
4	Demostrate the use of data mining techniques in solving problems
5	Distinguish the use of various techniques and apply by selecting the appropriate the method of data ming

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	**PO2**	**PO3**
CO1	1	1	2
CO2	3	1	2
CO3	3	-	2
Co4	3	-	2
Co5	3	-	2

1-Low, 2-Medium, 3-High

Course Name	**Computer Vision**
Course Code	**CSR 1209**
L T P	**2 0 2**
Credits	**3**
Type of course	**Department Elective Course – I (DEC-I)**

COURSE OBJECTIVES

1. To provide understanding of techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.
2. Software implementation of different concepts and techniques covered in the course.
3. Focus on algorithms for image and video analysis based on color, shading, stereo, and motion.

Course Contents: **Total No. Lectures: 28**
Total No. of Lab hrs. 28

Sr. No.	Course Content	No. of Lectures
1	**Overview:** Image acquisition, sampling and quantization, neighbors of pixels and connectivity, basic transformation, image enhancement, color image processing.	3
2	**Image Formation Models**: Monocular imaging system, Orthographic and Perspective Projection, Camera model and camera calibration, Binocular imaging systems..	4
3	**Image Processing and Feature Extraction:** Image representations (continuous and discrete), Edge detection	4
4	**Motion Estimation:** Regularization theory, Optical computation, Stereo vision, Motion Estimation, Structure from motion.	4
5	**Shape Representation and Segmentation:** Deformable curves and surfaces, snakes and active contours, level set representations, Fourier and wavelet descriptors, Medical representations, Multi-resolution analysis	4
6	**Object Recognition:** Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition.	5
7	**CASE STUDY**: Study of industrial applications, medical applications, etc. using computer vision methods.	4

Lab Work

Sr. No.	List of Practical's	No. of hours (28)
1.	Implement edge detection techniques	4
2.	Implement motion estimation and detection techniques	6
3.	Analysis of curves and surfaces	6
4.	Implement object recognition techniques	6
5.	Analysis of industrial applications, medical applications, etc. using computer vision methods.	6

Bibliography

Sr. No.	Book Detail	Year of Publishing

1	D. Forsyth, J. Ponce, “Computer Vision-A modern approach”, Prentice Hall of India, 2nd Edition	2015
2	R. Gonzalez and R.E. Woods, “Digital Image Processing”, Pearson Education, 3rd edition	2008
3	E. Trucco and A. Verri, “Introductory techniques for 3D computer vision”, Prentice Hall	1998

References:

1. B.K.P Horn, “Robot Vision”, McGraw Hill.
2. E. Trucco and A. Verri, “Introductory techniques for 3D computer vision”, Prentice Hall

Available MOOCS:

1. https://nptel.ac.in/courses/108103174
2. https://www.edx.org/course/computer-vision-and-image-analysis-0
3. https://www.edx.org/course/architecting-distributed-cloud-applications-0

Couse Outcomes:

Sr. No	Description	Blooms level of taxonomy
1	Understand the various edge detectors .	Understanding
2	Understand and apply the different ways that the shape of an object can be represented.	Applying
3	Analyse image segmentation, representation, description, and recognition techniques	Analysing
4	Analysing and implementing several image filtering algorithms	Evaluating
5	Analysis and build of industrial applications, medical applications, etc. using computer vision methods.	Creating

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	1	1	1
2	2	1	2
3	2	1	2
4	3	1	3
5	2	1	2

1-Low, 2-Medium, 3-High

Course Name	**Cluster and Grid Computing**
Course code	**CSR 1210**
L T P	**2 0 2**
Credits	**3**
Type of course	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. To understand the major computing environments, architectures and software toolsets to gain exposure towards cluster and grid computing
2. To learn various algorithmic and programming methodologies for implementation of cluster and grid computing
3. To understand the recent advancements in the area of cluster and grid computing

Course Contents: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Cluster Computing and the Grid-Introduction and History, High Performance Computing, Cluster based distributed computing, Architectures for Clusters-shared memory (OpenMP) and message passing (MPI) models, Grid Architectures: Open Grid Service Architecture, Cluster Components: Processors, High Speed Interconnection goals, topology, latency, bandwidth.	6
2.	Hardware and software Technologies for Cluster and Grid Computing, Programming, features and performance of standard MPI variants (LAM/MPICH/vendor specific MPI versions), Derived data types, communicators, Merging the Grid sources – Architecture with the Web Devices Architecture, OGSA – Sample use cases – OGSA platform components – OGSI – OGSA Basic Services.	8
3.	Setting up clusters, Managing Cluster Resources, Parallel I/O and Parallel Virtual File System, Performance evaluation tools, HINT, netperf, netpipe, ttcp, Iperf, Configuration and Tuning of clusters, Globus GT 3 Toolkit – Architecture, Programming model, High level services – OGSI .Net middleware Solutions.	8
4.	Cluster Operating Systems, Meta Clustering, Supercomputers, Computational grids, Data Grids: Management and applications, Grid Security, Fault Tolerance, Recent trends in cluster and grid computing	6

Lab Work:

Sr. No.	List of Practicals	No. of hours (28)
1.	Development of OGSA compliant web service	5
2.	Develop secured applications using basic security mechanisms available in Globus Toolkit	5
3.	Find procedure to run the virtual machine of different configuration. Check how many virtual machines can be utilized at particular time	6
4.	Use of Performance Evaluation tools- HINT, netperf, netpipe, ttcp, Iperf	6

SUGGESTED BOOKS
Text books:

1. The Grid - Core Technologies by Maozhen Li, Mark Baker, John Wiley & Sons; 2005
2. Distributed and Parallel Systems: From Cluster to Grid Computing, Peter Kacsuk, Thomas Fahringer, Zsolt Nemeth, 2002.
3. Grid and Cluster Computing: CSR Prabhu, 2008

Reference books:

1. High Performance Cluster Computing: Architectures and Systems, Rajkumar Buyya, 1999
2. Future generation grids, Alexander Reinefeld, Domenico Laforenza, Vladimir Getov, Springer, 2005

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_me61/preview
2. https://www.mooc-list.com/course/introduction-grid-computing-uva

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	**Understand** various architectures of cluster and grid computing.	Understanding
2	**Describe** the features and evaluate the performance of cluster and grid architectures	Apply and Evaluate
3	**Implement** the clusters and design secure, fault tolerant grids	Create
4	**Study** about various future generation grids and advances in cluster computing	Knowledge
5	**Compare** the performance of cluster computing and grid computing	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	3	1
2	3	3	3
3	2	1	1
4	3	2	3
5	3	2	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Cloud Native Services**
Course Code	**:**	**CSR 1211**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of course	**:**	**Department Elective Course – I (DEC-I)**

Course Objectives:	
1.	Students will learn how to develop a structure, package and release an application to a Kubernetes cluster, while using an automated CI/CD pipeline. Students will learn by applying a suite of good development practices within an application, package it with Docker and evaluate it by distribute it through DockerHub.
2.	Students will understand and gain information about using k3s to bootstrap a lightweight and functional Kubernetes cluster. Students will learn the fundamentals of Continuous Integration and Continuous Delivery (CI/CD) with GitHub

Total No. of Lectures – 28
Total No. of Lab hrs. – 28

Sr No.	**Course contents**	**Number of Lectures**
1	**Cloud Native Fundamentals:** Evaluate the cloud native ecosystem, Explore CNCF (Cloud Native Computing Foundation) and cloud native tooling.	4
2	**Architecture Consideration for Cloud Native Applications:** Choose monolith or microservice based-architecture for an application, Consider and evaluate the involved trade-offs for monoliths and microservices and apply good development practices to an application	6
3	**Container Orchestration with Kubernetes**: Use Docker to package an application and distribute it via DockerHub, Bootstrap a Kubernetes cluster using k3s, Explore Kubernetes resources for an application deployment, Differentiate between declarative and imperative Kubernetes management techniques	7
4	**Open Source PaaS:** Understand the usage and abstracted components while using a Platform as a Service (PaaS) solution. • Explore application deployment with Cloud Foundry	4
5	**CI/CD with Cloud Native Tooling:** Explain CI/CD and its benefits • Apply Continuous Integration fundamentals using GitHub Actions • Apply Continuous Delivery fundamentals using ArgoCD • Use Helm, as a configuration template manager, to parametrize declarative Kubernetes manifests • Deploy an application using ArgoCD and a Helm chart	7

Sr No.	**Lab contents**	**Number of Hours**
1	Design and build cloud-native applications using Java EE 8	5
2	Build robust and easily consumable REST APIs with JAX-RS and MicroProfile OpenApi	6
3	Develop loosely coupled, message-driven microservices with JMS and JSON-P	6
4	Add and implement service monitoring with Metrics and MicroProfile Health	5
5	Secure your microservices with BASIC Auth and JSON Web Tokens	6

Bibliography:

Sr No.	Book Detail	Year of Publication
1	Cloud Native Go: Building Reliable Services in Unreliable Environments , Matthew Titmus	2021
2	Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison and kris nóva	2017
3	Cloud Native Infrastructure with Azure, Michael Kehoe and Nishant Singh	2022

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. https://www.udacity.com/course/cloud-native-fundamentals--ud064
3. https://www.coursera.org/learn/developing-cloud-native-applications
4. https://www.edx.org/course/developing-cloud-native-applications

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1.	Students will learn how to develop a structure, package and release an application to a Kubernetes cluster, while using an automated CI/CD pipeline.	Create
2.	Students will learn by applying a suite of good development practices within an application, package it with Docker.	Apply and Evaluate
3.	Students will understand and gain information about using k3s to bootstrap a lightweight and functional Kubernetes cluster.	Understanding and Knowledge
4.	Students will learn the fundamentals of Continuous Integration and Continuous Delivery (CI/CD) with GitHub	Understand and Analyze
5.	Students will learn to evaluate how to distribute suite of good development practices within an application through DockerHub	Evaluate

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	3	1	3
2	2	1	3
3	3	1	3
4	3	1	3
5	3	1	3

1-Low, 2-Medium, 3-High

Course Name	**Design of Experiments and Research Methodology**
Course code	**CSR 1001**
L T P	**2 0 2**
Credits	**3**
Type of course	**compulsory**

Course Objectives:

The main objectives of this course are:

1. To develop an understanding of how to identify research topics, formulate research questions / hypotheses, select an appropriate research and, where applicable, experimental design.
2. Provides a basis so the student can effectively develop a research proposal for either a capstone project, master's thesis, research project, or designed experiment.

