



**DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING**

**HANDBOOK**

**M.Tech. in DATA SCIENCES**

**JSS TECHNICAL INSTITUTIONS CAMPUS MYSORE - 570 006**

**2024-2025**

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## **About JSS Science and Technology University**

JSS Science and Technology University was started under the Private Management of J.S.S. Mahavidyapeetha, Mysuru, during the year 2016. The Government of Karnataka has accorded approval to establish and commence a Private University in the name and style “J.S.S Science and Technology University” at Sri Jayachamarajendra Engineering College campus, Mysuru (Notification No. ED 84 URC 2014).

JSS Science and Technology University is one of the recent additions to the institutions administered by JSS Mahavidyapeetha, and is the second University being established besides a Medical University at Mysuru. India’s higher education system is on the verge of major reforms and JSS Science and Technology University has been established to create a bright future and a desired learner centric eco-system and transform into a futuristic global University. The Availability of skilled human resources and trained technical manpower in engineering and technology is a major reason for growing investments in the state. In this context the higher education system has a key role and more particularly JSS S&T U with an objective of transforming the students at all levels of higher education including research and innovation with measures to improve the quality of workforce.

## **Vision of JSS Science and Technology University**

- Advancing JSS S&T University as a leader in education, research and technology on the international arena.
- To provide the students a universal platform to launch their careers, vesting the industry and research community with skilled and professional workforce.
- Accomplishing JSS S&T University as an epicenter for innovation, center of excellence for research with state of the art lab facilities.
- Fostering an erudite, professional forum for researchers and industrialists to coexist and to work cohesively for the growth and development of science and technology for betterment of society.

## **Mission of JSS Science and Technology University**

- Education, research and social outreach are the core doctrines of JSS S&T University that are responsible for the accomplishment of in-depth knowledge base, professional skill and innovative technologies required to improve the socio economic conditions of the country.
- Our mission is to develop JSS S&T University as a global destination for cohesive learning of engineering, science and management which are strongly supported with interdisciplinary research and academia.
- JSS S&T University is committed to provide world class amenities, infrastructural and technical support to the students, staff, researchers and industrial partners to promote and protect innovations and technologies through patents and to enrich entrepreneurial endeavors.
- JSS S&T University's core mission is to create a knowledge led economy through appropriate technologies, and to resolve societal problems by educational empowerment and ethics for better living.

## **Vision of Sri Jayachamarajendra College of Engineering**

- “Be an international leader in engineering education, research and application of knowledge to benefit society globally”.

## **Mission of Sri Jayachamarajendra College of Engineering**

- “To synergistically develop high-quality manpower and continue to stay competitive in tomorrow’s world”.
- “To foster and maintain mutually beneficial partnerships with our alumni, industry, state and central governments through public services assistance and collaborative research”.
- “To create empowered individuals with a sense of identity”.

## **Vision of Department of Information Science and Engineering**

- “To be an outstanding education center in Information Science and Engineering through excellence in teaching and research.”

## **Mission of Department of Information Science and Engineering**

- To empower the graduates with domain-specific knowledge, skill and creative thinking.
- To create wide-angle exposure to the stakeholder on thrust areas.
- To prepare graduates with research and entrepreneurship attitude having high moral and ethical values.

## **ABOUT THE DEPARTMENT OF INFORMATION SCIENCE & ENGINEERING**

- The Department of Information Science & Engineering was established in the year 2000.
- The department offers two undergraduate program B.E in Information Science and Engineering started in the year 2000, B.E in Computer Science & Business Systems (CSBS) started in the year 2019 and two postgraduate programs M.Tech in Software Engineering started in the year 1995 and M.Tech in Data Sciences started in the year 2017.
- The students of the department have a good placement record of more than 90%.
- The department has highly qualified faculty members who have rich experience in the areas of Machine Learning, Deep Learning, Artificial Intelligence, Pattern Recognition, Natural language processing, Medical Image Analysis, Computational Linguistics, Biomedical Informatics, Computer Networks, Wireless Networks, IoT, Speech Signal Processing.
- Faculty have international collaboration with various reputed International Universities like Harvard University, USA, Nanyang Technological University, Singapore, Saint Petersburg State Electro Technical University "LETI" (ETU), Russia, University of Mannheim, Germany, University of Genova, Italy, and many more.
- Faculty publish their research findings in the reputed Journals and Conference proceedings with good citation index.
- The department regularly conducts workshops, seminars, symposiums, and faculty development programmes to keep updated with emerging technologies.
- The department is housed with high end computing facilities like GPU machines such as ParamShavak, High End Internet Facilities, wifi facilities, access to reputed journals like IEEE, Springer, Elsevier and many more.
- Alumni of the department pursue their higher studies within the country as well as abroad and some of the alumni are successful entrepreneurs.

### **Programmes offered (UG & PG)**

#### **Department offers two Undergraduate programs**

- B.E in Information Science and Engineering (ISE) with an intake of 90
- B.E in Computer Science and Business Systems (CSBS) with an intake of 60

#### **Department offers two Postgraduate programs**

- M.Tech in Software Engineering (SE) with an intake of 18
- M.Tech in Data Sciences(DS) with an intake of 20
- M.Sc in Computer Science (Data Science) with an intake of 30

## Department Faculty Details

Sl. No.	Name	Designation	Qualification
1	Dr. B S Harish	Professor	B.E., M.Tech., Ph.D
2	Dr. D S Vinod	Professor	B.E., M.Tech., Ph.D
3	Dr. Mahanand B S	Professor	B.E., M.Tech., Ph.D
4	Dr. S P Shiva Prakash	HOD, Professor	BE, M.Tech, Ph.D.
5	Dr.Umesh K K	Associate Professor	BE, M.Tech, Ph.D.
6	Dr. R J Prathibha	Associate Professor	B.E., M.Tech, Ph.D
7	Dr. Vanishri Arun	Associate Professor	BE, M.Tech, Ph.D.
8	Dr. Vani H Y	Associate Professor	B.E., M.Tech., Ph.D.
9	Dr. Manju N	Associate Professor	BE, M.Tech, Ph.D.
10	Dr. C K Roopa	Associate Professor	BE, M.Tech, Ph.D.
11	Dr. M S Maheshan	Associate Professor	BE, M.Tech, Ph.D.
12	Ms. Shyla Raj	Assistant Professor	BE, M.Tech, Ph.D.
13	Mr. Praveen Murthy K S	Assistant Professor	BE, M.Tech, (Ph.D.)
14	Ms. Tejaswini M	Assistant Professor	BE, M.Tech , (Ph.D.)
15	Ms. Sindhu G	Assistant Professor	BE, M.Tech, (Ph.D.)
16	Ms. Malapriya S	Assistant Professor	BE, M.Tech , (Ph.D.)
17	Ms. Sindhu A S	Assistant Professor	BE, M.Tech, (Ph.D.)
18	Ms. Shruthi N	Assistant Professor	BE, M.Tech, (Ph.D.)
19	Dr. Vidyashree L	Assistant Professor	BE, M.Tech, Ph.D.
20	Ms. R S Anusha	Assistant Professor	BE, M.Tech, (Ph.D.)
21	Mr. Vinay Bharadwaj K	Assistant Professor	BE, M.Tech, (Ph.D.)
22	Ms. Parvathi S J	Assistant Professor	BE, M.Tech, (Ph.D.)
23	Ms. Vinutha Prakash	Assistant Professor	BE, M.Tech, (Ph.D.)

24	Ms. Lavanya M S	Assistant Professor	BE, M.Tech, (Ph.D.)
25	Mr. Nagarjun A	Assistant Professor	BE, M.Tech, (Ph.D.)
26	Ms. T S Kaveri	Assistant Professor	BE, M.Tech, (Ph.D.)
27	Ms.Vimarsha K	Assistant Professor	BE, M.Tech, (Ph.D.)
28	Ms.Vyshali Rao K P	Assistant Professor	BE, M.Tech, (Ph.D.)

## Laboratory facilities

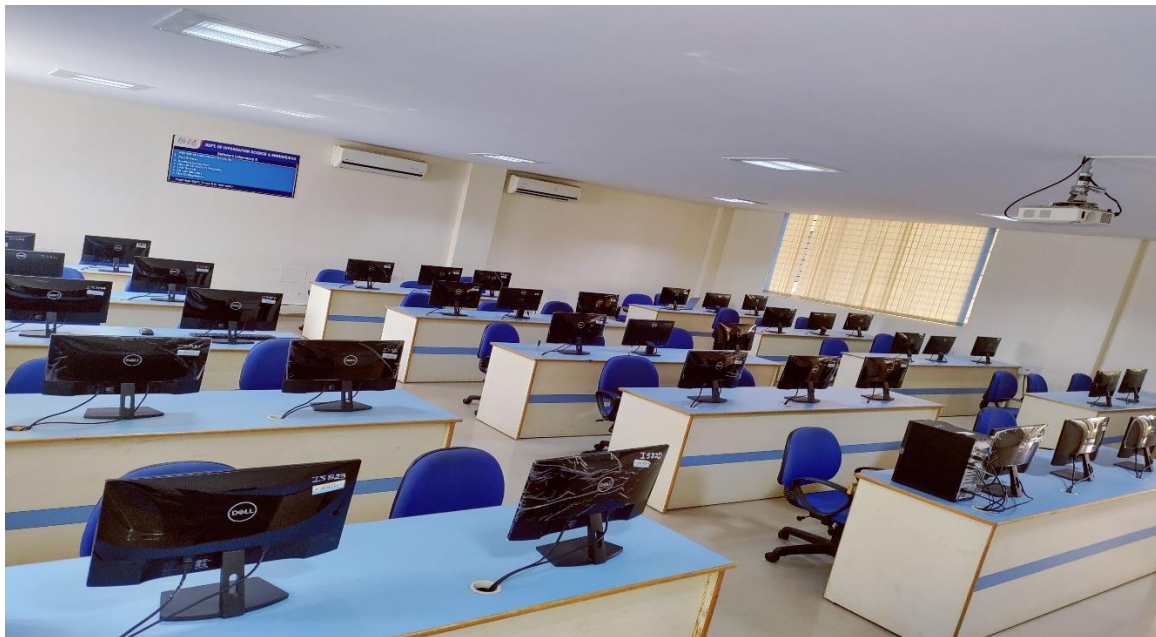
Department has well equipped laboratories which help in attaining program outcomes. Students develop a wide range of applications to enhance their learning abilities in the laboratory. Details of laboratory facilities are provided in the table below:

Sl. No.	Name of the Laboratory	Equipment Name	Equipment details
1	ISE Computer Lab-1	DELL  Quantity 37 Nos.	<ul style="list-style-type: none"> <li>• i7 8th Generation Processor,</li> <li>• Q 370Processor</li> <li>• 810G Mil Grad Chaises</li> <li>• 256 GB Solid State Drive (this gives high performance)</li> <li>• 22 inch Full High Definition Monitor with IPS panel,</li> <li>• 5 Year K7 Antivirus: top end protection with internet security</li> <li>• 8GB single chip RAM</li> <li>• Multimedia Keyboard, Mouse.</li> <li>• System box with build in Graphics card (Pre-fitted) : UHD 630</li> <li>• Built in Operating System: Windows 10.</li> <li>• Built in speaker.</li> </ul>
		DELL Vostro 3900 Series,  Quantity 2 Nos.	<ul style="list-style-type: none"> <li>• Intel core I5 4460 processor,3.2GHz</li> <li>• windows 8.1Professional OS,</li> <li>• 4GB DDDRAM,</li> <li>• 1TB SATA HDD,</li> <li>• 19.5 Wide TFT LED Wider monitor screen</li> </ul>
		HCL  Quantity 5 Nos.	<ul style="list-style-type: none"> <li>• 2 GB RAM DDR2, INTEL Core 2 DUO Processor</li> <li>• DVD writer</li> <li>• 160 GB HARD DISK,</li> <li>• 17" LCD Monitor</li> </ul>

2	ISE Computer Lab-2	DELL	<ul style="list-style-type: none"> <li>• i7 8th Generation Processor,</li> <li>• Q 370Processor</li> <li>• 810G Mil Grad Chaises</li> <li>• 256 GB Solid State Drive (this gives high performance)</li> <li>• 22 inch Full High Definition Monitor with IPS panel,</li> <li>• 5 Year K7 Antivirus : top end protection with internet security</li> <li>• 8GB single chip RAM</li> <li>• Multimedia Keyboard, Mouse.</li> <li>• System box with build in Graphics card (Pre-fitted) : UHD630</li> <li>• Built in Operating System : Windows 10</li> <li>• Built in speaker</li> </ul>
		Quantity 36 Nos.	
		DELL Vostro 3900 Series,	<ul style="list-style-type: none"> <li>• Intel core I5 4460 processor,3.2GHz,</li> <li>• windows 8.1Professional OS,</li> <li>• 4GB DDR RAM,</li> <li>• 1TB SATA HDD,</li> <li>• 19.5 inch TFT LED monitor</li> </ul>
		Quantity 8 Nos.	
3	PG Computer Lab	Computing Device	<ul style="list-style-type: none"> <li>• X3100 M4 IBM,</li> <li>Intel Xeon Quad core 500GB HDD,</li> <li>• 4 GB RAM, 2 GB Graphics card, 21.5 inch full HD Monitor</li> <li>• DVD writer, Keyboard &amp; Mouse.</li> </ul>
		Quantity 9 Nos.	
		HCL	<ul style="list-style-type: none"> <li>• 2 GB RAM DDR2, Intel core 2 Duo processor</li> <li>• DVD writer, 160 GB hard disk,</li> <li>• 17 inch LCD Monitor</li> </ul>
		Quantity 21 Nos.	



**ISE COMPUTER LAB-1**



**ISE COMPUTER LAB -2**



**PG Computer Lab**



**Data Science and Computer Lab**



**Computer Vision and Pattern Recognition Laboratory**



**Network Operating Center**

## **Research & Consultancy**

The department has highly qualified faculty members who have rich experience in the areas of Machine Learning, Deep Learning, Artificial Intelligence, Pattern Recognition, Natural language processing, Medical Image Analysis, Computational Linguistics, Biomedical Informatics, Computer Networks, Wireless Networks, IoT, Speech Signal Processing. Faculty have international collaboration with various reputed International Universities like Harvard University, USA, Nanyang Technological University, Singapore, Saint Petersburg State Electro Technical University "LETI" (ETU), Russia, University of Mannheim, Germany, University of Genova, Italy, and many more. Faculty publish their research findings in the reputed Journals and Conference proceedings with good citation index.

The department has well equipped research laboratories to develop research capabilities of the students. The students are allowed to access the devices through centralized computing facilities all through the day. Wi-Fi facility is provided to all the students and laboratories have access to scientific journals like IEEE, Science direct, etc.

## **Employment Opportunities**

Placement office encourages students to gain a great deal of knowledge. In order to offer Placement, the placement officer and the companies involve themselves in a lot of industry institute activities which are as follows:

- Regular Students development programs are offered by domain specific core companies, in means of Technical workshops, seminars and quiz programs.
- Regular Industry visits will be organized.
- Special scholarships will be given out to students who are achievers.
- Encouraging students to participate in Hackathons and Coding contests.
- Coordinate with companies in organizing workshops on latest trends in the industries specific to core sectors.
- Involving companies in syllabus formation and delivery of new courses to students.

