PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY
Periyar Nagar, Vallam, Thanjavur - 613 403, Tamil Nadu, India. **www.pmu.edu**

M.Sc. Data Science

Curriculum & Syllabus (Regulation - 2023)

(Applicable to the students admitted from the Academic year 2023 - 2024)

Department of Computer Science and Applications
Faculty of Computing Sciences & Engineering
Periyar Maniammai Institute of Science & Technology (PMIST)
Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403.
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University Vision and Mission

Vision

To be a university of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society.

Mission

UM1: Offering well balanced programmes with scholarly faculty and state-of-art facilities to impart high level of knowledge.

UM2: Providing student - centered education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and collaborative work.

UM3: Involving progressive and meaningful research with concern for sustainable development.

UM4: Enabling the students to acquire the skills for global competencies.

UM5: Inculcating Universal values, Self-respect, Gender equality, Dignity and Ethics.

Vision and Mission

Vision

To be a leading, contemporary, innovative Computer Science and Applications department in inculcating professional competencies in the field of Computing and related interdisciplinary technologies to achieve academic excellence and to facilitate research activities as a timely response to dynamic needs and challenges of industry and society.

Mission

DM1: Imparting quality education in the field of Computing Sciences and Applications and generate successful computing professional

DM2: Encouraging students to collaborate with industry environment and analyze the real-world problems culminating in efficient solutions.

DM3: Transforming students into computing professionals and entrepreneurs by imparting quality training and hands on experience with latest tools and technologies.

DM4: Promoting activities in creating applications in emerging areas of computing technologies and applications in order to serve the needs of research, industry, society and scientific community.

DM5: Inculcating value based and ethical commitment for bringing out successful professionals.

MEMBERS OF THE BOARD OF STUDIES

S. No	Name of the Member	Role	Designation and Address
1.	Dr. J. JEYACHIDRA	Dean	Professor and Dean, Faculty of Computing Sciences and Engineering (FCSE), Periyar Maniammai Institute of Science & Technology, Vallam.
2.	Dr. D. RUBY	BoS Chairman	Associate Professor and Head, Department of Computer Science and Applications, Periyar Maniammai Institute of Science & Technology, Vallam.
3.	Dr. S. NICKOLAS	Academic Expert	Professor, Department of Computer Applications, NIT, Tiruchirappalli. nickolas@nitt.edu, nickolasnitt@gmail.com, 94435 61989, 94860 01131
4.	Mr. J. SENGATHIR	Industry Expert	Manager Enterprise Resource Planning, BHEL Trichy – 620 014 Sengathir@bhel.in 9489051236
5.	Dr. V. ADITHYA POTHAN RAJ	Industry Expert	Associate Operations Manager, CTS, Chennai. apr1991@rediffmail.com 9444408814
6.	Dr. A. MUTHAMIZH SELVAN	BoS Member Internal	Associate Professor, Department of Computer Applications, Periyar Maniammai Institute of Science & Technology, Vallam.
7.	Dr. S. ARUMUGAM	BoS Member Internal	Associate Professor, Department of Computer Applications, Periyar Maniammai Institute of Science & Technology, Vallam.
8.	Dr. V. SRITHAR	BoS Member Internal	Assistant Professor, Department of Computer Applications, Periyar Maniammai Institute of Science & Technology, Vallam.
9.	Dr. S. BHUVANESWARI	BoS Member Internal	Associate Professor and Head, Department of Mathematics Periyar Maniammai Institute of Science & Technology, Vallam.
10.	Dr. D. THAYALNAYAKI	BoS Member	Associate Professor and Head, Department of Civil Engineering

		Internal	Periyar Maniammai Institute of Science & Technology, Vallam.
11.	Dr. V. SARANYA	BoS Member Internal	Associate Professor and Head, Department of Languages, Periyar Maniammai Institute of Science & Technology, Vallam.
12.	Ms. K. BIRUNTHA	Student Member	MCA 2nd Year Student Periyar Maniammai Institute of Science & Technology, Vallam.
13.	Mr. R. MURUGANANDHAM	Alumni Member	Alumni, MCA (Batch : 2019-2021) Machine Learning Engineer Changepond Technologies, Sipcot IT park, Siruseri, Chennai-103

The current M.Sc. Data Science Curriculum is undergone in **Department Advisory Committee Meeting on 25.05.2023 and Board of studies Meeting on 15.06.2023** to tune the syllabus towards Outcome based Education and meet the UGC requirements and in turn the suggestions provided will be implemented in Regulations 2023.