Course Content: **Total No. Lectures: 28**
Total No. of Lab hrs. 28

Sr. No.	Course Content	No. of Lectures
1	**Introduction:** Types of Research and Their Purposes, Locating, Analysing, stating and evaluating research problem, need for literature review, steps in conducting literature review, Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, research questions and hypothesis, types of hypothesis, evaluation of hypothesis.	6
2	**Intellectual Property**: The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity,	2
3	**Formal Methods:** Formal Specification, Algorithm, and Complexity; Building Artefacts: Proof of Performance, Proof of Concept, and Proof of Existence	2
4	**Research Design and Sampling Design:** Concept of research design, features of a good research design, concept of population and sample, characteristics of sample design, types of sampling techniques	4
5	**Methods of data collection and measurement:** Primary data and Secondary data, data collection techniques: observation, interview, questionnaires, schedules, case-study, levels of measurement.	5
6	**Statistical Methods of Analysis:** Descriptive statistics: mean, median, mode, range, mean deviation and standard deviation, regression and correlation analysis, inferential statistics: t-tests, Chi-square tests.	5
7	**Procedure for writing a research report and manuscript:** Types of research reports, steps of writing a report, layout of report, layout of research paper, ethical issues related to publishing, Plagiarism and Self Plagiarism.	4

Lab Work

Sr. No.	List of Practical's	No. of hours (28)
1.	Select a problem from your area of interest, identifying the type of research problem it is and perform the SWOT analysis of the existing literature.	4
2.	Generate research questions and hypotheses for a problem from your area of interest	4
3.	Identify the population and sample for the study (highlighting the technique used for sample selection) for a problem from your area of interest.	4
4.	Design a questionnaire for the problem of interest.	4
5.	Utilizing software such as Statistical Package for the Social Sciences(SPSS), Mini Tab, etc. for the statistical analysis of the results obtained for the desired questionnaire	6
6.	Preparing a research paper for the problem of interest	6

Bibliography

Sr. No.	Book Detail	Year of Publishing
1	Probability and Statistics for Engineers and scientists by Anthony J. Hayter, Cencage Learning, 4th Edition	2016
2	Probability and Statistics for Engineers and scientists by Walpole, Myers, Myers and Ye, 8th ed Pearson Education	2007
3	Research Methodology - Methods and Techniques, C. K. Kothari, New Age International, 2nd Edition	2004
4	English for writing research papers by Adrian Wallwork, 2nd Edition. Springer	2016
5	Statistics: Concepts and Controversies by David S. Moore, William I. Notz, W. H. Freeman	2016

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_mg48/preview
2. https://www.coursera.org/learn/research-methods
3. https://www.lawctopus.com/certificate-course-on-research-methodology-online/

Couse Outcomes:

Sr. No	Description	Blooms level of taxonomy
1	Developed an understanding of how to identify research topics, formulate research questions and corresponding hypotheses, select an appropriate research and where applicable, experimental design.	Understanding
2	Perform required statistical analyses for any univariate application in a business / industrial setting, regardless of data form, and will be familiar with major indices for measuring correlation and association.	Analysing
3	Further, the underlying assumptions related to each statistical test and its interpretation will be thoroughly reviewed.	Knowledge and Evaluate
4	Identifying research topics, formulate research questions and corresponding hypotheses, select an appropriate research and where applicable, experimental design.	Applying
5	Preparing a research paper for the problem of interest	Create

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	1
2	1	2	2
3	1	1	1
4	2	1	1
5	3	2	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Soft Computing**
Course Code	**:**	**SCR 1001**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Common to all Branches**

Course Objectives:
1. To understand and analyse various soft computing techniques for a given problem.
2. To get familiar with latest trends for problem solving in soft computing domain.

Total No. of Lectures: 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Soft Computing and MATLAB/Octave** Evolution of Soft computing, Soft and Hard Computing, Characteristics and Application of Soft Computing, Soft Computing Constituents Introduction to MATLAB/Octave, Arrays and array operations, Functions and Files	4
2	**Fuzzy Logic** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Fuzzy Logic Controller Design and Applications	6
3	**Neural Networks** Biological Neurons, Perceptron, Multi-Layer Neural Network, Machine Learning Using Artificial Neural Network (ANN), Feed forward Networks, Supervised Learning Neural Networks, Adaptive Networks, Unsupervised Learning Neural Networks, Adaptive Resonance Architectures, Advances in Neural Networks, Application of ANN in Solving Engineering Problems	5
4	**Genetic Algorithms (GA)** Introduction to GA, GA Operations, Phases of GA, Applications of GA in Machine Learning, Machine Learning Approach to Knowledge Acquisition, Hybrid System, Solving of Single Objective Problems, Solving of Multi Objective Optimization Problems	5
5	**Introduction to AI & ML** Introduction to AI and its applications, Introduction to Machine Learning, Types of Machine Learning, Machine Learning Techniques, Introduction to Deep Learning, Reinforcement Learning	8

Total no. of Lab hours: 28

List of Experiments:		**Number of Hours**
1	Setting up MATLAB/Octave	2
2	Experiments with fuzzy logic toolbox	4
3	Experiments with neural network toolbox	4
4	Implementing fuzzy logic	6
5	Implementing artificial neural network	6
6	Implementing genetic algorithms	6

Sr. No.	Name of Book/ Authors/ Publisher	Year of publication
1	Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall of India	2009
2	S. N. Deepa, S. N. Shivanandam, "Principles of Soft Computing", Wiley India, 2nd Edition	2011
3	George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall of India	2009

Available MOOCS:

1. https://nptel.ac.in/courses/106105173
2. https://www.classcentral.com/course/swayam-introduction-to-soft-computing-10053
3. https://www.class-central.com/tag/soft%20computing
4. https://swayam.gov.in/course/4574-introduction-to-soft-computing

Course Outcomes: At the end of the course, students will be able to:	
1	Apply Fuzzy Logic and reasoning to handle uncertainty and solve various engineering problems
2	Apply different types of Neural Networks to solve problems related to recognition and prediction
3	Apply Genetic Algorithms to solve optimization problems
4	Apply various machine learning and deep learning techniques
5	Evaluate and compare solutions by various soft computing approaches for a given problem

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	1	1
CO5	2	-	2

1-Low, 2-Medium, 3-High

Semester II

Semester II

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 1104	Distributed & High Performance Computing	2	0	2	3	PCC-IV
2.	CSR 1105	Software Testing Techniques	2	0	2	3	PCC-V
3.	CSR 1106	Advanced IOT	2	0	2	3	PCC-VI
4.	CSR 1251 to CSR 1261	Department Elective Course-II	2	0	2	3	DEC-II
5.	CSR 3001 to CSR 3005	Open Elective	2	0	2	3	OE
6.	CSR 1001	Engineering Mathematics (CB) / Design of Experiments & Research Methodology (NCB)	2	0	2	3	Maths DERM
7.	CSR 4001	Industrial Tour				0	
					Total Credits	18	

CB : Circuital Branches (CSE, CSIS, Electrical, VLSI, Healthcare, Energy System)
NCB: Non-circuital branches (Aerospace, Environmental, Transportation, Water Resources, Structural, Mechanical, IMM & Production)

Department Elective Course - II (DEC-II)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 1251	Wireless Sensor Networks	2	0	2	3
2.	CSR 1252	Data Science	2	0	2	3
3.	CSR 1253	Logic and Functional Programming	2	0	2	3
4.	CSR 1254	Bioinformatics	2	0	2	3
5.	CSR 1255	Intelligent Systems	2	0	2	3
6.	CSR 1256	Advanced Computer Networks	2	0	2	3
7.	CSR 1257	Advanced Machine Learning	2	0	2	3
8.	CSR 1258	Blockchain and Cryptocurrency	2	0	2	3
9.	CSR 1259	Software Defined Networks	2	0	2	3
10.	CSR 1260	Recommender System	2	0	2	3
11.	CSR 1261	Container Micro Services	2	0	2	3

Open Elective (OE)

Sr. No.	Course Code	Course Name	L	T	P	Credits
1.	CSR 3001	Data Science	2	0	2	3
2.	CSR 3002	Internet of Things	2	0	2	3
3.	CSR 3003	Machine Learning	2	0	2	3
4.	CSR 3004	Software Project Management	2	0	2	3
5.	CSR 3005	Mobile Computing	2	0	2	3

Course Name	Distributed and High Performance Computing
Course code	CSR 1104
L T P	2 0 2
Credits	3
Type of course	Program Core Course – IV (PCC-IV)

Course Objectives:

1. To learn the concept of formal modelling for concurrent distributed and parallel computing algorithms
2. To understand memory hierarchy and memory models (shared and message passing) to handle various coordination issues in distributed and parallel architectures.
3. To learn the HPC benchmarks, frameworks and open source tools for large scale job executions.