The Placement and Training department takes initiatives to provide adequate training for students to enable them to have better employability skills compared to other colleges. During the final year of their program, students work in and for companies as interns. In this way they gain valuable practical experience, while bringing their own added value of knowledge and expertise to the companies they are working for. Majority of these students will be converted to full time employees based on their internship perform

## **Industry-Institute-Interaction**

Interaction between technical institutions and industry is the need of the hour. Industry Institute Interaction will have great bearing on the engineering curriculum, exposure of engineering students to industrial atmosphere. There is a need to create avenues for a close academia and industry interaction through all the phases of technology development, starting from conceptualizing to commercialization. The Industry Institute Interaction Cell is established at JSS Science and Technology University with the following objectives:

- To cultivate the strong links with industry.
- To promote various industrial activities by the faculty members and students
- To have a closer linkage and promote research suited to industry needs, and consultancy
- To provide continuing education to people working in industries so that they can upgrade their technical knowledge, and / or obtain higher degrees
- To catalyze the further growth and development of interaction between the Institute and Industry
- To bring about Memoranda of Understanding and Agreements with various industrial and research organizations

## Board of Studies

Sl. No.	Category	Designation	Name of the Person
1	The Dean(s) of the Faculties	Ex-Officio Member	Dr. Manoj Kumar B
2	Dean (Engineering & Technology)		Dr. C. Nataraju
3	Head of the Department	Chairperson	Dr. S.P. Shiva Prakash
4	All Professors of the Department	Members	Dr. B S Harish Dr.D.S.Vinod Dr.B.S.Mahanand
5	Two Senior Associate Professors of the concerned Department by rotation	Members	Dr. Prathibha R J Dr. Vanishri Arun
6	One Senior Assistant Professor of the concerned Department by rotation	Member	Dr. Shyla Raj
7	One External Subject Expert from any reputed Academic /Research Institution/ Other Universities nominated by the Academic Council	Member	Dr. S. Ramanarayana Reddy Professor, Department of Computer Science and Engineering, Indira Gandhi Delhi Technical University for Women (IGDTUW), Delhi, India Email: srnreddy@igdtuw.ac.in Mobile: +919810101742
8	Two External subject expert from any reputed Academic / Research Institutions/other Universities nominated by the Vice Chancellor upon recommendation by the Dean of respective faculty.	Members	1. Dr. Mohammed Javed Assistant Professor, Computer Vision & Biometrics Lab (CVBL), Department of Information Technology, Indian Institute of Information Technology (IIIT) Allahabad Email:javed@iiita.ac.in Mobile: +919741161929  2. Dr. Mallikarjun M Kodabagi Professor and Head Department of Computer Science and Engineering, Nagarjuna College of Engineering and Technology, Bengaluru Email:mmkodabagi@gmail.com Mobile: +917022244613

9	Two external members from concerned industry/Government Departments/Public Sector undertakings/ allied area relating to placement, nominated by the Academic Council upon recommendation by the Dean of respective faculty.	Members	<p>1. Mr. Deepak Krishnappa Head - Transformation Management Office Manufacturing Businesses Group TCS, Bengaluru Email:krish.deepak@tcs.com Mobile: +9199456 54321</p> <p>2. Dr. PM Shiva Murthy Data Scientist iNDx Technology (India) Private Limited is 7th Floor, Sigma, Technology Street, Hiranandani Gardens, Powai, Mumbai- 400076, Maharashtra, India Email: pmshiva@indxtechnology.com Mobile: +919480326986</p>
10	One postgraduate meritorious alumnus, to be nominated by the Head of the Department.	Member	<p>Mr. Santhosh Kumar M N Senior Project Manager - Safety Oracle, Bangalore. Email: santhosh.d.kumar@oracle.com Mobile: +919986021443</p>
11	<p>The Chairperson, Board of Studies, may with the approval of the Vice Chancellor, co-opt as Members:</p> <p>a) One external subject expert from reputed Academic/Research Institution/Other Universities/Industry/Government departments/public sector undertakings, whenever special courses of studies are to be formulated.</p>	Member	<p>Mr. Nagaraja Rao M Project Engineer Karnataka State Council for Science and Technology Indian Institute of Science campus, Bengaluru-560012 Email: mnrao@kscst.org.in, mnrao.kscst@ka.gov.in Mobile: +918310617417</p>
	b) Two other members of faculty of the concerned Department.	Members	<p>1. Dr. Pradeep M Associate Professor Email: pradeep.manjunath@jssstuniv.in Mobile: +919986621114</p> <p>2. Dr. Vidyashree L Assistant Professor Email: vidyashreel@jssstuniv.in Mobile:+918050549571</p>

## Programme Overview

Data science has become the central approach in tackling complex real-world problems. Data engineers build intelligent systems to manage, interpret, understand and derive key knowledge from big data sets. M.Tech in Data Sciences is a two-year post-graduate program focuses on drawing meaningful knowledge from data to drive business decision-making or research findings. Program also helps in developing analytical and technical skills to guide strategic decisions in data science.

## Programme Educational Objectives

#	Program Educational Objectives:-The Graduates will be able to:
PEO – 1	Critically think and apply the principles of data science to solve real world problems.
PEO – 2	Contribute to research and development in cutting edge technology.

## Programme Outcomes

#	Program Outcomes: -The Graduates will be able to:
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 Data Science program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO-4	Ability to develop and apply software engineering principles to solve real world problems.
PO-5	Analyze and apply emerging IT tools to model complex engineering activities.
PO-6	To excel in IT profession, entrepreneurship and research activities with ethical standards

## Quality Policy

- To deliver excellent academic programs and develop innovative strategies to educate Undergraduate, Postgraduate and Research students.
- To instill quality education to students in terms of academics, research and societal needs.
- To improve the quality of the undergraduate, postgraduate and research programs.
- Improve infrastructure for student laboratories and classes.
- To encourage undergraduate and postgraduate students to begin startups.
- To introduce modern computing and managerial skills in the curriculum.



## M. Tech. Program Structure 2024-25

### Scheme of Teaching and Examination for I to IV semester

Semester	Credits
I	27
II	27
III	10
IV	16
<b>TOTAL</b>	<b>80</b>

### Credit Pattern

Semester	Type of Course	Number	Credits
I	Professional Core	04	16 credits
	Professional Elective	02	08 credits
	Professional Core Laboratory	01	1.5 credits
	Mini Project with Seminar/ Lab	01	1.5 credits
	<b>Sub Total = 27 credits</b>		
II	Professional Core	03	12 credits
	Professional Elective	02	08 credits
	Open Elective	01	04 credits
	Research Methodology and IPR	01	1.5 credits
		01	1.5 credits
<b>Sub Total = 27 credits</b>			
III	Internship/ Industrial Training	01	04 credits
	Project work (Phase 1)	01	06 credits
<b>Sub Total = 10 credits</b>			
IV	Project work (Phase 2)	01	<b>16 credits</b>
<b>TOTAL</b>			<b>80 credits</b>



**JSS MAHAVIDYAPEETHA**  
**JSS SCIENCE AND TECHNOLOGY UNIVERSITY**  
**SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU**  
**Scheme of Teaching and Examination 2024-25**  
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**



**M. Tech in Data Sciences**

**SEMESTER I**

Sl. No.	Code	Course Title	Course	Teaching Hours per Week				Credits	Examination			
				L	T	P/S/SDA	Total Contact Hours		CIE	SEE	Total Marks	Duration in Hours
1	24SDS110	Principles of Data Science	PCC 1	4	0	0	4	4	40	60	100	3
2	24SDS120	Big Data Analytics	PCC 2	3	1	0	5	4	40	60	100	3
3	24SDS130	Machine Learning	PCC 3	4	0	0	4	4	40	60	100	3
4	24SDS140	Internet Of Things	PCC 4	4	0	0	4	4	40	60	100	3
5	24SDS15X	Professional Elective 1	PEC 1	4	0	0	4	4	40	60	100	3
6	24SDS16X	Professional Elective 2	PEC 2	4	0	0	4	4	40	60	100	3
7	24SDS170L	Machine Learning Laboratory	PCCL	0	0	3	3	1.5	50	-	50	-
8	24SDS180	Minor Project – 1	Mini Project with Seminar (MPS)/ Lab (PCCL)	-	-	3	3	1.5	50	-	50	-
<b>TOTAL</b>								<b>27</b>	<b>340</b>	<b>360</b>	<b>700</b>	
<b>Note:</b> L: Lecture/ Theory; T: Tutorial; P: Integrated Practical/ Practice; S: Seminar; SDA: Skill Development Activities PCC: Professional Core Course; PEC: Professional Elective Course; PCCL: Professional Core Course Laboratory; MPS: Mini Project with Seminar.												

Professional Elective 1		Professional Elective 2	
Course Code	Course Title	Course Code	Course Title
24SDS151	Computational Statistical Methods	24SDS161	Linear Algebra and Applications
24SDS152	Information Retrieval	24SDS162	System Security
24SDS153	Image & Video Analytics	24SDS163	Exploratory Data Analysis & Visualization



**M. Tech. in Data Sciences**

**SEMESTER II**

Sl. No.	Code	Course Title	Course	Teaching Hours per Week				Credits	Examination			
				L	T	P/S/SDA	Total Contact Hours		CIE	SEE	Total Marks	Duration in hours
1	24SDS210	Advanced Data Mining Techniques	PCC 5	3	1	0	5	4	40	60	100	3
2	24SDS220	Cloud Computing and Virtualization	PCC 6	4	0	0	4	4	40	60	100	3
3	24SDS230	Deep Learning	PCC 7	4	0	0	4	4	40	60	100	3
4	24SDS24X	Professional Elective 3	PEC 3	4	0	0	4	4	40	60	100	3
5	24SDS25X	Professional Elective 4	PEC 4	4	0	0	4	4	40	60	100	3
6	24SDS26X	Open Elective	OEC	4	0	0	4	4	40	60	100	3
7	24SDS270	Research Methodology and IPR	MC	1.5	0	0	1.5	1.5	50	-	50	-
8	24SDS280L	Deep Learning Laboratory	PCCL	0	0	3	3	1.5	50	-	50	-
<b>TOTAL</b>								<b>27</b>	<b>340</b>	<b>360</b>	<b>700</b>	

**Note:** L: Lecture/ Theory; T: Tutorial; P: Integrated Practical/ Practice; S: Seminar; SDA: Skill Development Activities  
PCC: Professional Core Course; PEC: Professional Elective Course; OEC: Open Elective Course; MC: Mandatory Course; PCCL: Professional Core Course Laboratory

Professional Elective 3		Professional Elective 4	
Course Code	Course Title	Course Code	Course Title
24SDS241	Optimization Theory	24SDS251	Scalable systems for Data Science
24SDS242	Computational Linguistics	24SDS252	Web Databases & Information Systems
24SDS243	Bioinformatics	24SDS253	Social & Information Network Analysis

Open Elective	
Course Code	Course Title
24SDS261	Introduction to Data Structures & Algorithms
24SDS262	Introduction to Database Management Systems
24SDS263	Introduction to Big Data Analytics



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**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**  
**M. Tech. in Data Sciences**



**SEMESTER III**

Sl. No.	Code	Course Title	Course	Teaching Hours				Credits	Examination			
				L	T	P/S/SDA	Total Contact Hours		CIE	SEE	Total Marks	Duration in hours
1	24SDS310P	Internship/ Industrial Training	INT	Minimum 08 weeks commencing from intervening vacation of II and III semesters				4	50	-	50	-
2	24SDS320P	Project Work (Phase-1)	PROJ	-	-	12	12	6	50	-	50	-
<b>TOTAL</b>								<b>10</b>	<b>100</b>		<b>100</b>	
<b>Note:</b> L: Lecture/ Theory; T: Tutorial; P: Integrated Practical/ Practice; S: Seminar; SDA: Skill Development Activities INT: Internship/ Industrial Training; PROJ: Project Work												

**SEMESTER IV**

Sl. No.	Code	Course Title	Contact hours	Total credits	CIE	SEE	Total Marks	Exam Duration in hours
1	24SDS410P	Project Work (Phase-2)	32	16	100	200	300	3
<b>Total</b>				<b>16</b>				

**Note:** For passing the student has to score a minimum of 45 marks (CIE + SEE: 20 + 25 OR 21 + 24)

# **SEMESTER I**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS110</b>			<b>Course Title: PRINCIPLES OF DATA SCIENCE</b>			
<b>Total Credits: 04</b>			<b>Course Category: PCC</b>		<b>Course Type: Professional Core Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE: LINEAR ALGEBRA, PYTHON PROGRAMMING**

**COURSE OBJECTIVES:** To enable discovery of information and knowledge to guide effective decision making and to gain insights from various data sets.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain a flow process to solve data science problems.	L2
<b>CO2</b>	Apply mathematical concepts to classify data science problems into standard topology.	L3
<b>CO3</b>	Incorporate the concepts of probability theory and its applications on real world problems	L3
<b>CO4</b>	Analyze and illustrate statistical techniques.	L3
<b>CO5</b>	Assess the solution approach through visualization and presentation.	L5

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
1	<b>Introduction</b> What is Data Science?, Basic Terminology, Why Data Science?, Example – Sigma Technologies, The data science Venn diagram, The math: Example – Spawner-Recruit Models, Computer programming (Preferably Python/R/Matlab/PERL), Some more terminology, Some Data science case studies, Data Models and its types. Types of Data, Flavors of data, Structured versus unstructured data, Quantitative versus qualitative data, The four levels of data, The Five Steps of Data Science.	<b>Lecture 10</b>
2	<b>Basic Mathematics – Vectors and Matrices</b> Vectors and Linear Combinations, Lengths and Dot Products, Matrices, Solving Linear Equations: Vectors and Linear Equations, The Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices, Elimination = Factorization: $A = LU$ , Transposes and Permutations, Vector Spaces and Subspaces: Spaces of Vectors, The Nullspace of A: Solving $Ax = 0$ and $Rx = 0$ , The Complete Solution to $Ax = b$ , Independence, Basis and Dimension, Dimensions of the Four Subspaces	<b>10</b>
3	<b>Probability</b> Basic definitions, Probability, Bayesian versus Frequentist, Frequentist approach, Compound events, Conditional probability, The rules of probability, Collectively exhaustive events, Bayesian ideas revisited, Bayes theorem, Random variables.	<b>10</b>
4	<b>Statistics</b> Basic Statistics, What are statistics ?, How do we obtain and sample data?, Obtaining data, Sampling data, How do we measure statistics?, Point estimates, Sampling distributions, Confidence intervals, Hypothesis tests, Conducting a hypothesis test, Type I and type II errors, Hypothesis test for categorical variables.	<b>10</b>
5	<b>Visualization</b> Basic principles, ideas and tools for data visualization, why does communication matter?, Identifying effective and ineffective visualizations, Scatter plots, Line graphs, Bar charts, Histograms, Box plots, When graphs and statistics lie, Correlation versus causation, Simpson's paradox, If correlation doesn't imply causation, then what does?, Verbal communication, The why/how/what strategy of presenting, Data Science ethical issues.	<b>12</b>

### Text Books:

1. Sinan Ozdemir, Principles of Data Science, PACKT Publisher, First Edition, 2016.

### Reference Books:

1. Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth Edition, 2016.
2. Cathy O'Neil, Rachel Schutt, Doing Data Science: Straight Talk from the Frontline, O'Reilly Media, 2013.
3. Jure Leskovec, Anand Rajaraman, Jeff Ullman, Mining of Massive Datasets, Cambridge University Press Publisher, Second Edition, 2015.