It is thoroughly felt there is a need to change the present curriculum in order to graduate the students who possess skills that are employable. Hence, appropriate modification in the existing curriculum will augment the manpower and skill requirement of our country. The quality of an educational system can be judged from at least three perspectives: the inputs to the system, what happens within the system and the outputs from the system. In order to refine the input to the system, BoS members redefined the curriculum with the focus towards outcome-based education.

In this connection, it is felt to frame the department vision and attain the vision through a well-structured mission framed in consultation with the faculty members and other administrators of Periyar Maniammai Institute of Science & Technology.

Department Vision and Mission Definition Process

The development of vision and mission of the department is carried out as per the following steps.

Step : I Brainstorming/Feedback carried out at different levels

First level - Department faculty by the HOD

Second level – Current students by the faculty

Third level - Employers, alumni and academia and industry experts

Step: II Benchmarking with other Universities: Understanding the Vision and Mission

Step: III Validation by the Board of studies and then Academic Council

Step: IV Wide publicity in the department and institution

The University Vision is split up into small elements and verifies its compliance with Department Vision.

To be a university of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society.

To be a leading, contemporary, innovative Computer Science and Applications department in inculcating professional competencies in the field of Computing and related interdisciplinary technologies to achieve academic excellence and to facilitate research activities as a timely response to dynamic needs and challenges of industry and society.

University Vision	Department Vision
To be a university of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society	To be a leading, contemporary, innovative Computer Science and Applications department in inculcating professional competencies in the field of Computing and related interdisciplinary technologies to achieve academic excellence and to facilitate research activities as a timely response to dynamic needs and challenges of industry and society.
Global Dynamism **Excellence in Knowledge** **Social Responsibility**	Placement (Global Level) Teaching Learning (New Technologies) Contribution (Needs and challenges of Industry and Society)

To accomplish the vision stated, well-structured mission is established with consultation with administrators, faculty members and other officials.

University Mission	Department Mission
Offering well balanced programmes with scholarly faculty and state-of-art facilities to impart high level of knowledge.	Imparting quality education in the field of Computing Sciences and Applications and generate successful computing professional
Providing student - centered education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and collaborative work.	Encouraging students to collaborate with industry environment and analyze the real-world problems culminating in efficient solutions.
Involving progressive and meaningful research with concern for sustainable development.	Transforming students into computing professionals and entrepreneurs by imparting quality training and hands on experience with latest tools and technologies.
Enabling the students to acquire the skills for global competencies.	Promoting activities in creating applications in emerging areas of computing technologies and applications in order to serve the needs of research, industry, society and scientific community.
Inculcating Universal values, Self-respect, Gender equality, Dignity and Ethics.	Inculcating value based and ethical commitment for bringing out successful professionals.

Mapping of University Vision and Department Mission

	DM1	DM2	DM3	DM4	DM5	**Total**
UM1	3	1	1	1	1	**7**
UM2	1	2	3	2	0	**8**
UM3	0	1	2	3	2	**8**
UM4	1	1	3	3	0	**8**
UM5	1	1	0	1	3	**6**