Pre-requites: Computer Organisation and Architecture, Operating Systems

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Introduction to computing architectures: Parallel computing, Distributed computing, Cluster computing, Grid computing, Cloud computing, High-performance computing; Concepts of modern processors: stored program, general-purpose cache-based, Moore's law, pipelining, superscalarity, SIMD, Multicore processors, Multi-threading, Vector programming, Profiling, performance pitfalls	2
2.	Distributed Computing Systems and Algorithms: Relation to Parallel Multiprocessors/Multicomputer Systems, Distributed and Concurrent Programs, Formal Models, Message Passing vs. Shared Memory Systems, Synchronous vs. Asynchronous Executions, Design Issues and Challenges; Clocks and Synchronization: Model Timing Assumptions, Temporal ordering of events, Lamport's Logical Clock Framework, Physical Clock Synchronization, Vector Clock Implementation. Distributed Mutual Exclusion Algorithms: Token, Non-Token, Quorum-Based (Lamport, Ricart-Agrawala, Singhal's, Suzuki-Kasmi) Leader Election Algorithms: Bully, Modified Bully, Chang-Robert's Ring, HS bidirectional ring algorithm Consensus: Paxos and Multi-Paxos, Byzantine Agreement Global State and Distributed Transactions: Snapshot algorithm for FIFO and Non-FIFO Channels (Chandy-Lamport)	10
3.	Parallel Processing Concepts: Levels of parallelism (instruction, transaction, task, thread, memory, function), Models and Architectures: SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation; N-wide superscalar architectures, multi-core, multi-threaded Parallel Programming with CUDA: Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures (Examples: IBM CELL BE, Nvidia Tesla GPU) Memory hierarchy and transaction specific memory design, Thread Organization Fundamental Design Issues in Parallel Computing: Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms	10
4.	Programming for HPC clusters – OpenMP and MPI programming. Programming for accelerators – OpenCL/CUDA/Xeon-PHIs. HPC Benchmarks – LINPACK/HPL. Recent, relevant high-performance computing advances from literature from Supercomputing and other sources. Introduction to Deep Learning frameworks like Caffe, Tensorflow. Implementation of HPC techniques in DNN frameworks including TPUs. Advanced Topics: Petascale Computing, Optics in Parallel Computing, Quantum Computers, Recent developments in Nanotechnology and its impact on HPC	6

Lab Work: Each lab sessions will be aimed to create a distributed computing and parallel computing framework and implement coordination algorithms through programming paradigms and tools, and open-source framework for high performance computing (Github)	**No. of labs: 14**

SUGGESTED BOOKS

Text books:

1. High Performance Computing: Programming and Applications by John Levesque and Gene Wagenbreth, Chapman & Hall/CRC Computational Science, 2010
2. Distributed Computing- Principles, Algorithms and Systems by Mukesh Singhal and Ajay D. Kshemkalyani, Cambridge, 2008

Reference books:

1. Parallel and High Performance Computing by Robert Robey and Yuliana Zamora, Manning Publications, 2021
2. Distributed Systems- Concepts and Design by G. Coulouris, Dollimore and Kindberg, Addison Wesley, 2012

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc20_me61/preview
2. https://www.coursera.org/lecture/introduction-high-performance-computing/linux-part-1-ODjiy

Couse Outcomes and Blooms Level mapping:

	Description	**Blooms level of taxonomy**
1	**Understand** the concepts within parallel, distributed and high-performance computing architectures.	Understanding
2	**Describe** the comprehension of using high performance computing architectures for large-scale and commercial applications.	Apply
3	**Design and create** new concurrent algorithms based on computing technologies and verify their correctness.	Create
4	**Study** the benchmarks and different programming interfaces as well as frameworks for implementation and evaluation.	Knowledge
5	**Compare** and critically assess the performance of different algorithms on open-source tools and demonstrate the execution of computing algorithms to solve real-time problems.	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

Course Outcomes (COs)	**Program Outcomes (POs)**		
	PO1	**PO2**	**PO3**
CO1	3	1	1
CO2	3	1	2
CO3	3	2	2
CO4	2	-	2
CO5	2	3	3

1-Low, 2-Medium, 3-High

Course Name	**Software Testing Techniques**
Course code	**CSR 1105**
L T P	**2 0 2**
Credits	**3**
Type of course	**Program Core Course – V (PCC-V)**

Course Objectives:

1. To study and understand fundamental concepts in software testing.
2. To understand different testing techniques used in designing test cases.
3. To understand how developers incrementally develop and test code.

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Overview: Introduction to Test cases, test case design, Levels of testing - module, integration, system, regression, Structural versus Functional Technique Categories, Static versus Dynamic Testing, Control flow & Data flow testing, Regular expressions in testing, Determining Metrics, Black Box Testing, White Box Testing, Test Prioritization, Performance, Load, Stress & Security Testing, Debugging.	8
2.	Object Oriented Testing - Object Oriented Testing Issues, OO Testing Methodologies, Analysis and Design Testing-UML Based, Class Testing, Integration Testing, Testing Hierarchies.	6
3.	Testing Automation – Software test automation, scope of automation, design and architecture for automation, requirements for a test tool, challenges in automation, Regression testing, Test cases prioritization and minimization, Testing tool.	6
4.	Modern Testing Trends: Modern Testing Principles, Agile, DevOps & CI/CD, AI and ML in Software Testing, Test-driven development, User Experience and Usability Testing, Robotic Process Automation (RAP) Testing, Shift-Left and Shift-Right Testing, IEEE Standard for testing.	8

SUGGESTED BOOKS

1. Yogesh Singh, Software Testing, Cambridge University Press.

2. Marcus S. Fisher, Software Verification and Validation: An Engineering and

Scientific Approach, Springer.

3. Aditya P. Mathur, Foundations of Software Testing, Pearson Education.

4. Srinivasan Desikan, Gopalaswamy Ramesh, Software Testing: Principles and Practices,

Pearson Education India (2006)

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs71/preview
2. https://www.coursera.org/learn/introduction-software-testing

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Understand the software testing concepts.	Understanding
2	List a range of different software testing techniques and strategies and be able to apply specific testing method to the projects.	Explain, Apply
3	Design test cases based on various techniques for software projects	Create
4	Demonstrate various issues for object oriented testing.	Knowledge
5	Distinguish characteristics of various structural testing methods.	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	3	2	3
2	3	3	2
3	3	2	3
4	2	2	3
5	3	2	3

1-Low, 2-Medium, 3-High

Course Name	**Advanced IoT**
Course Code	CSR 1106
Credits	**3**
L T P	**2 0 2**
Type of Course	**Program Core Course – VI (PCC-VI)**

Course Objectives
1. To develop an understanding of advanced concepts in the field of the Internet of Things 2. To understand various applications in the Industry 4.0 paradigm.

Total number of Lectures: 28

S.No.	Lecture wise breakup	Number of Lectures
1.	**Advanced IoT: Issues and requirements** Introduction to IoT: definition and characteristics, IoT physical design, Communication models, Introduction to IoT ecosystem, IoT, Deployment strategies, Security, scalability, mobility.	5
2.	**Modern Networking for IoT** Background and motivation: requirements, architecture, characteristics and standards, SDN planes (Data, Control, and Application), Network Function Virtualization (NFV), SDN Controllers: Openflow and other derivatives, Security, SDN architecture for IoT, SDN-Scalability for the IoT, SDN Traffic Flow Optimization for the IoT-Security and Connectivity	6
3.	**Industrial IoT (IIOT)/Industry 4.0** Cyber-Physical Systems, Model of Industry 4.0: Concepts, deployment, business model and reference architecture, Industrial IoT Layers: sensing, processing and communication, Security aspects and issues in Industry 4.0, IIoT vs Industry 4.0	6
4.	**Industrial IoT Application Domains** Healthcare, Petrochemicals, Pharmaceuticals, and Power Plants, Ubiquitous connectivity planning for various applications (Blockchain, Data Analytics, Fog Computing), Real-world case studies	4
5.	**Advanced IoT Applications** First responder IoT networks, Sensors and protocols for next-generation automobiles, Automotive IoT, Speech to text processing, Air quality monitoring, Localization in IoT, Smart energy monitoring, Cargo monitoring	7

S.No.	List of Experiments	Number of Turns
1.	Project-based lab work: Design and build systems that will use sensors, communication protocols, and actuators using Arduino and Raspberry Pi.	6

2.	Mininet: A simulation environment for SDN 1. Network Topology creation and REST API introduction. 2. Influencing flows via cURL commands. 3. Create a network and run a simple performance test.	4
3.	Collaborative Computing Git and GitHub, YAML, CI-CD pipelines and the Cloud, Jenkins	4

Available MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. https://www.coursera.org/learn/iiot-google-cloud-platform
3. https://www.udemy.com/course/sdn-openflow-nfv-introduction/

S.No.	Course Outcomes
CO1	to understand of issues and requirements of the deployment of IoT.and Industrial IoT
CO2	To learn modern networking concepts of IoT and Industrial IoT
CO3	Analyse the industrial applications of IoT and their implementations in different networks.
CO4	Design various applications in Industrial, healthcare, commercial, andbuilding automation etc
CO5	Evaluate different application models and there performances

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	-	-	1
CO2	1	1	1
CO3	1	1	2
CO4	1	-	2
CO5	2	-	2

1-Low, 2-Medium, 3-High

Course Name	**Wireless Sensor Networks**
Course Code	**CSR 1251**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Department Elective Course – II (DEC-II)**

Course Objectives:

1. To introduce the basic concepts of wireless sensor networks and learn the node architecture and its various components
2. To understand various protocols related to various layers of wireless sensor networks
3. To learn various localization and programming techniques used in wireless sensor networks

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	**Introduction** Sensing and sensors, definition of wsn, challenges and constraints, Applications of wireless sensor networks.	4
2.	**Node Architecture** The Sensing Subsystem, The Processor Subsystem, Communication Interfaces, Prototypes.	6
3.	**Sensor Network Protocol Stack** Physical layer, Medium Access Control: Wireless Medium Access Control (MAC) Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols,Fundamentals on PHY, Medium Access Control Sublayer for Low-Rate Personal and Body-Area Networks ((Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 / IEEE 802.15.6)	8
4.	**Localization** Overview, Ranging Techniques, Range-Based Localization, Range-Free Localization, Event-Driven Localization, WSN programming, Distributed detection, Distributed estimation	6
5.	**Sensor network programming** Challenges, node centric programming, Microprogramming, dynamic reprograming, sensor network simulators	4

List of experiments:		**No. of Turns**
1.	Implement simulation experiments and projects based on MAC layer of wireless sensor network	4
2.	Implement simulation experiments and projects based on network layer of wireless sensor network	3
3.	Implement simulation experiments and projects based on transport layer of wireless sensor network	3
4.	Implement simulation experiments and projects based on application layer of wireless sensor network	4

Suggested Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	W. Dargie and C. Poellabauer, "Fundemntals of Wireless Sensor Networks – Theory and Practice", Wiley.
2	KazemSohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks - Technology, Protocols, and Applications", Wiley Interscience.