### Journals/Magazines:

1. Yu, "Three principles of data science: predictability, computability, and stability (PCS)," 2018 IEEE International Conference on Big Data (Big Data), 2018, pp. 4-4, doi: 10.1109/BigData.2018.8622080.
2. <https://link.springer.com/book/10.1007/978-3-030-43981-1>

**SWAYAM/NPTEL:**

1. Swayam : [https://swayam.gov.in/nd1\\_noc19\\_cs60/preview](https://swayam.gov.in/nd1_noc19_cs60/preview)
2. NPTEL : <https://nptel.ac.in/courses/106106179/>

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Use datasets and Generate the Summary statistics and interpret the results.	JMP Pro tool	Interpret the outcome and draw inferences.
2	Develop Python codes to build a simple Machine Learning models	Python Programming	Visualize the results and interpret them.

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	-	-
CO2	2	1	2	2	2	-
CO3	2	2	2	2	2	-
CO4	1	2	2	2	2	-
CO5	1	2	2	2	2	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS120</b>		<b>Course Title: BIG DATA ANALYTICS</b>				
<b>Total Credits: 04</b>		<b>Course Category: PCC</b>			<b>Course Type: Professional Core Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>03</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>02</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>05</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

**COURSE PREREQUISITE:** Data Mining

**COURSE OBJECTIVES:** To learn how to handle big data using various techniques

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain big data analytics and methods to create innovative analytics systems for big data	L2
<b>CO2</b>	List the components of Hadoop and Hadoop Eco-System	L2
<b>CO3</b>	Apply data mining algorithms to process data streams	L3
<b>CO4</b>	Apply data mining methods and recommendation methods to handle big data	L3
<b>CO5</b>	Apply Machine Learning Techniques using R/Python	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	<b>Introduction</b> Overview of Big Data, History, Structuring Big Data, Types of Data, Elements of Big Data, Data analytics project life cycle, Problems & challenges in understanding Data Analytics, Web page categorization, computing the frequency of stock market change. Use of Big Data in Social Networking, Use of Big Data in preventing Fraudulent activities, Use of Big Data in Retail Industry.	8	5
2	<b>Big Data Technology</b> Exploring Big Data Stack, Virtualization, Virtualization Approaches, Distributed and parallel computing for Big Data, The cloud and Big Data, Cloud Deployment Models, Cloud Delivery Models, Cloud providers in Big Data Market. Introducing Hadoop, Hadoop Ecosystem, Hadoop Distributed File Systems(HDFS), Features of HDFS : Hadoop YARN, MAP Reduce, Features of Map Reduce, Working of Map Reduce, Techniques to Optimize Map Reduce Jobs, Uses of Map Reduce, HBase, Features of HBase, Role of HBase in Big Data processing, Other tools of Hadoop (Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, OOZie),	7	6
3	<b>Mining Data Streams</b> The Stream Data Model, A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing, Sampling Data in a Stream, Filtering Streams, Estimating Moments, Dealing With Infinite Streams, Counting Ones in a Window.	8	5
4	<b>Frequent Itemsets and Recommendation Systems</b> The Market Basket Analysis, A Priori Algorithm, Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream. Recommendation System: A Model, Content Based Recommendations, Collaborative Filtering, Dimensionality Reduction Problem, TheNetFlix Problem.	8	5
5	<b>Large Scale Machine Learning</b> Introduction, Types of Machine Learning Algorithms, Machine Learning Architecture, Applications of Machine Learning, Supervised Machine Learning Algorithms: Learning from Nearest Neighbors, Support Vector Machines. Unsupervised Machine Learning Algorithms: Hierarchical Clustering Techniques, K-means Algorithms.	8	5

**Text Books**

1. Big Data: Black Book, DT Editorial Services, Dream Tech Press Publishers, 2015.
2. Mining of Massive Datasets, Jure Leskovec, AnandRajaraman, Jeff Ullman, Second Edition, Cambridge University Press Publisher, 2015.

**Reference Books**

1. Big Data Analytics with R and Hadoop, Vignesh Prajapati, Packt Publishing, 2013
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 2015.

**Journals/Magazines:**

1. Gandomi, A.H.; Chen, F.; Abualigah, L. Machine Learning Technologies for Big Data Analytics. Electronics 2022, 11, 421. <https://doi.org/10.3390/electronics11030421>

**Web/Digital resources:**

1. <https://www.coursera.org/big-data-analytics>

**SWAYAM/NPTEL:**

1. <https://nptel.ac.in/courses/106104189>; NOC: Big Data Computing, IIT Patna Dr. Rajiv Misra

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	2	2	-
CO2	3	-	2	2	3	-
CO3	3	-	2	2	3	-
CO4	3	-	2	2	3	-
CO5	3	-	3	2	3	1

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS130</b>			<b>Course Title: MACHINE LEARNING</b>			
<b>Total Credits: 04</b>			<b>Course Category: PCC</b>		<b>Course Type: Professional Core Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Mathematics, Data Structures, Linear Algebra

**COURSE OBJECTIVES:** To be able to formulate machine learning problems corresponding to different applications.

**COURSEOUTCOMES(COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain the basic principles of Learning theories	<b>L2</b>
<b>CO2</b>	Explain the principles of dimensionality reduction and feature selection techniques	<b>L2</b>
<b>CO3</b>	Develop a wide variety of supervised learning algorithms	<b>L4</b>
<b>CO4</b>	Analyze various clustering algorithms	<b>L4</b>
<b>CO5</b>	Understand the basics, structure and approaches for multilayer neural networks.	<b>L2</b>

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction &amp; Bayesian Decision Theory</b> What Is Machine Learning?, Challenges, Examples of Machine Learning Applications, Present Research Avenues, Introduction to Bayesian Decision Theory, Classification, Losses and Risks, Discriminant Functions, Utility Theory, Association Rules	10
2	<b>Dimensionality Reduction</b> Introduction, Feature Generation, Feature Selection, Principal Component Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis, Locality Preserving Projections (LPP) and its variants, Locality Preserving Indexing and its variants.	10
3	<b>Supervised Learning</b> Learning a Class from Examples, Probably Approximately Correct (PAC) Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithms, Decision Tree Induction, Nearest Neighbors, Bayesian Classifier, Artificial Neural Networks, Model Over fitting, Performance Evaluation of classifiers.	12
4	<b>Clustering</b> Basic Concepts, Proximity Measures, Sequential Algorithms, Hierarchical Algorithms, Schemes based on Functional Optimization, Clustering Algorithms based on Graph Theory, Cluster Validity.	10
5	<b>Multilayer Perceptron</b> The Perceptron, Learning Boolean Functions, MLP as a universal approximator, Back Propagation Algorithm, Training Procedures, Tuning Networks, Recurrent Networks, Radial Basis functions.	10

### Text Books:

1. Introduction to Machine Learning, Ethem Alpaydin, Second Edition, PHI Learning Publisher, 2013 edition.
2. Pattern Recognition, Sergios Theodoridis and Konstantinos Koutroumbas, Fourth Edition, Academic Press Publisher, 2014.

### Reference Books:

1. Richard Duda, Peter Hart and David Stork, Pattern Classification, 2nd Edn., John Wiley and Sons, 2001.
2. Richard Sutton and Andrew Barto, Reinforcement Learning: An Introduction, MIT Press, 1998.
3. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.
4. Judith Hurwitz and Daniel Kirsch, Machine Learning, IBM Ltd. Edn., 2018.
5. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, 2nd Edn., Springer, 2008

### Journals/Magazines:

1. ML Trends
2. ML Research
3. Machine Learning Recommender systems
4. Chatbot Magazine
5. ML in Medical
6. ML in Agriculture

**Web/Digital resources:**

1. [https://www.cse.iitb.ac.in/~pjyothi/cs419\\_spr18/index.html](https://www.cse.iitb.ac.in/~pjyothi/cs419_spr18/index.html).
2. <https://lgatto.github.io/IntroMachineLearningWithR/an-introduction-to-machine-learning-with-r.html>
3. <https://ocw.mit.edu/courses/sloan-school-of-management/15-097-predictionmachine-learning-and-statistics-spring-2012/lecture-notes/>

**SWAYAM/NPTEL:**

1. <https://nptel.ac.in/courses/117/105/117105084/>
2. <https://matthewwrenze.com/workshops/practical-machine-learning-with-r/>
3. <http://www.eduplus.in/>

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Detection	Mat lab/Python Lib and Various ML Techniques	Understand the key concepts, tools and approaches of machine learning Techniques
2	Classification		
3	Clustering		
4	Optimization		

**Self-Learning Exercises:****1. Case Study projects**

1. How Auto industry Is Preparing For The 4th Industrial Revolution using ML
2. How Indian Retail Giant Is Using ML to Prepare For The 4th Industrial Revolution
3. Rolls-Royce And Google Partner To Create Smarter, Autonomous Ships Based On ML
4. The Amazing Ways Tesla Is Using Machine Learning And Big Data
5. The Incredible Ways John Deere Is Using Machine Learning To Transform Farming

**2. Mini Projects**

1. Inventory management E Commerce
2. Stock market price prediction
3. Identification / detection
4. Smart city water / light management system
5. Human Tracking system
6. Automatic Interview Conduction system
7. Student Information Chatbot Project.
8. Product Review Analysis For Genuine Rating
9. Customer Targeted E-Commerce

**3. List of Course Group Discussion Topics:**

1. Machine Learning and Artificial Intelligence
2. Machine Learning and Data science
3. Machine Learning applications
4. Machine Learning future
5. Machine Learning after 10 years / 2030
6. Supervised Learning Techniques and Unsupervised Learning Techniques
7. Reinforcement Learning

8. Recommender systems
9. Will Automation and ML Reduce or Increase Jobs.
10. Cashless Economy using ML

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3

**High – 3, Medium – 2, Low – 1**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS140</b>			<b>Course Title: INTERNET OF THINGS</b>			
<b>Total Credits: 04</b>			<b>Course Category: PCC</b>		<b>Course Type: Professional Core Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Embedded Systems, Python Programming

**COURSE OBJECTIVES:** To explore the interconnection and integration of the physical world and cyberspace and also to design & develop IOT Devices and applications.

**COURSE OUTCOMES (COs)**

<b>CO</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Identify and design IoT protocol layers and design IoT levels.	L1
<b>CO2</b>	Describe IoT system management and link layer protocols.	L2
<b>CO3</b>	Interface sensors for industrial applications.	L3
<b>CO4</b>	Develop and demonstrate IoT solutions for data processing and analysis	L4
<b>CO5</b>	Apply IoT design and deployment methodologies to various applications	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction to Internet of things</b> Physical design of IOT, Logical Design of IOT, IOT enabling technologies, IOT Levels & Deployment Templates, Domain Specific IOTs, Introduction: Home Automation, Cities, Environment, Retail, Agriculture, Industry, Health & Lifestyle	10
2	<b>IOT and M2M</b> Introduction: M2M, Difference between IoT and M2M, SDN and NFV for IOT, IOT System Management with NETCONF-YANG, Need for IOT Systems Management, Simple Network Management Protocol (SNMP), Network Operator Requirements, NETCONF, YANG, IoT Systems Management with NETCONF-YANG	10
3	<b>DEVELOPING INTERNET OF THINGS</b> Introduction, IoT Design Methodology, Case Study on IoT System For Weather Monitoring, Motivation for Using Python, IoT Systems - Logical Design using Python: Introduction, Installing python, Python Data Types and Data structures, Control flow Functions, Modules, Packages, File Handling, Operations, Classes, Python Packages of Interest for IoT	12
4	<b>IoT Physical Devices &amp; End points</b> What is an IoT Device, Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python, Other IoT Devices, IoT Physical Services and Cloud Offerings: Introduction to cloud storage models and Communication APIs, WAMP-AutoBahn for IoT, Xively Cloud for IoT, python Web Application framework – Django, Designing a RESTful Web API, Amazon Web Services for IoT, SkyNetIoT Messaging platform	10
5	<b>Applications of IoT</b> Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications	10

**Text Books:**

1. ArshdeepBahga, Vijay Madiseti, " Internet of Things: A Hands on Approach" Universities Press., 2015

**Reference Books:**

1. Daniel Minoli, " Building the Internet of Things with IPv6 and MIPv6: The Evolving world of M2M Communications", Wiley, 2013
2. Michael Miller, "The Internet of Things", First Edition, Pearson, 2015.
3. Claire Rowland, Elizabeth Goodman et.al, " Designing Connected Products", First Edition, O'Reilly, 2015

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	-	-
CO2	2	2	2	2	-	-
CO3	2	2	2	2	-	-
CO4	2	2	3	3	-	-
CO5	3	2	2	2	-	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS151</b>		<b>Course Title: COMPUTATIONAL STATISTICAL METHODS</b>				
<b>Total Credits: 04</b>		<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - I</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Statistics, Machine Learning

**COURSE OBJECTIVES:** To introduce computational methods in statistics with emphasis on the usage of statistical tools and give a solid mathematical foundation of computational statistics.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Demonstrate the ability to apply technical skills to solve statistical problems.	L3
<b>CO2</b>	Identify and apply appropriate regression models on datasets.	L3
<b>CO3</b>	Apply Supervised learning techniques in real life situation.	L3
<b>CO4</b>	Perform Dimensionality Reduction using statistical techniques.	L4
<b>CO5</b>	Analyze and solve real time problems using unsupervised approaches.	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	HOURS
1	<b>Statistical Learning</b> Introduction, what is Statistical Learning, Assessing Model Accuracy	10
2	<b>Linear Regression</b> Simple Linear Regression, Multiple Linear Regression, Other considerations in the Regression Model, The Market Plan, Comparison of Linear Regression with K-Nearest Neighbors	10
3	<b>Classification</b> Overview of Classification, Why not Linear Regression, Logistics Regression, LDA, Comparison of Classification Methods	10
4	<b>Resampling Methods/ Linear Model Selection &amp; Regularization</b> Cross Validation, The Bootstrap Subset Selection, Shrinkage Methods, Dimensionality Reduction Methods, Considerations in High Dimension	10
5	<b>Tree based Methods/SVM/Unsupervised Learning</b> Basics of Decision Trees, Bagging, Random Forests, Boosting SVMs: Maximal Margin Classifier, Support Vector Classifiers, SVMs, SVMs with more than two classes, Relation to Logistic Regression Unsupervised Learning: Challenges, PCA, Cluster Methods	12

### Text Books:

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2014.
2. Geof Givens, Jennifer Hoeting, "Computational Statistics", Wiley, 2nd edition, 2013.

### Reference Books:

1. Max Kuhn, Kjell Johnson, "Applied Predictive Modeling", Springer, 2013.

### Journals/Magazines:

1. Computational Statistics. 2012 Journal Citation Reports. Web of Science (Science ed.). Thomson Reuters. 2013.
2. <https://www.springer.com/journal/180>
3. <https://www.sciencedirect.com/journal/computational-statistics-and-data-analysis>

### Web/Digital resources:

1. [http://home.ustc.edu.cn/~liweiyu/documents/Geof%20H.%20Givens%20%20Jennifer%20A.%20Hoeting\(auth.\)%20-%20Comp.pdf](http://home.ustc.edu.cn/~liweiyu/documents/Geof%20H.%20Givens%20%20Jennifer%20A.%20Hoeting(auth.)%20-%20Comp.pdf)
2. <https://sccn.ucsd.edu/~arno/mypapers/statistics.pdf>

### SWAYAM/NPTEL:

1. [https://onlinecourses.nptel.ac.in/noc23\\_ma34/preview](https://onlinecourses.nptel.ac.in/noc23_ma34/preview)
2. [https://onlinecourses.swayam2.ac.in/cec22\\_ma02/preview](https://onlinecourses.swayam2.ac.in/cec22_ma02/preview)

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Use datasets and Generate the Summary statistics and interpret the results.	JMP Pro tool	Interpret the outcome and draw inferences.
2	Develop Python codes to build a simple Machine Learning models	Python Programming	Visualize the Results and interpret them.