3	Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, springer.
4	Edgar H. Callaway, “Wireless Sensor Networks: Architectures and Protocols”, CRC press.
5	C. S. Raghavendra, Krishna M. Sivalingam and TaiebZnati, “Wireless sensor networks”, kluwer academic publishers.
6	Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks:An Information Processing Approach”, Elsevier.
7	Robert Faludi, “Building Wireless Sensor Networks”, O’Reilly.
8	8 Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John wiley and sons.
9	9 Rajeev Shorey, A. Ananda, MunChoon Chan and Wei Tsang Ooi, “Mobile, wireless, and Sensor networks - technology, applications, and future directions”, IEEE press and wiley interscience.

Available MOOCS:

1. https://archive.nptel.ac.in/courses/106/105/106105160/
2. https://www.coursera.org/lecture/internet-of-things-history/sensor-networks-n-to-1-iOmzK

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Understand the concepts and characteristics of radio standards and communication protocols for wireless sensor networks	Understanding
2	List the various components of node architecture, and be able to apply the use of sensor nodes for various applications and networks.	Explain, Apply
3	Design the wireless sensor networks and identify the various design issues of WSN and its architecture	Create
4	Demonstrate the use of sensor nodes in sensor network programming	Knowledge
5	Distinguish the characteristics of various localization techniques used for wireless sensor networks	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	3
2	2	2	3
3	3	3	3
4	3	2	3
5	3	2	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Data Science**
Course Code	**:**	**CSR 1252**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Department Elective Course – II (DEC-II)**

Total No. Lectures: 28

Course Objectives:

1. To be able to learn about the entire pipeline of a typical system involving data, collection, preprocessing, storage, retrieval, processing, analysis, and visualization.
2. To demonstrate an understanding of statistics and machine learning concepts that are vital for data science

Course Contents:

Sr. No.	Course contents	No. of Lectures
1	What is data Science-Definition, Why it is important, Uses, Data Science vs Machine learning, Ethics, Python in data science, User defined Modules and Packages in Python for data science	04
2	Data mining, structured and unstructured data, transformation and sampling of data	04
3	Data cleaning and exploration: Cleaning data, missing data imputation, noise elimination, feature selection and dimensionality reduction, normalization	04
4	Feature Engineering, Training, validation, testing, generalization, overfitting, Decision trees, random forests, Linear classifiers, Attribute selection- Filter methods, Wrapper methods Data discretization- Unsupervised discretization, Supervised discretization	06
5	Predictive modelling, Decision trees, Rule learners, Linear/logistic regression, Nearest neighbour learning, Support vector machines Properties of prediction algorithms and practical exercises, Combining classifiers	06
6	Measuring performance of a model- Accuracy, ROC curves, precision, recall curves, Loss functions for regression Interpretation of results- Confidence interval for accuracy, Hypothesis tests for comparing models, algorithms	04

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	Case Studies in Data Science: Eve, the Pharmaceutical Robot Scientist: Data Science for Drug Discovery	07
2	Case Studies in Data Science: Data science for sports analytics in python	07
3	Case Studies in Data Science: Data science for sensor data using python	07
4	Case Studies in Data Science: Data science for healthcare using python	07

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Joel Grus, Data Science from Scratch: First Principles with Python, O‟Reilly Media	2019
2	I. Witten, E. Frank, M. Hall. Data Mining: Practical Machine Learning Tools and Techniques (3rd Edition), Morgan Kaufmann	2019

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs60/preview
2. https://www.coursera.org/specializations/data-science

Course Outcomes:

At the end of the course, students will be able to:	
1.	To develop relevant programming abilities to analyse the data
2.	Create competitive advantage from both structured and unstructured data transformation
3.	Predict outcomes with feature selection and engineering techniques.
4.	Unearth patterns in customer behaviour with predictive modelling techniques.
5.	To apply data science techniques to solve real-time problems and communicate impact of work

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	3	2	2
CO2	2	-	1
CO3	2	-	1
CO4	2	-	1
CO5	3	3	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Logic and Functional Programming**
Course Code	**:**	**CSR 1253**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Department Elective Course – II (DEC-II)**

Course Objectives:	
1.	To understand functional programming techniques and constructs such as recursive definitions, higher-order functions, type inference, polymorphism, abstract data types, and modules. The programming exercises will illustrate the utility of list-processing, pattern matching, abstraction of data/control, strong typing, and parameterized modules
2.	To understand logic programming paradigm and Prolog. To understand the syntax and the semantics of Prolog, the workings of a Prolog interpreter, and various applications of Prolog. The use of declarative programming and pattern matching for database querying, parsing, meta-programming, and problem solving in AI.

Total No. of Lectures – 28
Total No. of Lab hrs. – 28

Sr No.	**Course contents**	**Number of Lectures**
1	Functional Programming Basics; Higher-order functions. Type Inference; Polymorphic Type System	3
2	Programming with lists: Pattern matching, Introduction to Haskell	3
3	Fold operations : foldr, foldl, Types : Concrete and Abstract, Modules, Recursion and Induction	5
4	Combinatorial Functions, Efficiency; Streams; Records; Exceptions; References	3
5	Lambda Calculus, Logic Programming Paradigm, Prolog and Unification, Meaning of Prolog Programs	4
6	Meaning of Prolog Programs, List Processing; Operators, Arithmetic; Structures	5
7	Controlling Backtracking, Negation as Failure and Built-in Predicates, Definite Clause Grammars	3
8	Meta-Programming/Interpreters, Constraint Logic Programming, Logic and Models : Semantics of Prolog Programs	2

Sr No.	**Lab contents**	**Number ofHours**
1	Using SML-NJ to implement Linear Search.	4
2	Using SML-NJ to implement Binary Search.	4
3	Using SML-NJ to implement Bubble Sort.	4
4	Using SML-NJ to implement Selection and Insertion Sort.	5
5	Implement using LISP: Write a function that compute the factorial of a number	2
6	Implement using LISP: Write a function that evaluate a fully parenthesized infix arithmetic expression	4
7	Write a PROLOG program that answers questions about family members and relationships includes predicates and rules which define sister, brother, father, mother, grandchild, grand father and uncle. The program should be able to answer queries such as the following: 1. father(x, Amit)	5

	2. grandson(x, y) 3. uncle(sumit, puneet) 4. mother(anita, x)	

Bibliography:

Sr No.	Book Detail	Year of Publication
1	Elements of ML Programming (ML 97 Ed.), J. D. ULLMAN, Prentice Hall,	1998
2	Introduction to Functional Programming in Haskell (2nd Ed.), R. S BIRD, International Series in Computer Science. Prentice Hall	1998
3	W. F. Clocksin and C.S.Mellish, Programming in Prolog (Fourth Edition), Springer-Verlag,	2000
4	Ulf Nilsson and Jan Maluszynki, Logic Programming and Prolog (Second Ediiton)	2000

Available MOOCS:

1. https://nptel.ac.in/courses/106106137
2. https://www.udemy.com/topic/functional-programming/

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	To create the concepts of higher order functions and inferences	Create
2	Develop and evaluate algorithms for any searching and sorting techniques using LISP and Prolog	Apply and Evaluate
3	Understand Meta-Programming and Interpreters	Understanding and Knowledge
4	To understand and analyze the issues and challenges in the implementation using SML-NJ	Understand and Analyze
5	Analyse the constraint Logic Programming, Logic and Models	Analyse

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	1	2
2	2	1	3
3	2	1	2
4	3	-	2
5	2	-	1

1-Low, 2-Medium, 3-High

Course Name	**Bioinformatics**
Course code	**CSR 1254**
L T P	**2 0 2**
Credits	**3**
Type of course	**Department Elective Course -II (DEC-II)**

Course Objectives:

1. The students should be able to understand the scope of Bioinformatics.
2. They should know about popular bioinformatics databases and sequence alignment algorithms.

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	INTRODUCTION History, scope and important contributions, aims and tasks of Bioinformatics, applications of Bioinformatics, challenges and opportunities, introduction to NCBI data model, various file formats for biological sequences.	6
2.	BIOLOGICAL DATABASES Importance of databases, biological databases, primary sequence databases, composite sequence databases, secondary databases, nucleic and sequence databases, protein sequence databases, structure databases, bibliographic databases, specialized genomic resources, analysis packages	7
3.	DATABASE SEARCH METHODS Methods for searching sequence databases like FASTA and BLAST algorithms, Statistical analysis and evaluation of BLAST results.	7
4.	SEQUENCE COMPARISON METHODS Methods for comparison of two sequences, Needleman Wush and Smith Waterman algorithms. Analysis of computational complexities, merits and demerits of these algorithms, theory of scoring matrices and their use for sequence comparison.	8

Lab Work

Sr. No.	List of Practical's	No. of hours (28)
1.	Hands-on with Nucleic acid databases (NCBI, DDBJ, EMBL), Protein databases (Primary, Composite and Secondary)	6
2.	Hands-on with Specialized Genome databases (SGD, TIGR, ACeDB), Structure databases (CATH, SCOP, PDBsum)	8
3.	Hands-on with methods for searching sequence databases	6
4.	Hands-on with sequence comparison methods	6

SUGGESTED READINGS

1. Andreas D Baxevanis & B F Francis, “Bioinformatics-A practical guide to analysis of Genes and Proteins”, John Wiley 2010
2. T K Attwood, D J Parry-Smith, “ Introduction to Bioinformatics”, Pearson Education 2005
3. Neil C. Jones, Pavel A. Pevzner, “An introduction to Bioinformatics Algorithms”, MIT Press 2005
4. Gary Benson Roderic, “Algorithms in Bioinformatics”, Springer 2004

Available MOOCS:

1. https://nptel.ac.in/courses/102106065
2. https://onlinecourses.swayam2.ac.in/cec21_bt04/preview
3. https://www.coursera.org/specializations/bioinformatics

Couse Outcomes:

Sr. No	Description	Bloom’s Level
CO1	Understanding, applying, search various biological sequence databases	**Understanding and applying**
CO2	Knowledge of computer applications in bioinformatics	**Understand**
CO3	Analyze various Perform sequence alignment	**Analyzing**
CO4	Perform sequence alignment	**Create**
CO5	Understand and Evaluate Specialized Genome databases and Structure databases	**Understand and Evaluate**

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	1	2	1
2	1	1	1
3	2	2	1
4	1	2	2
5	1	1	1

1-Low, 2-Medium, 3-High

Course Name	**:**	**Intelligent Systems**
Course Code	**:**	**CSR 1255**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Department Elective Course – II (DEC-II)**

Course Objectives:
1. To understand and analyse various soft computing techniques for a given problem.
2. To describe and learn various algorithms in the neural networks for optimizing real world problems
3. To learn fuzzy logic and its implementation methods

Total No. of Lectures: 28

Lecture wise breakup		**No. of Lectures**
1	**Rule-based expert systems** Introduction, Structure of a rule-based expert system, Fundamental characteristics of an expert system, Forward chaining and backward chaining inference techniques, Advantages and disadvantages of rule-based expert systems, Uncertainty management in rule-based expert systems	5
2	**Fuzzy Logic** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making	5
3	**Artificial Neural Networks** basic neuron, Modelling the single neuron, perception, limitation of perceptron, Multilayer neural networks, Hopfield network, Bidirectional associative memory (BAM), Self-organising neural networks	6
4	**Genetic Algorithms** Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning : Machine Learning Approach to Knowledge Acquisition, Genetic programming	6
5	**Hybrid intelligent systems** Introduction, Neural expert systems, Neuro-fuzzy systems, Adaptive Neuro-Fuzzy Inference System, Fuzzy evolutionary systems	6

Total no. of hours: 28

List of Experiments:		**Number of turns**
1	Experiments with fuzzy logic toolbox	2
2	Experiments with neural network toolbox	2
3	Implementing fuzzy logic	6
4	Implementing artificial neural network	6
5	Implementing genetic algorithms	6
6	Implementing Hybrid Intelligent systems	6

Sr. No.	Name of Book/ Authors/ Publisher	Year of publication
1	Michael Negnevitsky, "ARTIFICIAL INTELLIGENCE – A GUIDE TO INTELLIGENT SYSTEMS", Addison Wesley	2011
2	Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall of India	2009
3	S. N. Deepa, S. N. Shivanandam, "Principles of Soft Computing", Wiley India, 2nd Edition	2011
4	George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall of India	2009

Available MOOCS:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/108104049
3. https://www.edx.org/learn/artificial-intelligence
4. https://onlinecourses.swayam2.ac.in/cec20_cs10/preview
5. https://www.udacity.com/course/intro-to-artificial-intelligence--cs271

Course Outcomes: At the end of the course, students will be able to:	
1	Understand and develop expert systems using Rule-based expert systems
2	Understand and develop expert systems using Fuzzy Logic
3	Understand and develop expert systems using ANN
4	Understand and develop expert systems using GA and Hybrid Intelligent systems
5	Evaluate and compare solutions for building expert systems using various approaches for a given problem

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	3	-	-
CO2	3	-	-
CO3	3	-	-
CO4	3	-	-
CO5	-	-	2

1-Low, 2-Medium, 3-High

Course Name	**Advanced Computer Networks**
Course Code	**CSR 1256**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Department Elective Course – II (DEC-II)**

Course Objectives:

1. To introduce the fundamentals of the layered communication architecture, network protocols and algorithms
2. To understand the functioning of different types of multicast communication, multimedia networking techniques
3. To understand the QoS, resource management and security requirements of the networks

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	**Introduction** Layered communication architecture: layers, services, protocols, layer entities, service access points, protocol functions	2
2.	**Network Protocols and algorithms** NAT, DHCP, traditional and next generation IP: addressing and format, mobility, peer-to-peer networks, hierarchical routing, routing in the internet	6
3.	**Multimedia networking** Multimedia networking applications, streaming stored video, content distribution networks (CDN), case studies – netflix, youtube, Kankan; RTP	5
4.	**Multicast communication** Broadcast and multicast routing: broadcast routing algorithms, multicast routing algorithms, multicast routing in the internet, IP multicasting, IGMP	5
5.	**QoS & Resource Management** MPLS, data center networking, Differentiated Service and Integrated Service QoS architecture, dimensioning best effort networks, providing multiple classes of service, scheduling mechanisms – FIFO, priority queuing, round robin, WFQ, policing: the leaky bucket, Diffserv, per connection QoS guarantees- resource reservation and call admission,	5
6.	**Security** What is network security, end point authentication, securing email, securing TCP connections, network layer security, virtual private networks, operational security	5

List of experiments:		**No. of Turns**
1.	Simulation experiments based on layered network architecture, network protocols and algorithms	4
2.	Simulation experiments based on multimedia networking	3
3.	Simulation experiments based on multicast networking	3
4.	Simulation experiments based on QoS and resource management	2
5.	Simulation experiments based on security	2

Suggested Books:	
Sr. No.	**Name of books / Author/ Publisher**
1.	A.S. Tanenbaum, “Computer Networks”, 5th Edition, PHI

2.	James F. Kurose and Keith W. Ross, "Computer Networking: A top down approach", Pearson Education, 6th edition.
3.	B.A. Forouzan, "Local Area Networks", TMH.
4.	G. Keiser, "Local Area Networks", 2nd Edition, TMH
5.	D. Bertesekas and R. Gallager, "Data Networks", 2nd Edition, PHI
6.	B.A. Forouzan, "Data communications and networking", TMH, 5th Edition
7.	B.A. Forouzan, "TCP/IP Protocol Suite", TMH.
8.	Schiller J., Mobile Communications, Addison Wesley.
9.	William Stallings, "Data & Computer Communication", PHI, 10th Edition

Available MOOCS:

1. https://nptel.ac.in/courses/106105081
2. https://onlinecourses.nptel.ac.in/noc22_cs19/preview
3. https://nptel.ac.in/courses/106106091
4. https://onlinecourses.swayam2.ac.in/cec21_cs04/preview
5. https://www.coursera.org/learn/computer-networking

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Understand the concepts and characteristics of layered network architecture, network protocols and algorithms	Understanding
2	List the various types of QoS and resource management techniques and be able to apply in various types of networks	Explain, Apply
3	Design the various network protocols and identify the various design issues of the multimedia networking protocols	Create
4	Demonstrate the working principles of various security issues in computer networks	Knowledge
5	Distinguish the characteristics, working principles and design issues of various multicast routing protocols	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	3
2	2	2	3
3	3	3	3
4	3	2	3
5	3	2	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Advanced Machine Learning**
Course Code	**:**	**CSR 1257**
Credits	**:**	**3**
LTP	**:**	**2 0 2**
Type of course	**:**	**Department Elective Course – II (DEC-II)**

Course Objectives:

The main objectives of this course are:
1. To introduce the fundamentals of deep learning and the main research activities in this field. 2. To learn architectures and optimization methods for deep neural network training

Course Contents: **28**

Sr. No	**Contents**	**No of lectures**
1.	**LINEAR ALGEBRA REVIEW AND OPTIMIZATION:** Brief review of concepts from Linear Algebra, Types of errors, bias-variance trade-off, overfitting-underfitting, brief review of concepts from Vector Calculus and optimization, variants of gradient descent, momentum	6
2.	**LOGISTIC REGRESSION:** Basic concepts of regression and classification problems, linear models addressing regression and classification, maximum likelihood, logistic regression classifiers	6
3.	**NEURAL NETWORKS:** Basic concepts of artificial neurons, single and multi-layer perceptrons, perceptron learning algorithm, different activation functions, cross entropy loss function.	6
4.	**CONVNETS:** Basic concepts of Convolutional Neural Networks, Convolution and pooling operation, Discussions on famous convnet architectures - AlexNet, ZFNet, VGG, GoogLeNet, ResNet	5
5.	**RECURRENT NEURAL NETWORKS:** Basic concepts of Recurrent Neural Networks (RNNs), backpropagation through time, Long-Short Term Memory (LSTM) architectures, the problem of exploding and vanishing gradients, and basics of word embedding	5

Lab Work:

Sr. No	**Lab contents**	**No of hours**
1.	Introduction to python libraries for deep learning: Keras, Tensorflow, OpenCV	2
2.	Implementation of MultiLayer Perceptron(MLP)	2
3.	Implementation Basic CNN model and various CNN architectures - transfer learning	4
4.	Implementation of Recurrent neural networks	2
5.	Deep Learning based project	4

Bibliography:

Sr.No.	Book Detail	Year of Publishing
1	Ian Goodfellow, YoshuaBengio, Aaron Courville. Deep Learning, the MIT press, 2016	2016
2	Bengio, Yoshua. " Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1, Now Publishers, 2009	2009

Available MOOCS:

1. https://nptel.ac.in/courses/106106139
2. https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
4. https://www.coursera.org/specializations/aml/

Course Outcomes

At the end of the course, students will be able to:	
1	Be familiar with the programming frameworks of deep learning
2	Understand the fundamentals of deep learning and its applications.
3	Apply the learned concepts and methods to a real-world problem
4	Analyse, design and implement various deep learning techniques
5	Evaluate the various deep learning techniques

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	PO1	PO2	PO3
CO1	3	-	2
CO2	3	-	2
CO3	3	-	2
CO4	3	-	2
CO5	3	-	2

1-Low, 2-Medium, 3-High

Course Name	**Blockchain and Cryptocurrency**
Course code	**CSR 1258**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Department Elective Course – I (DEC-I)**

Course Objectives:

1. To acquire a basic understanding of the fundamental concepts of blockchain technology and cryptocurrency
2. To study the security issues and safeguards related to bitcoin trading.
3. To understand the issues, challenges and research directions in blockchain and cryptocurrency

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Introduction- Blockchain, Disruption/News: Price Rise, Distinction between Blockchain vs Cryptocurrency vs Token, Definition diagram: Pillars of Blockchain, Industry Applications of Blockchain: Government, Healthcare, His- tory of Centralized Services, trusted third party: Shift from gold standard to flat currency to Hash cash/digital currency (look at BEM)/Bitcoin, Trustless system, Immutability, Security, Privacy, Anti-fragility.	8
2.	Cryptocurrency and Markets: Cryptocurrencies - talk about Bitcoin / Ethereum, where is the value - what are people investing in, Methods to purchase Bit- coins/Ethereum Setting up a Wallet, Programming smart contracts on Ethereum	8
3.	Issues with Blockchain: Security and Safeguards, Protection from attackers, Hacks on exchanges, what is stopping adoption, Scalability problems, Network attacks to destroy bitcoin, Legal adoption in various countries and laws.	7
4.	Bitcoin mining strategy, Altcoins, Sidechains, Post-quantum crypto, seg wit & aggregate signatures, smart property, data feeds and public randomness, Research perspectives and challenges in blockchain and cryptocurrency	5

Lab Work

Sr. No.	List of Practicals	No. of hours (28)
1.	Building blocks by using MetaMask wallet and creating Ethereum transactions	5
2.	Programming smart contracts on ethereum	5
3.	Implementation of Shared wallet	6
4.	Developing programs using Web3.js	6
5.	Implementation of Hyperledger Fabric	6

SUGGESTED BOOKS

1. Blockchain: The Complete Step-by-step Guide to Understanding Blockchain and the Technology Behind It by Jay Isaac, 2012
2. Blockchain Revolution by Don and Alex Tapscott

3. The Basics of Bitcoins and Blockchains by Antony Lewis
4. The Blockchain Developer by Elad Elrom

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc22_cs44/preview
2. https://www.coursera.org/learn/cryptocurrency

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Build efficient blockchain models to carry out advanced tasks with the practical approach.	Apply and Create
2	Evaluate the use and risks involved with Blockchain.	Apply and Evaluate
3	To understand what problem a blockchain can solve	Understanding and Knowledge
4	To understand and analyze the issues and challenges in the implementation of blockchains	Understand and Analyze
5	To create blockchain platforms for interdisciplinary areas to make them more secure and efficient	Create

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	2
2	3	3	2
3	2	1	3
4	2	2	3
5	3	1	2

1-Low, 2-Medium, 3-High

Course Name:	**Software Defined Networks**
Course Code:	**CSR 1259**
Credits:	**3**
L T P:	**2 0 2**
Type of Course	**Department Elective Course – II (DEC-II)**

Course Objectives	1. To understand Software Defined Networking Paradigm, Requirements and Challenges 2. To design futuristic communication network models integrating upcoming technologies like ITS, Cloud Computing, IoT, Blockchains, and IIoT

Total no. of lectures: 28

	Course Syllabus	Number of Lectures
1.	**Software-Defined Networking (SDN) and use cases** SDN background and motivation: requirements, characteristics, and standards	3
2.	**SDN Architecture planes** Architecture, data plane, open flow switches, southbound and northbound protocols, and control planes, abstraction, SDN Controllers, Open daylight, Open-flow and other derivatives	10
3.	**Network Function Virtualization (NFV)** Network Function Virtualization (NFV), Segregation to hardware and software functionalities, Virtual network functions, North bound and Southbound interfaces, Advantages and requirements	6
4.	**Applications of SDN and Issues** Application architecture, IoT, cloud computing, traffic engineering, data centers networking, mobile networks, SDN-Scalability, Reliability, SDN Traffic Flow Optimization, Security and Connectivity Issues	6
5.	**Industrial IoT (IIOT) (Industry 4.0 and Application Domains)** Model of Industry 4.0: Concepts, deployment, Industrial IoT Layers: sensing, processing and communication, Security aspects and issues in Industry 4.0, Ubiquitous connectivity planning for various applications (Blockchain, Data Analytics, Fog Computing)	3

List of Experiments:		**Number of Turns**
1.	Mininet: A simulation environment for SDN (Use case simulation of SDN based Smart Home Application) 1. Network Topology creation and REST API introduction. 2. Influencing flows via cURL commands. 3. Create a network and run a simple performance test. 4. Use "ovs-vsctl" command to directly control open v switch. 5. Dynamically change the network parameters—link delay analysis. 6. Dynamically change the forwarding rules. 7. Mininet Random Topology Generator.	14

References:

Books:

- Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud by William Stallings, Addison-Wesley Professional.
- SDN – Software Defined Networks by Thomas Nadeau (Author), Ken Gray, Addison-Wesley Professional.
- Software-Defined Networks: A Comprehensive Approach, By Paul Goransson and Chuck Black, MK Publication with Elsevier

e-books:

- https://sdn.systemsapproach.org/

Available MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. https://www.coursera.org/learn/iiot-google-cloud-platform
3. https://www.udemy.com/course/sdn-openflow-nfv-introduction/

S.No	Course Outcomes
CO-1	To learn SDN basic paradigm, requirements and challenges
CO-2	To understand concept of segregation of control and data planes with network virtualization function
CO-3	To be able to analyse and evaluate different application specific use cases and their requirements
CO-4	To learn and understand Application of SDN with forthcoming technologies.
CO-5	To be able to evaluate different application models use cases and their performance

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	-	-	1
CO2	-	-	1
CO3	1	-	2
CO4	1	-	2
CO5	2	-	2

1-Low, 2-Medium, 3-High

Course Name	Recommender System
Course Code	CSR 1260
L T P	2 0 2
Credits	3
Type of Course	Department Elective Course – II (DEC-II)

Course Objectives:

1. To understand the basic concepts of recommender systems
2. To develop state-of-the-art recommender systems that automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	**Introduction:** Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.	7
2.	**Collaborative Filtering:** User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems. **Content-based recommendation:** High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.	8
3.	**Knowledge based recommendation:** Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders. **Hybrid approaches:** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.	8
4.	**Evaluating Recommender System:** Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics. **Recommender Systems and communities:** Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group recommender systems.	7

SUGGESTED BOOKS

Text books:

1. F. Ricci, L Rokach, B. Shapira and P.B. Kantor, Recommender systems handbook, Springer 2010.
2. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed.

Reference books:

1. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.

2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.

Available MOOCS:

1. https://www.classcentral.com/subject/recommender-systems
2. https://www.coursera.org/specializations/recommender-systems

Lab Practical :

1. Designing a Hybrid Recommendation System
2. Designing a Hybrid Collaborative Filtering Recommendation System
3. Designing a Hybrid Knowledge-based Recommendation System
4. Building a Neural Network Hybrid Recommendation System

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	**Understand** the basic concepts of recommender systems	Understanding
2	**Solve** mathematical optimization problems pertaing to recommender systems	Evaluate and Analyze
3	**Carry** out performance evaluation of recommender systems based on various metrics	Evaluate and Analyze
4	**Implement** machine-learning and data-mining algorithms in recommender systems data sets.	Create
5	**Learn** about advanced topics and current applications of recommender systems in other realms such as mobile computing.	Understanding

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	1	1	1
2	2	2	-
3	3	2	1
4	2	3	1
5	1	1	-

1-Low, 2-Medium, 3-High

Course Name	**:**	**Container Micro Services**
Course Code	**:**	**CSR 1261**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of course	**:**	**Department Elective Course – II (DEC-II)**

Course Objectives:	
1.	Students will learn a migration strategy to refactor a service from a monolith to its own microservice and implement the migration. Students will learn how to evaluate and refactor microservice capabilities from a monolithic architecture and employ different forms of message passing in microservices.
2.	Students will be introduced to industry standard best practices for message passing in a service architecture. Students will analyze and understand the design decisions and the implementations of different forms of message passing in development and production systems.