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	-	-
CO2	3	2	1	2	2	-
CO3	3	2	1	2	2	-
CO4	3	2	1	2	1	-
CO5	3	2	1	2	1	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS152</b>			<b>Course Title: INFORMATION RETRIEVAL</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - I</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** DBMS, Data Mining and Searching Techniques

**COURSE OBJECTIVES:** The main objective of this course is to present the basic concepts in information retrieval and more advanced techniques of multimodal based information systems.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Describe set theoretic and algebraic Information Retrieval models	L2
<b>CO2</b>	Describe Boolean Model to retrieve relevant documents	L2
<b>CO3</b>	Describe inverted index implementation on parallel and distributed architecture	L2
<b>CO4</b>	Analyze Vector Space Model using different representations to evaluate the results	L4
<b>CO5</b>	Analyze the results of Retrieval models using various techniques	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction:</b> Motivation, Basic concepts, Past, present, and future, The retrieval process. <b>Modeling:</b> Introduction, A taxonomy of information retrieval models, Retrieval: Adhoc and filtering, A formal characterization of IR models, Classic information retrieval, Alternative set theoretic models, Alternative algebraic models, Alternative probabilistic models, Structured text retrieval models, Models for browsing.	10
2	<b>IR Using Boolean Model:</b> Information retrieval using the Boolean model, An example information retrieval problem, A first take at building an inverted index, Processing Boolean queries, The dictionary and postings lists, Determining dictionary terms, Postings lists, revisited, Tolerant retrieval, Wildcard queries, Spelling correction, Phonetic correction.	10
3	<b>Indexing</b> Introduction; Inverted Files; Other indices for text; Boolean queries; Sequential searching; Pattern matching; Structural queries; Compression. Index construction, Construction of large indexes, Distributed indexing, Dynamic indexing, Other types of indexes Parallel and Distributed IR: Introduction, Parallel IR, Distributed IR.	10
4	<b>Vector space retrieval</b> Scoring and term weighting, Parametric and zone indexes, Weighted zone scoring, Term frequency and weighting, Inverse document frequency, tf-idf weighting, Variants in weighting functions, Documents as vectors, Inner products ,Queries as vectors, Heuristics for efficient scoring and ranking, Inexact top K document retrieval, Interaction between vector space and other retrieval methods , Query parsing and composite scoring, Text Operations: Introduction, Document preprocessing, Document classification and clustering.	12
5	<b>Retrieval Evaluation</b> Introduction, Retrieval performance evaluation, Reference collections. Query Languages: Introduction, keyword-based querying, Pattern matching, Structural queries, Query protocols. Query Operations: Introduction, User relevance feedback, Automatic local analysis, Automatic global analysis. Searching the Web: Introduction, Challenges, Characterizing the web, Search engines	10

### Text Books:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze: Introduction to Information Retrieval, Cambridge University Press, 2012

### Reference Books:

1. Ricardo Baeza-Yates, Berthier Ribeiro-Neto: Modern Information Retrieval, Pearson, 2003.
2. David A. Grossman, Ophir Frieder: Information Retrieval Algorithms and Heuristics, 2nd Edition, Springer, 2004.

### Web/Digital resources:

1. <https://nlp.stanford.edu/IR-book/information-retrieval.html>

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Explain basic information storage and retrieval concepts.	Explore the contents by referring papers	Literature Survey
2	Give applications of alternative search strategies and explain why the particular search strategy is appropriate for the application.	Explore the contents by referring papers	Literature Survey
3	Design and implement a small to medium size information storage and retrieval system.	Use Python to develop vector space and Boolean IR Model	Develop and Demonstrate
4	Simulate Inverted index in Parallel IR	Use Python	Develop and Demonstrate

**Course Articulation:**

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-

**High – 3, Medium – 2, Low – 1**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS153</b>			<b>Course Title: IMAGE AND VIDEO ANALYTICS</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - I</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Linear Algebra, Calculus and Probability theory.

**COURSE OBJECTIVE:** To be able to find solutions to different Engineering problems using Image Processing and video analysis algorithms.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain the fundamental principles of image and video analysis.	L2
<b>CO2</b>	Construct filters for image enhancement.	L3
<b>CO3</b>	Apply motion estimation techniques for digital video.	L3
<b>CO4</b>	Apply segmentation and motion tracking methods for Image and Video.	L3
<b>CO5</b>	Develop Image and Video compression algorithms.	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction</b> Digital Image Fundamentals, Elements of visual perception, Image sensing and acquisition, Sampling and Quantization, Relationships between pixels, Linear and Non-Linear operations. Image and Video Processing: Basic Linear Filtering to Image Enhancement, Non-Linear Filtering for Image Analysis and Enhancement, Morphological Filtering for Image Enhancement and Detection, Image Restoration, Motion Detection and Estimation, Video enhancement and restoration.	10
2	<b>Image Enhancement</b> Basic Gray Level Transformations, Histogram Processing, Enhancement using Arithmetic and Logical Operations, Basics of Spatial Filtering, Image Enhancement in Frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filters.	10
3	<b>Digital Video &amp; Motion Estimation</b> Human Visual System and Color, Analog and Digital Video, 3D Video, Digital Video Applications, Image and Video quality, Motion Models, 2D Apparent Motion estimation, Differential Methods, Matching Methods, Non-Linear Optimization Methods, Transform Domain Methods.	10
4	<b>Image and Video Segmentation</b> Detection of Discontinues, Edge Linking and Boundary Detection, Threshold Based Segmentation, Region Based Segmentation, Segmentation by Morphological Watersheds, The use of Motions in Segmentation, Change Detection, Motion Tracking, Image and Video Matting.	11
5	<b>Image &amp; Video Compression</b> Basics of Image Compression, Lossless Image Compression, Discrete Cosine Transform Coding and JPEG, Wavelet Transform Coding and JPEG2000, Video Compression Approaches, Early Video Compression Standards, MPEG-4, H.264 Standard, High Efficiency Video Coding (HEVC) Standard, Scalable Video Compression.	11

### Text Books:

1. Digital Video Processing, Murat Tekalp, Second Edition, Prentice Hall, 2015.
2. Digital Image Processing, *Rafael C. Gonzalez and Richard E. Woods*, Fourth Edition, Pearson Publisher, 2017.

### Reference Books:

1. Handbook of Image and Video Processing, *Alan C. Bovik*, Second Edition, Academic Press, 2005.

### Journals/Magazines:

1. Wang, J., & Cohen, M. F. (2008). Image and video matting: a survey. *Foundations and Trends® in Computer Graphics and Vision*, 3(2), 97-175.
2. Xu, Y., Dong, J., Zhang, B., & Xu, D. (2016). Background modeling methods in video analysis: A review and comparative evaluation. *CAAI Transactions on Intelligence Technology*, 1(1), 43-60.

### Web/Digital resources:

1. <https://ocw.mit.edu/courses/6-801-machine-vision-fall-2020/>

**SWAYAM/NPTEL:**

1. <https://nptel.ac.in/courses/117105079>

**PRACTICE BASED LEARNING:**

SL NO	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Implement a program to handle and display digital image and digital video	OpenCV	Image analysis
2	Implement different spatial filtering techniques and filters in frequency domain to enhance image data.	Numpy, Matplotlib and OpenCV	Image analysis
3	Implement algorithms to estimate motion in 2D images.	OpenCV	Video analysis
4	Implement segmentation and motion tracking in video.	OpenCV	Video analysis
5	Implement JPEG and MPEG4 image and video compression algorithms.	OpenCV	Video analysis

**Course Articulation:**

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	3	-
CO2	3	-	3	-	3	-
CO3	3	-	3	-	3	-
CO4	3	-	3	-	3	-
CO5	3	-	3	-	3	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS161</b>			<b>Course Title: LINEAR ALGEBRA AND APPLICATIONS</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - II</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Engineering Mathematics

**COURSE OBJECTIVE:** To understand the basic concepts of Linear Algebra

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Solve linear equations through matrix representation	L3
<b>CO2</b>	Identify the vector space and subspace	L4
<b>CO3</b>	Understand the basic concepts of inner product space, Orthogonality and projection and implementing the Gram-Schmidt process, to obtain least square solution	L3
<b>CO4</b>	Apply Eigen vectors to solve differential equations.	L3
<b>CO5</b>	Apply Linearly transformation and represent the same in matrix form	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
1	<b>Introduction</b> Introduction, The Geometry of Linear Equations, An Example of Gaussian Elimination, Matrix Notation and Matrix Multiplication, Triangular Factors and Row Exchanges, Inverses and Transposes, Special Matrices and Applications.	10
2	<b>Vector Space</b> Vector Spaces and Subspaces, Solving $Ax = 0$ and $Ax = b$ , Linear Independence, Basis, and Dimension, The Four Fundamental Subspaces, Graphs and Networks, Linear Transformations, Review Exercises.	10
3	<b>Orthogonality</b> Orthogonal Vectors and Subspaces, Cosines and Projections onto Lines, Projections and Least Squares, Orthogonal Bases and Gram-Schmidt, The Fast Fourier Transform.	10
4	<b>Computations with Matrices</b> Eigen values ,Eigen Vectors , Applications to differential Equations, Introduction, Matrix Norm and Condition Number, Computation of Iterative Methods for $Ax = b$ .	10
5	<b>Linear Transformations</b> Linear transformations, algebra of linear transformations, isomorphism, representation of transformations by matrices, Positive Definite Matrices: Minima maxima, Saddle point ,Singular Value Decomposition, Principal Component Analysis	12

**Text Books:**

1. Linear Algebra and Its Applications by Gilbert Strang, 2016 Edition, Wellesley-Cambridge Press and SIAM, ISBN:978-09802327-7-6.

**Reference Books:**

1. Numerical Linear Algebra, William Layton and Myron Sussman, University of Pittsburgh Pittsburgh, Pennsylvania, ISBN 978-1-312-32985-0

**Journals/Magazines:**

1. Vittoria Bonanzinga some applications of linear algebra and geometry in real life arXiv:2202.10833, February 2022,

**Web/Digital resources:**

1. [https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video\\_galleries/video-lectures/](https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video_galleries/video-lectures/)

**SWAYAM/NPTEL:**

1. [https://nptel.ac.in/courses/111106051- Linear Algebra](https://nptel.ac.in/courses/111106051-Linear%20Algebra), IIT Madras Dr. K.C. Sivakumar

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	3	2	-
CO2	3	-	2	3	2	-
CO3	3	-	2	3	2	-
CO4	3	-	2	3	2	-
CO5	3	-	2	3	2	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS162</b>			<b>Course Title: SYSTEM SECURITY</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - II</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Data Communication, Computer Networks

**COURSE OBJECTIVES:** To explore the considerations of common security flaws in a computer system, security of widely used computer platforms, and user authentication

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Identify the security, and cryptography techniques.	L1
<b>CO2</b>	Explain the techniques to provide security for OS.	L2
<b>CO3</b>	Explain ways of providing security to databases	L2
<b>CO4</b>	Explain the ways to provide security to networks.	L2
<b>CO5</b>	Apply security and privacy techniques to cyber-related issues.	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

<b>UNIT No.</b>	<b>Content</b>	<b>Hours</b>
		<b>Lecture</b>
<b>1</b>	<b>Security/Cryptography</b> The Meaning of Computer Security, Computer Criminals, Methods of Defense. Elementary Cryptography, Terminology and Background, Substitution Ciphers, Transpositions (Permutations), Making a Good Encryption Algorithms, The Data Encryption Standard, The AES Encryption Algorithm, Public Key Encryption, The Uses of Encryption, Summary of Encryption	<b>10</b>
<b>2</b>	<b>Program / OS Security</b> Program Security, Secure Programs, no malicious Program Errors, Viruses and Other Malicious Code, Targeted Malicious Code, Controls Against Program Threats, Summary of Program Threats and Controls	<b>10</b>

	Protection in General-Purpose Operating Systems, Protected Objects, and Methods of Protection, Memory and Address Protection, Control of Access to General Objects, File Protection Mechanisms, User Authentication, Summary of Security for Users	
<b>3</b>	<b>Trusted OS / Database Security</b> Designing Trusted Operating Systems, Security Policies, Models of Security, Trusted Operating System Design, Assurance in Trusted Operating Systems, Summary of Security in Operating Systems Database and Data Mining Security, Introduction to Database, Security Requirements, Reliability and Integrity, Sensitive Data, Inference, Multilevel Databases, Proposals for Multilevel Security, Data Mining	<b>10</b>
<b>4</b>	<b>Network / Administrative Security</b> Security in Networks, Network Concepts, Threats in Networks, Network Security Controls Section, Firewalls, Intrusion Detection Systems, Secure E-Mail, Summary of Network Security Administering Security, Security Planning, Risk Analysis, Organizational Security Policies, Physical Security	<b>10</b>
<b>5</b>	<b>Cyber Security / Privacy</b> The Economics of Cyber security, making a Business Case, Quantifying Security, Modeling Cyber security, Current Research and Future Directions, Summary Privacy in Computing, Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, and Privacy on the Web, E-Mail Security, Impacts on Emerging Technologies	<b>12</b>

**Text Books:**

1. "Security in Computing", 4<sup>th</sup> edition, Charles P. Pfleeger - Pfleeger Consulting Group, Shari Lawrence Pfleeger - RAND Corporation

**Reference Books:**

1. "Network and System Security", 2nd Edition, John Vacca, Syngress, ISBN: 9780124166950

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	3	2	3	-	-
<b>CO2</b>	2	1	3	3	-	-
<b>CO3</b>	2	3	3	2	-	-
<b>CO4</b>	3	2	3	3	-	-
<b>CO5</b>	3	2	2	2	-	-

**High – 3, Medium – 2, Low – 1**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS163</b>			<b>Course Title: EXPLORATORY DATA ANALYSIS AND VISUALIZATION</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - II</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Data Literacy Fundamentals. Python Fundamentals. R Programming. Python Programming. SQL Fundamentals.

**COURSE OBJECTIVES:** To learn the essential exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analytics.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Describe different types of EDA tools	L4
<b>CO2</b>	Describe EDA assumptions and list the consequences	L4
<b>CO3</b>	Explore EDA techniques to visualize the data	L5
<b>CO4</b>	Ability to conduct experiments involving massive data sources	L5
<b>CO5</b>	Ability to demonstrate EDA with massive data sources	L5

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction</b> EDA Introduction, What is EDA? EDA vs Classical & Bayesian, EDA vs Summary, EDA Goals, The Role of Graphics, An EDA/Graphics Example, General Problem Categories.	10
2	<b>EDA Assumptions</b> Underlying Assumptions, Importance, Techniques for Testing Assumptions, Interpretation of 4-Plot, Consequences.	10
3	<b>EDA Techniques</b> Introduction, Analysis Questions, Graphical Techniques: Alphabetical, Graphical Techniques: By Problem Category, Quantitative Techniques, Probability Distributions.	10
4	<b>EDA Case Studies</b> Case Studies Introduction, Case Studies: Normal random numbers, Uniform random numbers, Random walk, Josephson Junction Cry thermometry, Beam Deflections, Filter Transmittance, Standard Resistor, Heat Flow Meter 1, Airplane Glass Failure Time, Ceramic Strength.	10
5	<b>Data Visualization</b> Introduction to R, Rstudio, and Data cleaning and aggregation, Design principles for charts and graphs, ggplot2 and Tableau tools for creating data visualizations, The process creating visualizations and selecting the appropriate visual display, Designing effective digital presentations, Visualization as exploration, Visualizing categorical data, Visualizing time series data, Visualizing multiple variables, Visualizing geospatial data, Dashboard design, Web-based visualizations, Interactive visualizations and motion.	12

**Text Books:**

1. Exploratory Data Analysis With R, Roger D.Peng
2. Interactive Data Visualization for the Web, Scott Murra

**Reference Books:**

1. Engineering Statistics Handbook
2. Advanced Analytics with R and Tableau, Jen Stirrup, Packt Publications

**Web/Digital resources:**

1. <https://neptune.ai/blog/data-exploration-and-visualization-best-tools>

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Expected Skill/Ability
1	Summarize some of the best data exploration and visualization tools – Matplotlib, scikit learn, plotly, seaborn, pandas, D3, bokeh, altair, yellowbrick, folium, tableau.	Survey
2	Get familiar with these tools through some examples	Demonstrate
3	Understand the need for a visualization tools	Survey
4	Undesratnd the difference between these tools and how to choose	Survey

**Course Articulation:**

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	-
CO2	3	2	3	3	3	-
CO3	3	2	3	3	3	-
CO4	3	2	3	3	3	-
CO5	3	2	3	3	3	-

**High – 3, Medium – 2, Low – 1**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS170L</b>		<b>Course Title: MACHINE LEARNING LABORATORY</b>				
<b>Total Credits: 1.5</b>		<b>Course Category: PCCL</b>			<b>Course Type: Professional Core Course Laboratory</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	-		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>100</b>	-	<b>100</b>
	<b>Practical</b>	<b>03</b>	<b>Maximum Marks</b>	<b>50</b>	-	<b>50</b>
	<b>Total</b>	<b>03</b>	<b>Minimum Marks</b>	<b>25</b>	-	<b>25</b>

**COURSE PREREQUISITE:** Advanced Data Structures and Algorithms.

**COURSE OBJECTIVES:** To solve real-world problems with machine learning and libraries.

**COURSE OUTCOMES(COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Demonstrate knowledge of learning algorithms and concept learning through implementation for sustainable solutions of applications	<b>L4</b>
<b>CO2</b>	Analyze research based problems using Machine learning techniques.	<b>L4</b>
<b>CO3</b>	Apply different clustering algorithms used in machine learning to generic datasets and specific multidisciplinary domains.	<b>L4</b>
<b>CO4</b>	Demonstrate advanced methods like Naive Bayes, k-NN, SVM for Classifications and regression	<b>L4</b>
<b>CO5</b>	Evaluation of different algorithms on well formulated problems along with stating valid conclusions that the evaluation supports	<b>L5</b>

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

<b>Week</b>	<b>List of Experiments/ Programs</b>	<b>No. of Hours</b>
<b>1</b>	R Language/Python/Matlab Basics, Data Structures, Data Frames, Installing and Loading R Packages	<b>3</b>
<b>2</b>	Perform Data exploration and pre-processing in R/python/matlab	<b>3</b>
<b>3</b>	Implement regularized Linear regression.	<b>3</b>
<b>4</b>	Implement Naive Bayes classifier for dataset stored as CSV file	<b>3</b>
<b>5</b>	Implement regularized logistic regression.	<b>3</b>
<b>6</b>	Build models using Decision trees	<b>3</b>
<b>7</b>	Build model using SVM with different kernels.	<b>3</b>
<b>8</b>	Implement K-NN algorithm to classify a dataset.	<b>3</b>
<b>9</b>	Implementation of Agglomerative, DBSCAN,	<b>3</b>
<b>10</b>	Build model to perform Clustering using K-means after applying PCA and determining the value of K using Elbow method.	<b>3</b>
<b>11</b>	Implementation of Reinforcement Learning	<b>3</b>
<b>12</b>	Implementation of Recommender Systems, Anomaly Detection.	<b>3</b>
<b>13</b>	Laboratory Test	<b>3</b>

**Text Books:**

1. Scott V. Burger, "Introduction to Machine Learning with R Rigorous Mathematical Analysis", Published by O'Reilly Media, Inc., First Edition-March-2018.

**Reference Books:**

1. Michael Clark, "An Introduction to Machine Learning with Applications in R".
2. Sebastian Palmas, Kevin Oluoch, "Introduction to Machine Learning in R", -2019.
3. Matthew Renze, Practical Machine Learning with R,

**Journals/Magazines:**

1. ML Trends
2. ML Research
3. Machine Learning Recommender systems
4. Chatbot Magazine
5. ML in Medical
6. ML in Agriculture

**Web/Digital resources:**

1. [https://www.cse.iitb.ac.in/~pjyothi/cs419\\_spr18/index.html](https://www.cse.iitb.ac.in/~pjyothi/cs419_spr18/index.html).
2. <https://lgatto.github.io/IntroMachineLearningWithR/an-introduction-to-machine-learningwith-r.html>
3. <https://ocw.mit.edu/courses/sloan-school-of-management/15-097-predictionmachine-learning-and-statistics-spring-2012/lecture-notes/>

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES						
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS180</b>		<b>Course Title: MINOR PROJECT- 1</b>				
<b>Total Credits: 1.5</b>		<b>Course Category: MPS</b>			<b>Course Type: MINIPROJECT WITH SEMINAR</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	-		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>100</b>	-	<b>100</b>
	<b>Practical</b>	<b>03</b>	<b>MaximumMarks</b>	<b>50</b>	-	<b>50</b>
	<b>Total</b>	<b>03</b>	<b>Minimum Marks</b>	<b>25</b>	-	<b>25</b>

**COURSE PREREQUISITE:** Programming Skills

**COURSE OBJECTIVES:** To develop practical ability & knowledge about practical tools, techniques in order to solve real life problems

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Identify and analyze a problem to be solved computationally.	L4
<b>CO2</b>	Design and develop solutions to the problem and analyze results.	L3
<b>CO3</b>	Prepare project reports and presentations.	L6

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

This course is introduced to help the students to get a practical exposure of the subjects studied during this semester. It is expected that the work should be focused in a particular area for concept, design, implementation and analysis. Topics selection covering recent and relevant topics related to the emerging areas. Ideally, recent reputed journal papers abstraction and implementation shall be encouraged. At the end of the semester, a student has to submit a detailed report incorporating literature survey, problem formulation, clear problem statement, research methods, result analysis, conclusion, etc.

**Course Articulation:**

<b>COURSE OUTCOMES ↓</b>	<b>PROGRAM OUTCOMES</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3
<b>CO3</b>	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	3
<b>CO5</b>	3	3	3	3	3	3

**High – 3, Medium – 2, Low – 1**

# **SEMESTER II**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS210</b>		<b>Course Title: ADVANCED DATA MINING TECHNIQUES</b>				
<b>Total Credits: 04</b>		<b>Course Category: PCC</b>		<b>Course Type: Professional Core Course</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>03</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>02</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>MaximumMarks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>05</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Big data processing frameworks, Database knowledge, Data Structure & Algorithms, Machine Learning

**COURSE OBJECTIVES:** To understand various tools of Data Mining and their techniques to solve the real time problems.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain Data mining process techniques.	<b>L2</b>
<b>CO2</b>	Apply advanced data mining tools & techniques to develop a model.	<b>L3</b>
<b>CO3</b>	Apply association rules to design & develop a model.	<b>L3</b>
<b>CO4</b>	Explore Mining Data stream types and its techniques.	<b>L3</b>
<b>CO5</b>	Explore and apply Data mining concepts to build an application.	<b>L3</b>

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours	
		Lecture	Tutorial
<b>1</b>	<b>Introduction</b> The Data Mining Process: Basic Data Types, The Major Building Blocks: A Bird's Eye View, Scalability Issues and the Streaming Scenario, A Stroll through some Application Scenarios, Data Preparation, Feature Extraction and Portability, Data Cleaning: Data Reduction and Transformation, Similarity and Distances: Multidimensional Data, Text Similarity Measures, Temporal Similarity Measures, Graph Similarity Measures, Supervised Similarity Functions	<b>8</b>	<b>6</b>
<b>2</b>	<b>Mining Data Stream</b> Mining Time-Series Data, Mining Sequence Patterns in Transactional Databases, Mining Sequence Patterns in Biological Data, Graph Mining, Social Network Analysis, Multirelational Data Mining, Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.	<b>8</b>	<b>6</b>
<b>3</b>	<b>Advanced Concepts in Association Analysis</b> Frequent Itemset Generation, Compact Representation of Frequent Itemsets, FP- Growth Algorithms, Handling Categorical and Continuous Attributes, Handling a Concept Hierarchy, Sequential Patterns, Subgraph Patterns, Infrequent Patterns, Counting Frequent Items in a Stream	<b>8</b>	<b>4</b>
<b>4</b>	<b>Data Mining Methods as Tools</b> Memory-Based Reasoning Methods, Fuzzy Sets in Data Mining, Rough Sets, Support Vector Machines, Genetic Algorithm Support to Data Mining, Performance Evaluation for Predictive Modeling.	<b>7</b>	<b>4</b>
<b>5</b>	<b>Applications and Research Trends in Data Mining</b> Data Mining Applications (Financial Data Analysis, Retail Industry, Telecommunication Industry, Biological Data Analysis, Other Scientific Applications, Intrusion Detection), Data Mining System Products and Research Prototypes, Statistical Data Mining, Visual and Audio Data Mining, Data Mining and Collaborative Filtering, Data Mining, Privacy, and Data Security, Trends in Data Mining, Present Research Avenues.	<b>8</b>	<b>6</b>

**Text Books:**

1. Han, J. Micheline KAMBER a Jian PEI. Data mining: concepts and techniques, 6-7. (2012).
2. Olson, D. L., & Delen, D. Advanced data mining techniques. Springer Science & Business Media, (2008).

**Reference Books:**

1. Aggarwal, C. C. Recommender systems (Vol. 1). Cham: Springer International Publishing, (2016).
2. Dunham, M. H. Data mining: Introductory and advanced topics. Pearson Education India, (2006).

**Journals/Magazines:**

1. Guo, Y., Zhou, J., Qin, Q., Wei, Y., & Zhang, W. (2022). An Improved Algorithm and Implementation of Data Mining for Intelligent Manufacturing Association Rules Based on Pattern Recognition. IEEE Consumer Electronics Magazine.
2. Dhar, S., Das, S., & Majumder, S. (2022, May). A Study on NLP Based Approach in AI and Text Data Mining for Automated Highlighting of New Information in Clinical Notes. In 2022 6th International Conference on Intelligent Computing and Control Systems (ICICCS) (pp. 966-972). IEEE.
3. Zhang, L., & Zhang, L. (2022). Artificial intelligence for remote sensing data analysis: A review of challenges and opportunities. IEEE Geoscience and Remote Sensing Magazine.

**Web/Digital resources:**

1. <https://www.upgrad.com/blog/data-mining-techniques/>
2. <https://ngdata.com/data-mining-resources/#Videos>

**SWAYAM/NPTEL:**

1. <https://nptel.ac.in/courses/106105174>
2. <https://www.classcentral.com/course/swayam-data-mining-9821>

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Data pre-processing and vectorization. Data Similarity and set similarity. Frequent pattern mining and regression.	Statistical Tools	This course exposes multiple techniques of understanding and analysing the data from a mathematical point of view. In addition, they will also use multiple predictive models to analyse the future trend.
2	Quality analysis of data.		
3	Feature selection and Ranking.		
4	Association rule mining and implementation of the Apriori algorithm.		
5	Error analysis and model selection		
6	Discriminant Analysis, Factor Analysis		
7	Matrix Factorization.		
8	Recommendation System		

**Self-Learning Exercises:****1. Case Study projects :**

- a. On Banking Sector
- b. Web Data Ming
- c. Intrusion detection
- d. <https://www.worldscientific.com/doi/abs/10.1142/S021962201240007X>: 10 major Case studies

**2. Mini Projects:**

- a. Group Event Recommendation Framework
- b. Efficient similarity search for dynamic data streams
- c. Frequent pattern mining on uncertain graphs
- d. Protecting user data in profile-matching social networks

Description: <https://www.upgrad.com/blog/data-mining-projects-ideas-beginners/>

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	2	2	2	2	2	3
CO5	3	3	3	3	3	3

High – 3, Medium – 2, Low –1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS220</b>		<b>Course Title: CLOUD COMPUTING AND VIRTUALIZATION</b>				
<b>Total Credits: 04</b>		<b>Course Category: PCC</b>		<b>Course Type: Professional Core Course</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Computer Networks, DBMS, OS

**COURSE OBJECTIVES:** To understand the concepts, benefits and applications of cloud computing.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Make use of various services offered by the cloud.	L2
<b>CO2</b>	Discuss the various applications and challenges of cloud computing.	L2
<b>CO3</b>	Demonstrate the use of virtualization.	L3
<b>CO4</b>	Apply scheduling algorithms for cloud applications.	L3
<b>CO5</b>	Illustrate various security issues in cloud computing.	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction</b> Introduction, Cloud Infrastructure Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing.	10
2	<b>Computing</b> Cloud Computing: Application Paradigms. Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Grep The Web application , Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.	10
3	<b>Virtualization</b> Cloud Resource Virtualization. Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization.	10
4	<b>Management/Scheduling</b> Cloud Resource Management and Scheduling. Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling Map Reduce applications subject to deadlines, Resource management and dynamic scaling.	12
5	<b>Security</b> Cloud Security, Cloud Application Development. Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis.	10

**Text Books:**

1. Dan C Marinescu: Cloud Computing Theory and Practice. Elsevier(MK) 2013.

**Reference Books:**

1. RajkumarBuyya , James Broberg, AndrzejGoscinski: Cloud Computing Principles and Paradigms, Willey 2014.
2. John W Rittinghouse, James F Ransome:Cloud Computing Implementation, Management and Security, CRC Press 2013.

**Web/Digital resources:**

1. [https://www.tutorialspoint.com/cloud\\_computing/index.html](https://www.tutorialspoint.com/cloud_computing/index.html)

**SWAYAM/NPTEL:**

1. [https://onlinecourses.nptel.ac.in/noc23\\_cs42/preview](https://onlinecourses.nptel.ac.in/noc23_cs42/preview)

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Practical Exposure using cloud platform	AWS, Azure, Google	Thinking

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	2	3
CO2	3	1	3	1	-	3
CO3	3	-	3	1	3	3
CO4	3	-	3	2	3	3
CO5	3	1	3	3	3	3

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS230</b>			<b>Course Title: DEEP LEARNING</b>			
<b>Total Credits: 04</b>			<b>Course Category: PCC</b>		<b>Course Type: Professional Core Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Machine Learning, Neural Networks

**COURSE OBJECTIVE:** To make students comfortable with tools and techniques required in handling large amounts of datasets and also uncover various deep learning methods in NLP, Neural Networks etc

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain the basic concepts in the design of neural networks	L2
<b>CO2</b>	Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.	L2
<b>CO3</b>	Apply the concepts of neural networks in designing deep learning applications	L3
<b>CO4</b>	Illustrate parameter tuning for simple deep learning architecture	L4
<b>CO5</b>	Implement deep network architecture and solve real-world problems.	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
1	<b>Introduction to shallow network</b> A review of machine learning: how can machines learn, fundamentals for making a machine learning; linear algebra, statistics, and simple learning models: regression, clustering, classification. Foundations of neural networks: an introduction to the neural network, training neural network, activation function, loss function, hyper parameters.	10
2	<b>Introduction to deep learning</b> Fundamentals of deep learning: def, architecture, building blocks of deep learning. Major architecture of deep learning: unsupervised pertained network, convolution neural network, recurrent neural network, recursive neural network.	10
3	<b>Building a simple neural network</b> Building a neural network: matching neural network for the right problem, DL4J suit tools, modeling CSV data for MLP, modeling handwritten images using CNN, modeling sequence data using RNN, using autoencoders for anomaly detection, using variational autoencoders for reconstructing MNIST data.	10
4	<b>Tuning the deep neural network</b> Tuning deep neural network: matching input data and network architecture, relating model goals and network parameters, working with layer count, parameter count and memory, weight initialization strategies, apply loss function, applying optimization, controlling epochs and batch size, dealing with overfitting.	12
5	<b>Tuning specific deep network architecture</b> Tuning specific deep network architecture: CNN, RNN, Restricted Boltzmann machine, DBN. Vectorization: an introduction to vectorization in machine learning, using dataVec for ETL, vectorizing image data, working with sequential data and vectorization, working with text data.	10

### Text Books:

1. Josh Patterson and Adam Gibson, Deep Learning A Practitioner's Approach, Oreilly, 2017.

### Reference Books:

1. Nikhil Buduma, "Fundamentals of Deep Learning", Oreilly, 2017
2. Ian Goodfellow, YoshuaBengio, Aaron Courville., "Deep Learning", 2016,The MIT Press, Cambridge, Massachusetts, London.