Total No. of Lectures – 28
Total No. of Lab hrs. – 28

Sr No.	**Course contents**	**Number of Lectures**
1	**Introduction to Message Passing** • Define message passing • Understand historical context of how and why message passing is used	4
2	**Refactoring From a Monolith:** • Analyze and identify the first service or capability to decompose a monolith • Create a dependency map in order to prioritize how to refactor a service (based on business logic) • Determine the appropriate migration strategy • Migrate a service from a monolith into its own microservice • Apply the strangler pattern for migrating a monolith architecture	6
3	**Types of Message Passing** • Identify use cases & implement best practices of REST • Identify use cases of gRPC • Identify use cases & implement best practices of message queues	7
4	**Implementing Message Passing**: • Use and apply REST • Use and apply gRPC • Use and apply Kafka	4
5	**Message Passing in Production:** • Identify use cases of communication protocol in conjunction with one another • Use OpenAPI • Manage the life cycle of communication protocol	7

Sr No.	**Lab contents**	**Number of Hours**
1	Deploy and run Java EE 8 microservices using Docker and Kubernetes	5
2	Build resilient service clients using circuit breakers, bulkheads, timeouts and retries	6

3	Implement configurability with Kubernetes ConfigMaps and Secrets using MicroProfile Config	6
4	Implement service call tracing with MicroProfile OpenTracing	5
5	Implement Java EE Security APIs with JAX-RS	6

Bibliography:

Sr No.	Book Detail	Year of Publication
1	Microservices and Containers, First edition by Parminder Singh Kocher	2018
2	The Kubernetes Book by Nigel Poulton	2022
3	Microservices in .NET, Second Edition by Christian Horsdal Gammelgaard	2021

Available MOOCS:

1. https://cloudacademy.com/course/basics-of-using-containers-in-production/microservices-1/
2. https://www.udacity.com/course/scalable-microservices-with-kubernetes--ud615
3. https://www.udemy.com/topic/microservices/

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1.	Students will create a migration strategy to refactor a service from a monolith to its own microservice and implement the migration.	Create
2.	Students will learn how to evaluate and refactor microservice capabilities from a monolithic architecture	Evaluate
3.	Students will be introduced to industry standard best practices for message passing in a service architecture.	Understanding and Knowledge
4.	Students will analyze and understand the design decisions and the implementations of different forms of message passing in development and production systems.	Understand and Analyze
5.	Students will learn to apply different forms of message passing in microservices.	Apply

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	-	3
2	2	1	3
3	3	2	3
4	3	1	3
5	3	1	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Data Science**
Course Code	**:**	**CSR 3001**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Open Elective (OE)**

Total No. Lectures: 28

Course Objectives:

1. To be able to learn about the entire pipeline of a typical system involving data, collection, preprocessing, storage, retrieval, processing, analysis, and visualization.
2. To demonstrate an understanding of statistics and machine learning concepts that are vital for data science

Course Contents:

Sr. No.	Course contents	No. of Lectures
1	What is data Science-Definition, Why it is important, Uses, Data Science vs Machine learning, Ethics, Python in data science, User defined Modules and Packages in Python for data science	04
2	Data mining, structured and unstructured data, transformation and sampling of data	04
3	Data cleaning and exploration: Cleaning data, missing data imputation, noise elimination, feature selection and dimensionality reduction, normalization	04
4	Feature Engineering, Training, validation, testing, generalization, overfitting, Decision trees, random forests, Linear classifiers, Attribute selection- Filter methods, Wrapper methods Data discretization- Unsupervised discretization, Supervised discretization	06
5	Predictive modelling, Decision trees, Rule learners, Linear/logistic regression, Nearest neighbour learning, Support vector machines Properties of prediction algorithms and practical exercises, Combining classifiers	06
6	Measuring performance of a model- Accuracy, ROC curves, precision, recall curves, Loss functions for regression Interpretation of results- Confidence interval for accuracy, Hypothesis tests for comparing models, algorithms	04

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	Case Studies in Data Science: Eve, the Pharmaceutical Robot Scientist: Data Science for Drug Discovery	07
2	Case Studies in Data Science: Data science for sports analytics in python	07
3	Case Studies in Data Science: Data science for sensor data using python	07
4	Case Studies in Data Science: Data science for healthcare using python	07

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Joel Grus, Data Science from Scratch: First Principles with Python, O"Reilly Media	2019
2	I. Witten, E. Frank, M. Hall. Data Mining: Practical Machine Learning Tools and Techniques (3rd Edition), Morgan Kaufmann	2019

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs60/preview
2. https://www.coursera.org/specializations/data-science

Course Outcomes:

At the end of the course, students will be able to:	
1.	To develop relevant programming abilities to analyse the data
2.	Create competitive advantage from both structured and unstructured data transformation
3.	Predict outcomes with feature selection and engineering techniques.
4.	Unearth patterns in customer behaviour with predictive modelling techniques.
5.	To apply data science techniques to solve real-time problems and communicate impact of work

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	3	2	2
CO2	2	-	1
CO3	2	-	1
CO4	2	-	1
CO5	3	3	3

1-Low, 2-Medium, 3-High

Course Name	**:**	**Internet of Things**
Course Code	**:**	**CSR 3002**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Open Elective**

Total No. Lectures: 28

Course Objectives:

The main objectives of this course are:	
1.	Understanding of core technology, applications, sensors used and IOT architecture along with the industry perspective.
2.	Principles and operations of different types of sensors commonly used on mobile platform will be taught in a manner that by the end of the course the students will be able to design and implement real time solutions using IOT.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Introduction to IOT** What is IoT, how does it work? Difference between Embedded device andIoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market, Privacy issues in IOT	2
2.	**Setting Up Raspberry Pi/Arduino to Create Solutions** Explore Raspberry Pi, setting up Raspberry Pi, showing working of Raspberry Pi using Secure Shell (SSH) Client and Team Viewer, Understand Sensing actions, Understand Actuators and Microelectromechanical Systems (MEMS).	4
3.	**Communication Protocols in IoT** Types of wireless communication, Major wireless Short-range communication devices, properties, comparison of these devices (Bluetooth, Wireless Fidelity (WiFi), ZigBee, Low-power Wireless Personal Area Network (6LoWPAN)), Major wireless Long-range communication devices, properties, comparison of these devices (CellularIoT, Low-Power Wide-Area Network (LPWAN))	6
4.	**IoT Applications** Industrial Internet 4.0, Applications such as: Smart Homes, Wearables,Smart City, Smart Grids, Connected Car, Connected digital health, telehealth, telemedicine), smart retail.	4
5.	**Sensors** Applications of various sensors: Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: camerasGlobal positioning sensors: Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), Indian Regional Navigation Satellite System (IRNSS), Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, ProximitySensor, Gyroscope, Calibration, - noise modelling and characterization, and - noise filtering and sensor data processing, Privacy & Security	6
6.	**Cloud Computing Services** Introduction to GCP, AWS, Microsoft Azure, IoT Integration of IoT services with the cloud, IoT Data Analytics in the cloud	3
7.	**IoT Application Domains** Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring	3

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	Project based lab work: Design and build systems that will use sensors, communication protocols and actuators	14

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on- Approach)", VPT, 1st Edition	2014
2.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition	2013
3.	CunoPfister, "Getting Started with the Internet of Things", OReilly Media	2011
4.	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing	2015

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2. https://www.coursera.org/specializations/iot
3. https://www.edx.org/course/introduction-to-the-internet-of-things-iot

Course Outcomes:

At the end of the course, students will be able to:	
CO-1	Learn the concept of IOT
CO-2	Understand IOT architecture and applications in various fields
CO-3	Analyze the security and privacy issues in IOT.
CO-4	Design various applications of sensor in Industrial, healthcare, commercial, andbuilding automation.
CO-5	Evaluate different application models and there performances

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	PO2	PO3
CO1	-	-	1
CO2	-	-	1
CO3	2	-	2
CO4	3	-	2
CO5	2	-	2

1-Low, 2-Medium, 3-High

Course Name	**:**	**Machine Learning**
Course Code	**:**	**CSR 3003**
Credits	**:**	**3**
LTP	**:**	**2 0 2**
Type of course	**:**	**Open Elective (OE)**

Course Objectives:

The main objectives of this course are:

1. The students should be able to understand the basics of Machine Learning.
2. They should be able to apply different machine learning models using various datasets.
3. They should be able to develop an understanding of the role of machine learning in massive scale automation.

Course Contents: **28**

Sr. No	Contents	No of lectures
1.	**BASICS OF MACHINE LEARNING:** Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning.	5
2.	**SUPERVISED LEARNING:** Classification and Regression: K-Nearest Neighbour, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2,confusion matrix, precision, recall, F-Score, ROC-Curve.	6
3.	**UNSUPERVISED LEARNING:** Introduction to clustering, Types of Clustering: Hierarchical Agglomerative Clustering and Divisive clustering; Partitional Clustering - K-means clustering, Principal Component Analysis	6
4.	**BAYESIAN LEARNING:** Probability theory and Bayes rule, Naive Bayes learning algorithm, Bayes nets	6
5.	**DECISION TREES:** Representing concepts as decision trees, Recursive induction of decision trees, best splitting attribute: entropy and information gain, Overfitting	5

Lab Work:

Sr. No	Lab contents	No of hours
1.	Mathematical Computing with Python packages: Numpy, Matplotlib, Pandas, ScikitLearn, Tensorflow	4
2.	Implementation of data handling and reduction techniques	4
3.	Implementation of various classification and regression algorithms - KNN,SVM, Naïve Bayes, Decision Trees and Random Forest	2
4.	Implementation of Hierarchical clustering, K-means clustering, Density based clustering algorithms	2
5.	Machine learning based project	2

Bibliography:

Sr.No.	Book Detail	Year of Publishing
1	Tom Mitchell, Machine Learning, McGraw Hill,	2017
2	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer	2011
3	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e	2008
4	Yuxi (Hayden) Liu, "Python Machine Learning By Example", Packet Publishing Limited	2017

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
2. https://www.coursera.org/learn/machine-learning

Course Outcomes:

At the end of the course, students will be able to:	
1	Describe the basic concepts and applications of machine learning
2	Understand and classify different types of Machine Learning algorithms
3	Apply various machine learning algorithms in a range of real-world applications.
4	Analyse different machine learning solutions to classification, regression and clustering problems.
5	Design and evaluate different machine learning algorithms

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	PO1	PO2	PO3
CO1	3	-	2
CO2	3	-	2
CO3	3	-	2
CO4	3	-	2
CO5	3	-	2

1-Low, 2-Medium, 3-High

Course Name	**Software Project Management**
Course code	**CSR 3004**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Open Elective (OE)**

Course Objectives:

1. To understand Software Process, Project and Product concepts.
2. To understand the importance of software project management and identify main stages and stakeholders of a software project.
3. To understand different testing techniques used in designing test cases and how developers incrementally develop and test code.