### Journals/Magazines:

1. <https://journalofbigdata.springeropen.com/articles/10.1186/s40537-021-00444-8>
2. <https://www.sciencedirect.com/journal/machine-learning-with-applications>

### Web/Digital resources:

1. <https://d2l.ai/d2l-en.pdf>
2. [http://imlab.postech.ac.kr/dkim/class/csed514\\_2019s/DeepLearningBook.pdf](http://imlab.postech.ac.kr/dkim/class/csed514_2019s/DeepLearningBook.pdf)

### SWAYAM/NPTEL:

1. <https://nptel.ac.in/courses/106106184>
2. <https://nptel.ac.in/courses/106105215>

**PRACTICE BASED LEARNING:**

Sl No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Implementaion of various Machine Learning techniques and Neural Networks	Machine Learning Tools like Weka, Medcalc, etc.	Interpret results
2	Model Development using Deep Network Architecture	Tensorflow, Python Programming	Interpret results and tuning the architecture to improve the performance of the model.

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	-	-
CO2	3	2	1	-	-	-
CO3	3	2	1	2	3	3
CO4	3	2	1	1	1	1
CO5	3	2	1	3	3	3

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS241</b>			<b>Course Title: OPTIMIZATION THEORY</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - III</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Linear Algebra

**COURSE OBJECTIVE:** To learn optimization techniques for non-linear equations

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Apply classical optimization techniques and modern methods.	L3
<b>CO2</b>	Develop linear and Non-linear programming.	L3
<b>CO3</b>	Identify optimized solutions to constrained systems	L4
<b>CO4</b>	Contrast single variable and multivariable optimization problems.	L4
<b>CO5</b>	Analyze different system and evaluate solution to optimize resources.	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<p><b>Introduction</b>  <b>Introduction to Optimization:</b> Introduction, Historical Development, Engineering Applications of Optimization' Statement of an Optimization Problem, Classification of Optimization Problems.  <b>Classical Optimization Techniques:</b> Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem.</p>	10
2	<p><b>Linear Programming</b>  Applications of Linear Programming, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems, Definitions and Theorems, Solution of a System of Linear Simultaneous Equations, Pivotal Reduction of a General System of Equations, Motivation of the Simplex Method, Simplex Algorithm, Improving a Nonoptimal Basic Feasible Solution, Two Phases of the Simplex Method, Revised Simplex Method, Duality in Linear Programming.</p>	10
3	<p><b>Nonlinear Programming</b>  Introduction, Unimodal Function, Elimination Methods: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval Halving Method Fibonacci Method, Golden Section Method, Comparison of Elimination Methods. Interpolation Methods: Quadratic Interpolation Method, Cubic Interpolation Method, Direct Root Methods. Direct Search Methods: Random Search Methods, Grid Search Method, Univariate Method, Pattern Directions, Powell's Method.</p>	10
4	<p><b>Geometric Programming</b>  Posynomial, Unconstrained Minimization Problem, Solution of an Unconstrained Geometric Programming Program Using Differential Calculus, Solution of an Unconstrained Geometric Programming Problem Using Arithmetic–Geometric Inequality, Primal–Dual Relationship and Sufficiency Conditions in the Unconstrained Case, Constrained Minimization, Solution of a Constrained Geometric Programming Problem, Primal and Dual Programs in the Case of Less-Than Inequalities, Geometric Programming with Mixed Inequality Constraints, Complementary Geometric Programming.  <b>Stochastic Programming:</b> Basic Concepts of Probability Theory, Stochastic Linear Programming, Stochastic Nonlinear Programming.</p>	12
5	<p><b>Modern Methods</b>  Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy Systems, Neural-Network-Based Optimization.</p>	10

**Text Books:**

1. Singiresu S Rao, "Engineering Optimization Theory and Practice", John Wiley and sons, 4<sup>th</sup> Edition 2009.

**Reference Books:**

1. Edwin K. P. Chong and Stanislaw. Zak "An Introduction to Optimization", John Wiley and sons, 2<sup>nd</sup> Edition 2001.

**Journals/Magazines:**

1. Debojyoti Sarkar and Anupam Biswas, "Introduction To Optimization In Manufacturing Operations", in "Numerical Modelling and Optimization in Advanced Manufacturing Processes" Book series "Materials Forming, Machining and Tribology", Springer Nature, 2021.

**Web/Digital resources:**

1. [https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module\\_1/M1L1slides.pdf](https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L1slides.pdf)

**SWAYAM/NPTEL:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_me10](https://onlinecourses.nptel.ac.in/noc21_me10) : Optimization from fundamentals By Prof. Ankur A. Kulkarni | IIT Bombay .
2. <https://nptel.ac.in/courses/111105039>: Optimization, IIT Kharagpur Prof. A. Goswami, Dr. Debjani Chakraborty

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	3	2	-
CO2	3	-	2	3	2	-
CO3	3	-	2	3	2	-
CO4	3	-	2	3	2	-
CO5	3	-	2	3	2	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS242</b>		<b>Course Title: COMPUTATIONAL LINGUISTICS</b>				
<b>Total Credits: 04</b>		<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - III</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Theory of Computations, Machine Learning

**COURSE OBJECTIVES:** To obtain linguistic knowledge to build natural language processing applications using machine learning algorithms

**COURSE OUTCOMES(COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Apply linguistic rules using finite state transducers for language processing.	L3
<b>CO2</b>	Demonstrate parsers in computational linguistics.	L3
<b>CO3</b>	Explain the algorithms for co reference resolution.	L2
<b>CO4</b>	Discuss clustering of text data in natural language processing applications.	L3
<b>CO5</b>	Illustrate machine translation system using machine learning algorithms.	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction</b> What is computational linguistics? Ambiguity and uncertainty in language, regular languages, and their limitations, finite-state automata, morphology. Natural Language Toolkit.	12
2	<b>Context Free Grammars</b> Constituency, CFG definition, use and limitations. Chomsky Normal Form. Top-down parsing, bottom-up parsing, and the problems with each. The desirability of combining evidence from both directions	10
3	<b>Computational Discourse</b> Discourse segmentation, Text coherence, reference resolution, reference phenomena, Features for pronominal anaphora resolution, Algorithms for anaphora resolution, coreference resolution, evaluation of coreference resolution.	10
4	<b>Word Sense Disambiguation and Clustering</b> Holonomy, polysemy, different meanings, the power of context. Language neighborhood as a vector. Agglomerative clustering. Clustering by expectation maximization. Using clustering to discover different word senses. Semi-supervised document classification.	10
5	<b>Machine Translation</b> Probabilistic models for machine translation system, alignment, translation, language generation. Machine translation evaluation.	10

**Text Books:**

1. Daniel Jurafsky and James H. SPEECH and LANGUAGE PROCESSING: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Second Edition.
2. Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: May 1999.

**Reference Books:**

1. Edward Loper, Ewan Klein, and Steven Bird. Natural Language Processing with Python, First Edition, 2009.

**SWAYAM/NPTEL:**

1. <https://nptel.ac.in/courses/106105158>

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	3	-	-	-	-	-
CO3	3	-	-	3	-	-
CO4	3	-	-	3	-	-
CO5	3	-	-	3	-	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS243</b>			<b>Course Title: BIOINFORMATICS</b>			
<b>Total Credits: 04</b>			<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - III</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	-	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Machine Learning, Deep Learning

**COURSE OBJECTIVE:** To gain knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics; to extract information from large databases and to use the information in computer modeling; to develop problem-solving skills, including the ability to develop new algorithms and analysis methods.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain Bioinformatics, biological databases and data models.	L2
<b>CO2</b>	Identify sequence data from biological databases and compare different file formats.	L2
<b>CO3</b>	Analyze and evaluate methods of sequence alignment, utilize similarity finding tools to compare sequence data.	L4
<b>CO4</b>	Design applications using bioinformatics algorithms for gene finding, predictions and genome studies.	L3
<b>CO5</b>	Engage in independent study to analyze and interpret protein structure using biostatistics & biological tools and compare different methods and strategies of structure prediction.	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction and NCBI Data Model</b> Introduction to Bioinformatics, Goal, Scope, Applications, Limitations, New Themes, Introduction to Database, Types of Databases, Biological Databases, Pitfalls of Biological Databases. Introduction to NCBI data model, PUBs: Publications or Perish, SEQ-Ids: What's in a Name? BIOSEQs: Sequences, BIOSEQ-SETS: Collections of Sequences, SEQ-ANNOT: Annotating the Sequence, SEQ-DESCR: Describing the Sequence, Using the Model.	08
2	<b>Bioinformatics Database</b> Importance of Databases, Characteristics and Categories of Bioinformatics Database, Navigating Databases, Biological Databases, Primary Sequence Databases, Composite Sequence Databases, Secondary Databases, Nucleic Acid Sequence Databases, Structure Databases: File Formats, Protein Structure, PDB, MMDB, CATH, Other Database Enzyme, MEROPS, BRENDA, Pathway databases, Bibliographic Databases, Specialized Genomic Resources, Analysis Packages.	10
3	<b>Sequence Align Methods</b> Sequence Analysis of Biological Data, Significance of Sequence Alignment, Pairwise Sequence Alignment Methods, Use of Scoring Matrices and Gap Penalties in Sequence Alignments, Multiple Sequence Alignment Methods - Tools and Application of multiple sequence alignment, Gene Prediction Strategies, Protein Prediction Strategies, Phylogenetic Trees and Multiple Alignments.	10
4	<b>Bioinformatics Algorithms</b> Biological Algorithms versus Computer Algorithms, Exhaustive Search, Mapping Algorithms, Motif Finding Problem, Search Trees, Finding a Median String, Greedy Approach to Motif Finding, DNA Sequence comparison - Manhattan Tourist Problem - Edit Distance and Alignments - Longest Common Subsequences - Global Sequence Alignment - Scoring Alignment - Local Sequence Alignment – Alignment with Gap Penalties - Multiple Alignment, DNA Sequencing, Shortest Superstring Problem, DNA arrays as an alternative sequencing techniques.	12
5	<b>Biostatistics &amp; Tools</b> Handling Univariate and Bivariate Data, Measures of Central Tendency, Measures of Dispersion, Skewness & Kurtosis, Correlation and Regression. Local Alignment Search Tool (BLAST), Purpose of BLAST, BLAST Analysis, Purpose of BLAST II, Scoring Metrics, PAM, BLOSUM, Working of BLAST, Introduction to HMMER.	12

**Text Books:**

1. JinXiong, Essential Bioinformatics, Cambridge University Press, 2006.
2. Baxevanis A. D. and B. F. Francis Ouellette, Bioinformatics a practical guide to the analysis of genes and proteins. Second edition, John Wiley and Sons, 2001.
3. An Introduction to Bioinformatics Algorithms, Neil C Jones and Pavel A Pevzner, MIT Press, 2004.

**Reference Books:**

1. S.C. Rastogi, Namita Mendiratta, Parag Rastogi, Bioinformatics - Concepts, Skills, and Applications, CBS Publishers, Second Edition, 2003.

2. OrpitaBosu, Simminder Kaur Thukral, Bioinformatics: Databases, Tools, And Algorithms.,Oxford University Press Publisher, 2007.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics., Eleventh Edition, Sultan Chand & Sons Publishers, 2007.

**Journals/Magazines:**

1. <https://unl.libguides.com/c.php?g=51603&p=333685>
2. <https://www.worldscientific.com/worldscinet/jbcb>
3. <https://www.iscb.org/education-references>

**Web/Digital resources:**

1. <https://www.cs.helsinki.fi/bioinformatiikka/mbi/courses/08-09/itb/lectures/itb0809-slides-p1-431.pdf>
2. [https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003291612341467kuaum\\_yadav\\_Bioinformatics.pdf](https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003291612341467kuaum_yadav_Bioinformatics.pdf)

**SWAYAM/NPTEL:**

1. NPTEL: <https://nptel.ac.in/courses/102106065/>

**PRACTICE BASED LEARNING:**

SI No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Sequence Analysis of Biological Data	Basic Local Alignment Search Tool (BLAST)	Analysis
2	Implementation of Bioinformatics Algorithms on databases	Python Programming	Interpret the results

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	-	-
CO2	2	2	-	-	-	-
CO3	2	2	2	-	2	2
CO4	2	2	3	3	3	2
CO5	2	2	3	3	3	2

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS251</b>		<b>Course Title: SCALABLE SYSTEMS FOR DATA SCIENCE</b>				
<b>Total Credits: 04</b>		<b>Course Category: PEC</b>			<b>Course Type: Professional Elective Course - IV</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Big Data Analytics, Machine Learning

**COURSE OBJECTIVE:** To teach the fundamental “systems” aspects of designing and using scalable data science platforms; To acquire, store and query large, fast and linked datasets, to train machine learning models, and to process and analyze large datasets.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain big data platforms and distributed systems.	L2
<b>CO2</b>	Perform prediction using different algorithmic techniques	L3
<b>CO3</b>	Apply various Scalable logistic regression.	L3
<b>CO4</b>	Illustrate large scale matrix factorization	L3
<b>CO5</b>	Analyze algorithms and modify to adapt to a distributed setting.	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<b>Big Data</b> Big Data & Platform Design Goals, Big Data & other computing platforms. Programming for Large Datasets: Distributed systems, scalability and metrics, Degrees of Parallelism, MapReduce- Uses, Model working, simple and advanced applications programming. Runtime Systems: Hadoop- Open cloud server, Class cluster, Hadoop distributed file system. Hadoop YARN, Hadoop MapReduce, Fault Tolerance.	10
2	<b>Prediction</b> Prediction over graphs – Scalable learning and inference over graphs, Semi supervised learning (SSL)- self training and co training, Graph Based SSL. Streaming Naive Bayes – Introduction to Naïve Bayes, Complexity of Naïve Bayes, Implementation of Naïve Bayes Classifier, Large vocabulary counting, Sorting – Merge sort, Unix sort, Large vocabulary Naïve Bayes, Distributed Counting, optimizations.	10
3	<b>Learning</b> Scalable Logistic Regression and SGD. Learning as optimization, Stochastic gradient descent, SGD versus streaming, Logistic regression versus Rocchio and Naïve Bayes, Efficient Logistic Regression with Stochastic Gradient Descent, Regularized logistic regression, Sparse updates for Regularized logistic regression, Bounded memory logistic regression, SGD implementation.	10
4	<b>Matrix Factorization</b> Large-scale Matrix Factorization (MF) - Recovering Latent factor in a matrix, Matrix factorization for collaborative filtering, MF for image and text modeling, Large scale MF for distributed SGD, Distributed SGD for Mapreduce.MR Advanced Topics: Inverted Index, PageRank, Distributed graph processing: Apache Giraph, GoFish.	12
5	<b>Distributed stream processing</b> Distributed and fault-tolerant realtime computation, Distributed Stream Processing systems- Apache Storm. Parameter Server- Architecture, Key- value vectors, Range Push and Pull, User defined functions on the server, Asynchronous tasks and dependency, Flexible consistency, user defined filters, messages, consistent hashing, server management, worker management. Evaluation of parameter server - Sparse Logistic Regression and Latent Dirichlet Allocation.	10

### Text Books:

1. Jure Leskovec, Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, DREAMTECH Press, 2nd Edition, 2016.
2. Jimmy Lin and Chris Dyer, Data-Intensive Text Processing with MapReduce, 1st Edition, Morgan & Claypool Publishers, 2010

### Reference Books:

1. Research papers and articles - [MR for ML on Multicore, NIPS 06], [Hogwild!], [Bottou, 2010], [Gemulla et al., KDD 2011]

### Journals/Magazines:

1. <https://ieeecs-media.computer.org/assets/pdf/T-06842585.pdf>
2. <https://www.oracle.com/a/ocom/docs/oracle-ds-scaling-data-science.pdf>

**Web/Digital resources:**

1. <https://cds.iisc.ac.in/courses/ds256/>

**SWAYAM/NPTEL:**

1. NPTEL: <https://nptel.ac.in/courses/106105186/>
2. SWAYAM: [https://swayam.gov.in/nd1\\_noc19\\_cs61/preview](https://swayam.gov.in/nd1_noc19_cs61/preview)

**PRACTICE BASED LEARNING:**

Sl No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Hadoop distributed file system.	Hadoop- Open cloud server, Class cluster, Hadoop YARN, Hadoop MapReduce,	Analysis
2	Distributed Stream Processing systems	Apache Storm.	Interpret the results

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	3	2
CO2	2	2	1	2	3	3
CO3	3	2	1	3	3	3
CO4	3	2	1	3	3	3
CO5	3	2	1	3	3	3

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS252</b>		<b>Course Title: WEB DATABASES AND INFORMATION SYSTEMS</b>				
<b>Total Credits: 04</b>		<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - IV</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Web Programming

**COURSE OBJECTIVE:** Prepares students to apply database principles, algorithms, and optimization techniques to design, build, and manage current and future database and information systems.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Illustrate the concepts of web-based information systems.	L3
<b>CO2</b>	Explain n-tiered architectures to implement secure, scalable systems.	L2
<b>CO3</b>	Demonstrate database driven applications.	L1
<b>CO4</b>	Design and develop web-based applications.	L3
<b>CO5</b>	Describe XML and alternative technologies	L2

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<b>Web-based Information system</b> Web-Based Information Systems, Applications: electronic commerce, Variants of Web database access, Basic Web Standards, architecture. HTTP, Forms, Server-Side Programming and CGI Alternatives to CGI: Java Servlets and server APIs Browser detection, state, cookies and redirects	12
2	<b>Using n-tiered architectures to implement secure and scalable systems</b> Web App Architectures: Multi-Tier (2-Tier, 3-Tier) Model-Viewer-Controller (MVC)	10
3	<b>Database-driven websites and applications</b> Utilize JavaScript to improve database-driven websites. – Critical components of the modern Web infrastructure: DNS, CDN, etc Critical components of the modern Web infrastructure: DNS, CDN, etc	10
4	<b>DBMS and WWW:</b> Introduction Off-Line access to databases Static and Dynamic Web Pages SQL embedded in HTML CGI solution to database gateway Internet database connector JDBC: databases the Java way. Solutions from database vendors Association rule mining	10
5	<b>XML and its alternatives</b> HTTP, XML, SQL, JavaScript, AJAX XML and its Alternatives: XML: Basics of XML, namespace, schema languages, XSLT and XPath, alternatives to XML, SQL, CSS, RSS, and others.	10

### Text Books:

1. Professional Web 2.0 Programming: Using Xhtml, Css, Javascript And Ajax By Eric Van Der, Danny Ayers, Erik Bruchez
2. Weaving a Website - Programming in HTML, Javascript, Perl, and Java

### Reference Books:

1. Mastering HTML, CSS & Javascript Web Publishing Paperback – 15 Jul 2016 by Laura Lemay, Rafe Colburn, Jennifer Kyrnin.

### Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	2	2	-	-
CO2	3	1	3	3	-	-
CO3	2	3	3	2	-	-
CO4	1	3	1	3	-	-
CO5	3	2	2	2	-	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS253</b>		<b>Course Title: SOCIAL AND INFORMATION NETWORK ANALYSIS</b>				
<b>Total Credits: 04</b>		<b>Course Category: PEC</b>		<b>Course Type: Professional Elective Course - IV</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Graph Theory, Design of Algorithms and Statistics.

**COURSE OBJECTIVE:** This course introduces the concepts of representing Social Network and Information Network and analysis of Information flow in Social and Information Network.

#### **COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Illustrate Social Network as a connected graph.	L2
<b>CO2</b>	Demonstrate the social network as a small world	L3
<b>CO3</b>	Apply methods to evaluate the behavior of cascading networks and the diffusion over social and information networks.	L3
<b>CO4</b>	Develop graph models to describe the structure of the web and Information Network.	L3
<b>CO5</b>	Apply page rank algorithm to web pages in the Information Network	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<p><b>Introduction</b>  <b>Overview:</b> Aspects of Networks, Central Themes and Topics. Graphs: Basic Definitions, Paths and Connectivity, Distance and Breadth-First Search, Network Datasets: An Overview</p>	10
2	<p><b>The Small-World Phenomenon</b>            Six Degrees of Separation, Structure and Randomness, Decentralized Search, Empirical Analysis and Generalized Models, Core-Periphery Structures and Difficulties in Decentralized Search, Advanced Material: Analysis of Decentralized Search.  <b>Positive and Negative Relationships:</b> Structural Balance , Characterizing the Structure of Balanced Networks, Applications of Structural Balance , A Weaker Form of Structural Balance , Advanced Material: Generalizing the Definition of Structural Balance.</p>	10
3	<p><b>Cascading Behaviour in Networks</b>            Diffusion in Networks, Modeling Diffusion through a Network, Cascades and Clusters, Diffusion, Thresholds, and the Role of Weak Ties, Extensions of the Basic Cascade Model, Knowledge, Thresholds, and Collective Action, Advanced Material: The Cascade Capacity.  <b>Epidemics :</b> Diseases and the Networks that Transmit Them , Branching Processes, The SIR Epidemic Model , The SIS Epidemic Model , Synchronization , Transient Contacts and the Dangers of Concurrency , Genealogy, Genetic Inheritance, and Mitochondrial Eve, Advanced Material: Analysis of Branching and Coalescent Processes</p>	10
4	<p><b>Power Laws and Rich-Get-Richer Phenomena</b>            Popularity as a Network Phenomenon, Power Laws, Rich-Get-Richer Models, The Unpredictability of Rich-Get-Richer Effects, The Long Tail, The Effect of Search Tools and Recommendation Systems Advanced Material: Analysis of Rich-Get-Richer Processes.  <b>The structure of the Web :</b> The World Wide Web, Information Networks, Hypertext, and Associative Memory The Web as a Directed Graph, The Bow-Tie Structure of the Web, The Emergence of Web 2.0</p>	10
5	<p><b>Link Analysis and Web Search</b>  <b>Searching the Web:</b> The Problem of Ranking , Link Analysis using Hubs and Authorities, PageRank, Applying Link Analysis in Modern Web Search, Applications beyond the Web, Advanced Material: Spectral Analysis, Random Walks, and Web Search  <b>Strong and Weak Ties:</b> Triadic Closure , The Strength of Weak Ties, Tie Strength and Network Structure in Large-Scale Data , Tie Strength, Social Media, and Passive Engagement Closure, Structural Holes, and Social Capital, Advanced Material: Betweenness Measures and Graph Partitioning</p>	12

Text Books:

1. "Networks, Crowds, and Markets Reasoning about a Highly Connected World", David Easley, Cornell University, New York, Jon Kleinberg, Cornell University, New York, 2010

**Reference Books:**

1. "Networks: An Introduction By M. E. J. Newman, A College-Level Textbook About The Science Of Networks.", M. E. J. Newman Hardback, Oxford University Press, 2010

**Journals/Magazines:**

1. Shi, C., Li, Y., Zhang, J., Sun, Y., & Philip, S. Y.2. A survey of heterogeneous information network analysis. IEEE Transactions on Knowledge and Data Engineering, 29(1), 17-37, 2016.
2. Shi, C., Hu, B., Zhao, W. X., & Philip, S. Y.. Heterogeneous information network embedding for recommendation. IEEE Transactions on Knowledge and Data Engineering, 31(2), 357-370, 2018.

**Web/Digital resources:**

1. <https://ocw.mit.edu/courses/1-022-introduction-to-network-models-fall-2018/>

**SWAYAM/NPTEL:**

1. [https://onlinecourses.nptel.ac.in/noc22\\_cs117/preview](https://onlinecourses.nptel.ac.in/noc22_cs117/preview)

**PRACTICE BASED LEARNING:**

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Breadth First Search (BFS) to reach the target from a starting node.	Numpy and Matplotlib	BFS technique on social network
2	Simulate the co-ordination between academicians of various disciplines from different universities.	Numpy and Matplotlib	Simulation of social network on different case studies.
3	Implement the Schelling model for different grid sizes and different thresholds.	Numpy , Matplotlib, Pandas	Understand and analyse Schelling model
4	Implement Watts-Strogatz model and apply various search methods to reach the target.	Numpy , Matplotlib and Pandas	Application of Watts-Strogatz model.
5	For a social network with positive and negative relations; implement a method to determine the network is balanced or not balanced.	Numpy, Matplotlib and Pandas	Positive and Negative relations in social network.

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	3	3	-
CO2	3	3	-	3	3	-
CO3	3	3	-	3	3	-
CO4	3	3	-	3	3	-
CO5	3	3	-	3	3	-

High – 3, Medium – 2, Low – 1

# **OPEN ELECTIVES**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS261</b>		<b>Course Title: INTRODUCTION TO DATA STRUCTURES &amp; ALGORITHMS</b>				
<b>Total Credits: 04</b>		<b>Course Category: OEC</b>		<b>Course Type: Open Elective Course</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

**COURSE PREREQUISITE:** Fundamentals of Computer Science

**COURSE OBJECTIVES:** To understand the fundamental concepts and basic principles of Data Structures & Algorithms.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain asymptotic notations and analyze the performance of algorithms.	L2
<b>CO2</b>	Explain the working principle of linear data structure stack, queue, linked list and implement with their real time applications	L3
<b>CO3</b>	Explain the working principle of non-linear data structure trees and graphs and implement with their real time applications	L3
<b>CO4</b>	Apply concepts of linear and nonlinear data structures to solve problems.	L3
<b>CO5</b>	Apply file structures and hashing techniques for efficient searching.	L2

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Basic Terminologies &amp; Introduction to Algorithm and Data Organization:</b> Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation.	10
2	<b>Linear Data Structure:</b> Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures.	12
3	<b>Non-linear Data Structure:</b> Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree) and Graphs (Directed, Undirected), Various Representations, Operations (search and traversal algorithms) & Applications of Non-Linear Data Structures.	10
4	<b>Searching and Sorting on Various Data Structure:</b> Sequential Search, Binary Search, Breadth First Search, Depth First Search, Insertion Sort, Selection Sort, Merge Sort, Quick Sort, Heap Sort.	10
5	<b>File Organization:</b> Sequential, Direct, Indexed Sequential, Hashing and various types of accessing schemes.	10

**Text Books:**

1. Fundamentals of Data Structures, E. Horowitz and S. Sahni, 2<sup>nd</sup> edition, Universities Press, 2008.
2. Data Structures and Algorithms, Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman. Edition 1, Pearson, 1982

**Reference Books:**

1. The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth, Edition 1, Addison – Wesley – 2011
2. Introduction to Algorithms, Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, edition 3, MIT Press, 2009
3. Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31st ed. Edition.

**Web/Digital resources:**

1. <https://nptel.ac.in/courses/106/102/106102064/>

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	1	-
CO2	3	3	3	3	2	-
CO3	3	3	3	3	2	-
CO4	3	3	3	3	2	-
CO5	2	2	2	2	2	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS262</b>			<b>Course Title: INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS</b>			
<b>Total Credits: 04</b>			<b>Course Category: OEC</b>		<b>Course Type: Open Elective Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

**Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**COURSE PREREQUISITE:** Introduction to Discrete Mathematical Structures.

**COURSE OBJECTIVES:** To introduce Database Management Systems and emphasis on how to organize, maintain and retrieve information from a Database.

**COURSE OUTCOMES (COs):** After completing this course, students should be able to:

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	To understand the basic concepts of database management systems.	L2
<b>CO2</b>	Design a relational database and formulation of queries using Structured Query Language (SQL).	L3
<b>CO3</b>	Design a database using theoretical concepts.	L3
<b>CO4</b>	To understand the concepts of transaction processing systems.	L2
<b>CO5</b>	To understand database recovery techniques and database security.	L2

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction to Databases:</b> Introduction, Characteristics of database approach, Advantages of using the DBMS approach, History of database applications. Overview of Database Languages and Architectures: Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment. Conceptual Data Modelling using Entities and Relationships: Entity types, Entity sets, attributes, roles, and structural constraints, Weak entity types, ER diagrams, examples	10
2	<b>Relational Model:</b> Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations. SQL: SQL data definition and data types, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL, Views in SQL, Schema change statements in SQL.	12
3	<b>Normalization: Database Design Theory</b> – Introduction to Normalization using Functional and Multivalued Dependencies: Informal design guidelines for relation schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms. Normalization Algorithms: Inference Rules, Equivalence, and Minimal Cover, Properties of Relational Decompositions.	10
4	<b>Transaction Processing and Concurrency control:</b> Introduction to Transaction Processing, Transaction and System concepts, Desirable properties of Transactions, Characterizing schedules based on recoverability, Characterizing schedules based on Serializability, Transaction support in SQL. <b>Concurrency Control in Databases:</b> Two-phase locking techniques for Concurrency control, Concurrency control based on Timestamp ordering.	10
5	<b>Database Recovery and Security Techniques:</b> Recovery Concepts, NO-UNDO/REDO recovery based on Deferred update, Recovery techniques based on immediate update, Database backup and recovery from catastrophic failures. <b>Database Security:</b> Database security issues, Discretionary access controlled based on granting and revoking privileges, Mandatory access control and role based access control for multi-level security, flow control, encryption and public key infrastructures.	10

**Text Books:**

1. Database System Concepts. Fundamentals of Database Systems. R. Elmasri and S. Navathe, 7<sup>th</sup> edition Pearsom 2008

**Reference Books:**

1. Principles of Database and Knowledge – Base Systems, Vol 1 by J. D. Ullman, Computer Science Press 1988.
2. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, 7<sup>th</sup> edition 2021.