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Software, Process, Project and Product Overview: Introduction to Software Project, Process and Product, Software Vs Other products, Stakeholders in Software Project, Software Project Development: Software Development Life Cycle, Agile Development and DevOps. Fundamentals of Software Project Management (SPM), Need Identification, Vision and Scope document, Project Management Cycle, SPM Objectives, Management Spectrum, SPM Framework, Software Project Planning, Planning Objectives, Project Plan, Types of project plan, Structure of a Software Project Management Plan, Software project estimation.	6
2.	Project Organization and Scheduling: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Ways to Organize Personnel, Project schedule, Scheduling Objectives, Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, CPM, Bar Charts: Milestone Charts, Gantt Charts.	6
3.	Project Monitoring and Control: Dimensions of Project Monitoring & Control, Earned Value Analysis, Earned Value Indicators: 23 Budgeted Cost for Work Scheduled (BCWS), Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Interpretation of Earned Value Indicators, Error Tracking, Software Reviews, Types of Review: Inspections, Deskchecks, Walk through, Code Reviews, Pair Programming.	6
4.	Software Quality and Testing: Testing Objectives, Testing Principles, Test Plans, Test Cases, Types of Testing, Levels of Testing, Test Strategies, Program Correctness, Program Verification & validation, Testing Automation & Testing Tools, Concept of Software Quality, Software Quality Attributes, Software Quality Metrics and Indicators, The SEI Capability Maturity Model CMM), SQA Activities.	6
5.	Software Configuration Management: Software Configuration Items and tasks, Baselines, Plan for Change, Change Control, Change Requests Management, Version Control, Risk Management: Risks and risk types, Risk Breakdown Structure (RBS), Risk Management Process: Risk identification, Risk analysis, Risk planning, Risk monitoring, Cost Benefit Analysis,	4

	Software Project Management Tools: CASE Tools, Planning and Scheduling Tools, MS-Project.	

SUGGESTED BOOKS

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi.
2. Robert K. Wysocki ―Effective Software Project Management‖ – Wiley Publication.
3. Walker Royce: ―Software Project Management‖- Addison-Wesley.
4. Gopalaswamy Ramesh, ―Managing Global Software Projects‖ – McGraw Hill Education (India), Fourteenth Reprint.

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc19_cs70/preview
2. https://www.coursera.org/courses?query=software%20project%20management

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Demonstrate knowledge of project management terms and techniques.	Understand, Knowledge
2	Actively participate or successfully manage a software development project by applying project management concepts.	Apply
3	Obtain adequate knowledge about software process models and software effort estimation techniques.	Understand
4	Describe and determine the purpose and importance of project management from the perspectives of planning, tracking and completion of project	Knowledge
5	Implement a project to manage project schedule, expenses and resources with the application of suitable project management tools.	Apply, Create

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	3	3	2
2	3	3	3
3	3	3	3
4	3	3	3
5	2	3	2

1-Low, 2-Medium, 3-High

Course Name	**Mobile Computing**
Course Code	**CSR 3005**
L T P	**2 0 2**
Credits	**3**
Type of Course	**Open Elective (OE)**

Course Objectives:

1. To understand the concept and role of mobile computing.
2. To provide familiarity with the network protocol and modern mobile wireless communication

Course Content: **Total no. of lectures: 28**

Sr. No.	Course Content	No. of Lectures
1.	Introduction Overview of wireless and mobile systems and the challenges therein. Radio channel and wireless physical layer design. Medium access, multiplexing, link adaptation.	3
2.	Wireless Application Protocol Introduction of WAP, WAP applications, WAP Architecture, WAP Protocol Stack, Challenges in WAP	3
3.	Mobile network routing Multi-hop routing protocols, routing metrics. Multicast, multi-hop data forwarding, opportunistic routing. Solutions to handle mobility at various layers of the networking stack. TCP behaviour over wireless, other transport layer issues.	6
4.	Mobile network protocols Basic Mobile IP, Mobile IP Type-MIPV4 and MIPv6, Mobile IP: Concept, Four basic entities for MIPv4, Mobile IPv4 Operations, Registration, Tunnelling, MIPv4 Reverse Tunnelling, MIPv4 Triangular Routing, Problems and Limitations of Mobile IP (MIP), MIPv4 Route Optimization Energy efficiency, localization, security. Smartphone-based platform architectures and applications. Future directions: dynamic spectrum access, heterogeneous networks, internet of things.	8
5.	Cellular technologies Evolution of Modern Mobile Wireless Communication System, First Generation Wireless Networks, Second Generation (2G) Wireless Cellular Networks, Major 2G standards, 2.5G Wireless Networks, Third Generation 3G Wireless Networks, Wireless Local Area Networks (WLANs), Cellular –WLAN Integration, All-IP Network: Vision for 4G	8

List of experiments:		**No. of Turns**
1.	Use network simulators (NS2/NS3/NetSim etc.) Enhance any routing or mac layer protocol to provide quality of service metrics to VoIP or Video traffic.	6
2.	Develop, implement and evaluate different path selection criteria for on-demand routing protocols to determine under what network conditions each one gives the best performance.	4
3.	Create a small application for smartphones using android programming	4

Suggested Books:	
Sr. No.	**Name of books / Author/ Publisher**

1.	G. Coulouris, DollimorenadKindberg: Distributed Systems- Concepts and Design, fourth Edition.
2.	Jochen Schiller: Mobile Communications, Second Edition, Pearson Education.

Available MOOCS:

1. https://archive.nptel.ac.in/courses/106/106/106106147/
2. https://www.edx.org/course/mobile-computing-with-app-inventor-cs-principles-2

Couse Outcomes and Blooms Level mapping:

S. No	Description	Blooms level of taxonomy
1	Understand the concepts and characteristics of mobile systems	Understanding
2	List the various types of mobile routing protocols and be able to apply in various types of networks	Explain, Apply
3	Design the various types of mobile network protocols and identify the various design issues of the mobile network protocols	Create
4	Demonstrate the working principles of various cellular technologies	Knowledge
5	Distinguish the characteristics, working principles and design issues of wireless application protocol	Evaluate and Analyze

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

CO	Program Outcomes		
	PO1	PO2	PO3
1	2	2	3
2	2	2	3
3	3	3	3
4	3	2	3
5	3	2	3

1-Low, 2-Medium, 3-High

Semester III

Semester III

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CSR 5001	Seminar and Report Writing	2	0	0	2	Seminar
2.	RPR 6001	Research and Publication Ethics				2	RPE
3.	CSR 7001	Dissertation-I	0	0	28	14	Dissertation
					Total Credits	18	

Course Name	**Seminar and Report Writing**
Course code	**CSR 5001**
L T P	**2 0 0**
Credits	**2**
Type of course	**Compulsory**

Course Objectives:

After this course, the students will be able to

1. Identify a research topic
2. Collect literature
3. Present seminar and Discuss the queries

Course Content: **Total no. of lectures: 28**

Identify topic: identify an area of interest, collect papers of good journals/conferences and identify research topic and discussion, Identification of specific topic, Analysis, Organization of modules 7
Literature survey: importance of literature survey, selecting relevant material for your area of research, writing format of literature survey, presentation in terms of seminar 7
Report writing: report writing formats, introduction of report writing tools like latex software etc. and present the literature work in terms of a report, the report must be in the form of the review paper with a format used by IEEE / ASME etc, 7
Plagiarism: knowledge about plagiarism, and how to check in various tools available. prepare Report and any research writing according to the plagiarism policy 7

Suggested Books:	
Sr. No.	**Name of books / Author/ Publisher**
1.	Probability and Statistics for Engineers and scientists by Anthony J. Hayter, Cencage Learning, 4th Edition
2.	Probability and Statistics for Engineers and scientists by Walpole, Myers, Myers and Ye, 8th ed Pearson Education
3.	Research Methodology - Methods and Techniques, C. K. Kothari, New Age International, 2nd Edition
4.	English for writing research papers by Adrian Wallwork, 2nd Edition. Springer
5.	Statistics: Concepts and Controversies by David S. Moore, William I. Notz, W. H. Freeman

Available MOOCS:

1. https://onlinecourses.nptel.ac.in/noc22_hs05/preview
2. https://www.coursera.org/courses?query=academic%20writing
3. https://www.edx.org/learn/writing

Couse Outcomes:

1. Identify a problem in the area of your interest
2. Interpret by using the background knowledge and analyse it and propose a work plan to solve it.
3. Contrast the different theories/experiments done in literature
4. Support the solution proposed of the problem Present it before an audience and
5. organise the literature survey and solution proposed in seminar report(s).

Program Outcomes (POs):

- **PO 1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO 2:** An ability to write and present a substantial technical report/document.
- **PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program**.**

Mapping of Course Outcomes (Cos) with Program Outcomes (POs):

	PO1	**PO2**	**PO3**
CO1	-	-	1
CO2	1	3	2
CO3	2	3	3
CO4	3	3	3
CO5	-	3	3

1-Low, 2-Medium, 3-High