**Web/Digital resources:**

1. <https://nptel.ac.in/courses/106/105/106105175/>

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	P01	P02	P03	P04	P05	P06
CO1	3	3	3	-	3	-
CO2	3	3	3	-	3	-
CO3	3	3	3	-	3	-
CO4	3	3	3	-	3	-
CO5	3	3	3	-	3	-

**High – 3, Medium – 2, Low – 1**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS263</b>		<b>Course Title: INTRODUCTION TO BIG DATA ANALYTICS</b>				
<b>Total Credits: 04</b>		<b>Course Category: OEC</b>		<b>Course Type: Open Elective Course</b>		
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>04</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Total</b>	<b>04</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

**COURSE PREREQUISITE:** Data Mining

**COURSE OBJECTIVE:** To learn how to handle big data using various techniques

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Explain big data analytics and methods to create innovative analytics systems for big data	L2
<b>CO2</b>	List the components of Hadoop and Hadoop Eco-System	L2
<b>CO3</b>	Apply data mining algorithms to process data streams	L3
<b>CO4</b>	Apply data mining methods and recommendation methods to handle big data	L3
<b>CO5</b>	Apply Machine Learning Techniques using R/Python	L3

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

## Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	<b>Introduction</b> Overview of Big Data, History, Structuring Big Data, Types of Data, Elements of Big Data, Data analytics project life cycle, Problems & challenges in understanding Data Analytics, Web page categorization, computing the frequency of stock market change. Use of Big Data in Social Networking, Use of Big Data in preventing Fraudulent activities, Use of Big Data in Retail Industry.	10
2	<b>Big Data Technology</b> Exploring Big Data Stack, Virtualization, Virtualization Approaches, Distributed and parallel computing for Big Data, The cloud and Big Data, Cloud Deployment Models, Cloud Delivery Models, Cloud providers in Big Data Market. Introducing Hadoop, Hadoop Ecosystem, Hadoop Distributed File Systems(HDFS), Features of HDFS : Hadoop YARN, MAP Reduce, Features of Map Reduce, Working of Map Reduce, Techniques to Optimize Map Reduce Jobs, Uses of Map Reduce, HBase, Features of HBase, Role of HBase in Big Data processing, Other tools of Hadoop (Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, OOOZie),	12
3	<b>Mining Data Streams</b> The Stream Data Model, A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing, Sampling Data in a Stream, Filtering Streams, Estimating Moments, Dealing With Infinite Streams, Counting Ones in a Window.	10
4	<b>Frequent Itemsets and Recommendation Systems</b> The Market Basket Analysis, A Priori Algorithm, Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream. Recommendation System: A Model, Content Based Recommendations, Collaborative Filtering, Dimensionality Reduction Problem, TheNetFlix Problem.	10
5	<b>Large Scale Machine Learning</b> Introduction, Types of Machine Learning Algorithms, Machine Learning Architecture, Applications of Machine Learning, Supervised Machine Learning Algorithms: Learning from Nearest Neighbors, Support Vector Machines. Unsupervised Machine Learning Algorithms: Hierarchical Clustering Techniques, K-means Algorithms.	10

### Text Books

1. Big Data: Black Book, DT Editorial Services, Dream Tech Press Publishers, 2015.
2. Mining of Massive Datasets, Jure Leskovec, AnandRajaraman, Jeff Ullman, Second Edition, Cambridge University Press Publisher, 2015.

### Reference Books

1. Big Data Analytics withR and Hadoop, VigneshPrajapati, Packt Publishing, 2013
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 2015.

### Journals/Magazines:

1. Gandomi, A.H.; Chen, F.; Abualigah, L. Machine Learning Technologies for Big Data Analytics. Electronics 2022, 11, 421. <https://doi.org/10.3390/electronics11030421>

**Web/Digital resources:**

1. <https://www.coursera.org/big-data-analytics>

**SWAYAM/NPTEL:**

1. <https://nptel.ac.in/courses/106104189>; NOC: Big Data Computing, IIT Patna Dr. Rajiv Misra

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	2	2	-
CO2	3	-	2	2	3	-
CO3	3	-	2	2	3	-
CO4	3	-	2	2	3	-
CO5	3	-	3	2	3	1

High – 3, Medium – 2, Low –

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS270</b>			<b>Course Title: RESEARCH METHODOLOGY AND IPR</b>			
<b>Total Credits: 1.5</b>			<b>Course Category: MC</b>		<b>Course Type: Mandatory Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	<b>1.5</b>		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	<b>-</b>	<b>Weightage, %</b>	<b>100</b>	<b>-</b>	<b>100</b>
	<b>Practical</b>	<b>-</b>	<b>Maximum Marks</b>	<b>50</b>	<b>-</b>	<b>50</b>
	<b>Total</b>	<b>1.5</b>	<b>Minimum Marks</b>	<b>25</b>	<b>-</b>	<b>25</b>

**COURSE PREREQUISITE:** Mathematics

**COURSE OBJECTIVES:** To understand the fundamental concepts of research, Methodologies and intellectual property rights.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
CO1	Explain and illustrate the basic principles of research and defining the Research Problem.	L2
CO2	Explain the need of Literature Review and Research Design	L2
CO3	Design of various Sample Surveys, explain data collection methods and IPR	L2

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

<b>UNIT No.</b>	<b>Content</b>	<b>Hours</b>
		<b>Lecture</b>
1.	<b>Introduction to Research Methodology:</b> Meaning, Objectives, Characteristics Approaches of Research - Significance of Research - Research Methods Vs. Methodology Types of Research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research Process .	7
2.	<b>Reviewing of The Literature:</b> Introduction, Importance of Literature Review in Defining a Problem, Survey of Literature- Primary and Secondary Sources - Reviews, Treatise Monographs Patents. Research Design: Introduction – Meaning of Research Design - Need of Research Design -Features of Good Design.	6
3.	<b>Design of Sample Surveys:</b> Introduction, Sample Design, Sampling and Non - Sampling Errors, Steps in Sampling. <b>Data Collection:</b> Methods of Data Collection - Collection of Primary Data and Secondary Data. <b>Intellectual Property Rights</b> -Invention and Creativity, Intellectual Property, Importance and Protection of Intellectual Property Rights (IPRs) A Brief Summary of: Patents, Copyrights, Trademarks, Industrial Designs.	7

**Text Book:**

1. Kothari, C.R, Research Methodology: Methods and Techniques, New Age International, 2010
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K, An introduction to Research Methodology, RBSA Publishers, 2002.

**Reference Books:**

1. Anderson, T. W, An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
2. Fink, A, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 2009.
3. Keith Eugene Maskus, Intellectual Property Rights in the Global Economy, Institute for International Economics, Washington, DC, 2000

**Web Resources:**

1. <https://nptel.ac.in/courses/121106007>
2. [https://onlinecourses.swayam2.ac.in/cec20\\_hs17/](https://onlinecourses.swayam2.ac.in/cec20_hs17/)

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	-
CO2	3	3	-	-	3	-
CO3	3	3	-	-	3	-

High – 3, Medium – 2, Low – 1

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS280L</b>		<b>Course Title: DEEP LEARNING LABORATORY</b>				
<b>Total Credits: 1.5</b>		<b>Course Category: PCCL</b>			<b>Course Type: Professional Core Course Laboratory</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	-		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>100</b>	-	<b>100</b>
	<b>Practical</b>	<b>03</b>	<b>Maximum Marks</b>	<b>50</b>	-	<b>50</b>
	<b>Total</b>	<b>03</b>	<b>Minimum Marks</b>	<b>25</b>	-	<b>25</b>

**COURSE PREREQUISITE:** Python Programming, Tensor flow, Data Science.

**COURSE OBJECTIVES:** To build machine learning and deep learning models using python code and tensor flow.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Input Data and Preprocess datasets.	L4
<b>CO2</b>	Build Machine Learning Models using different datasets.	L4
<b>CO3</b>	Develop Classification and Prediction models.	L3
<b>CO4</b>	Build custom models using Deep Learning techniques.	L3
<b>CO5</b>	Monitor and evaluate models.	L5

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

**Course Content / Syllabus:**

<b>Week</b>	<b>List of Experiments/ Programs</b>	<b>No. of Hours</b>
<b>1</b>	Explore various datasets and analyse each variable in the dataset. Preprocess the dataset using Tensorflow.	3
<b>2</b>	Implement Machine Learning and Neural network approaches using ML tools.	3
<b>3</b>	Download MNIST, FMNIST and CIFAR10 datasets and perform classification using appropriate Deep learning techniques. Report your findings with the code.	3
<b>4</b>	Implement LSTM on a suitable dataset. Write the code that describes the resultant plots. Inference the results on the same.	3
<b>5</b>	Build an LSTM model for text classification by making use of the IMDB movie review dataset.	3
<b>6</b>	Develop a Keras Image Classification model using Intel Image Classification Dataset.	3
<b>7</b>	Demonstrate Object Detection with the help of a Python code.	3
<b>8</b>	Perform Medical Image Segmentation to segment the objects of interest in a medical image.	3
<b>9</b>	Implement the generative adversarial network (GAN) training algorithm and loss functions. (Train both the discriminator and the generator model in parallel.)	3
<b>10</b>	Demonstrate the implementation of a deep convolutional autoencoder for image denoising and mapping noisy digits images from the MNIST dataset to clean digits images using Keras.	3

<b>11</b>	Create a simple linear classifier in TensorFlow. Implement this model for classifying images of handwritten digits from MNIST dataset.	3
<b>12</b>	Perform Image Classification of MNIST dataset using Tensor Flow in Python.	3
<b>13</b>	Laboratory Test	3

**Text Books:**

1. François Chollet, Deep Learning with Python, Manning Publications Co., 2018

**Reference Books:**

1. John Hunt, Advanced Guide to Python 3 Programming, Springer, 2019

**Journals/Magazines:**

1. <https://www.edureka.co/blog/deep-learning-with-python/>
2. <https://readthedocs.org/projects/pythonguide/downloads/pdf/latest/>

**Web/Digital resources:**

1. [https://onlinecourses.nptel.ac.in/noc20\\_cs95/preview](https://onlinecourses.nptel.ac.in/noc20_cs95/preview)
2. [https://onlinecourses.nptel.ac.in/noc22\\_cs32/preview](https://onlinecourses.nptel.ac.in/noc22_cs32/preview)

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	1	1	1	1	3	2
<b>CO2</b>	2	2	1	2	3	3
<b>CO3</b>	3	2	1	3	3	3
<b>CO4</b>	3	2	1	3	3	3
<b>CO5</b>	3	2	1	3	3	3

High – 3, Medium – 2, Low – 1

# **SEMESTER III**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS310P</b>		<b>Course Title: INTERNSHIP/ INDUSTRIAL TRAINING</b>				
<b>Total Credits: 04</b>		<b>Course Category: INT</b>			<b>Course Type: INTERNSHIP/ INDUSTRIAL TRAINING</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	-		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>100</b>	-	<b>100</b>
	<b>Practical</b>	<b>08</b>	<b>Maximum Marks</b>	<b>50</b>	-	<b>50</b>
	<b>Total</b>	<b>08</b>	<b>Minimum Marks</b>	<b>25</b>	-	<b>25</b>

**COURSE OBJECTIVES:** Provide to students the feel of the actual working environment and to gain practical knowledge and skills, which in turn will motivate, develop and build their confidence.

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Describe use of advanced tools and techniques encountered during industrial training and visit.	L2
<b>CO2</b>	Develop awareness about general workplace behavior and build interpersonal and team skills.	L3
<b>CO3</b>	Develop solutions and prepare professional work reports and presentations	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create**

This course is designed to help the student obtain skills to use of advanced tools and techniques used in the industry during industrial training and visit. And also students get an opportunity to interact with industrial personnel and follow engineering practices and discipline prescribed in industry. It is also designed to develop awareness about general workplace behavior and build interpersonal and team skills

<b>COURSE OUTCOMES</b> ↓	<b>PROGRAM OUTCOMES</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3
<b>CO3</b>	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	3

**High – 3, Medium – 2, Low – 1**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS320P</b>			<b>Course Title: PROJECT WORK (PHASE-1)</b>			
<b>Total Credits: 06</b>			<b>Course Category: PROJ</b>		<b>Course Type: Project Work Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	-		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>100</b>	-	<b>100</b>
	<b>Practical</b>	<b>12</b>	<b>Maximum Marks</b>	<b>50</b>	-	<b>50</b>
	<b>Total</b>	<b>12</b>	<b>Minimum Marks</b>	<b>25</b>	-	<b>25</b>

**COURSE PREREQUISITE:** Regular Subjects Mentioned in The Scheme

**COURSE OBJECTIVES:** To understand formation of the problem as part of software life cycle

**COURSE OUTCOMES (COs)**

<b>CO#</b>	<b>Course Outcomes</b>	<b>Highest Level of Cognitive Domain</b>
<b>CO1</b>	Conduct literature review in the area relevant to the computer science.	L2
<b>CO2</b>	Formulate a problem.	L3
<b>CO3</b>	Prepare a consolidated report of the literature survey and problem formulation.	L4

**L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create**

The students are required to take up an in-house or industrial project work relevant to the course. In this course preliminary work involving literature review and problem formulation will be taken up. The candidate conducts the project under the supervision of project guide.

**Course Articulation:**

<b>COURSE OUTCOMES ↓</b>	<b>PROGRAM OUTCOMES</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3
<b>CO3</b>	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	3
<b>CO5</b>	3	3	3	3	3	3

**High – 3, Medium – 2, Low – 1**

# **SEMESTER IV**

<b>Department: INFORMATION SCIENCE AND ENGINEERING</b>						
<b>Course Code: 24SDS410P</b>			<b>Course Title: PROJECT WORK (PHASE-2)</b>			
<b>Total Credits: 16</b>			<b>Course Category: PROJ</b>		<b>Course Type: Project Work Course</b>	
<b>Teaching Learning Process</b>		<b>Contact Hours/Week</b>	<b>Assessment Weightage and Marks</b>			
	<b>Lecture</b>	-		<b>CIE</b>	<b>SEE</b>	<b>Total</b>
	<b>Tutorial</b>	-	<b>Weightage, %</b>	<b>40</b>	<b>60</b>	<b>100</b>
	<b>Practical</b>	<b>32</b>	<b>Maximum Marks</b>	<b>40</b>	<b>60</b>	<b>50</b>
	<b>Total</b>	<b>32</b>	<b>Minimum Marks</b>	<b>20</b>	<b>25</b>	<b>45*</b>

Note: \*For passing the course, the student must score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

**COURSE PREREQUISITE:** All regular subjects as per the Scheme

**COURSE OBJECTIVE:** To design, implement and preparing a technical report for the defined problem

**COURSE OUTCOMES (COs)**

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Conduct literature review and formulate a problem in the area relevant to the computer science.	L2
CO2	Conduct experiments/Design and Analysis/solution iterations and document the results.	L3
CO3	Prepare a technical report and presentations.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

The students are required to take up a project work relevant to the course, which involves literature review, problem formulation, experimentation, analysis of results and discussion. The entire project will be executed under the supervision of project guide.

**Course Articulation:**

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

**Guidelines:**

1. Student shall be associated with a faculty member serving as internal guide to supervise the project.
2. If the student is conducting the project work in an industry or an organization an external guide is to be chosen from industry or organization (along with internal guide) with the approval of the Head of the Department
3. The student will work with the project guide /supervisor towards the identification of the problem through a systematic literature review and finalize the objectives and scope of work.
4. Student is expected to come out with detail specifications, methodology, resources required, critical issues and any other issues related to design and implementation of the project should be provided in consultation with Guide.
5. The student should submit the proposal with in ten working days from the commencement of the semester to the Head of Department after due approval from the guide.
6. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
7. The student should present an interim progress review as per the department calendar of events.
8. Completed project work phase -1/ project work phase -2 documentation should be in the form of a report and the report should be submitted to the department at the end of the semester.
9. The report should include: Abstract, Content sheets, Introduction chapter with objectives, literature review chapter, materials and methodology chapter, results and discussion chapter, summary and conclusion followed by reference list and appendix if any.
10. The student should make a final presentation at the end of the semester as per the department Calendar of events.