0-No relation 3- High relation 2- Medium relation 1– Low relation

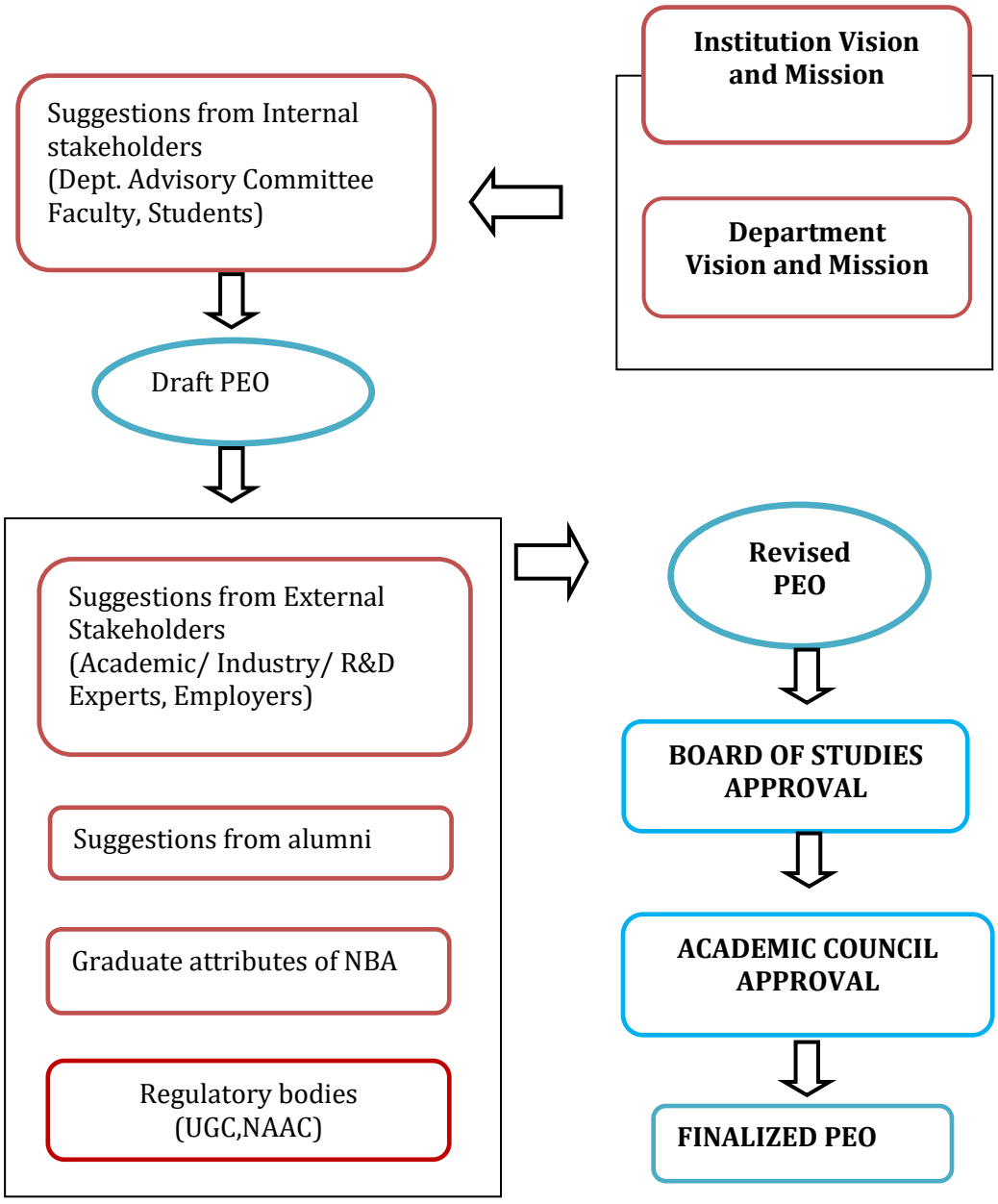
PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

Based on the mission of the department, the programme educational objectives are formulated as

PEO1	Graduates of the programme will be employed in industry, government and entrepreneurial endeavors to have a successful professional career.
PEO2	Graduates of the programme will pursue higher education and /or research
PEO3	Graduates of the programme will contribute to the society and human well-being by applying ethical principles.
PEO4	Graduates of the programme will reveal lifelong learning and team work in their chosen professional

PEO PROCESS ESTABLISHMENT

The faculty of the CSA department at our institution met on different occasions for discussion and a final work session to complete the steps of the process in order to draft the set of PEOs for CSA Department to assess the graduates few years after graduation.



The framework for the review and revision of the PEOs at the departmental level involving all the faculty members comprised the following broad stages.

1. Using the key words and phrases extracted from the Mission Statement of the institution and department to identify attributes to gauge graduates.
2. Capturing the distinction between the educational objective and the student outcomes.

3. Formulating each objective to be measurable.

The program educational objectives for the M.Sc. Data Science program describe accomplishments that graduates are expected to attain within three years after graduation. Graduates will have applied their expertise to contemporary problem solving, be engaged professionally, and have continued to learn and adapt, and have contributed to their organizations through leadership and teamwork.

Mapping of Program Educational Objectives (PEOs) with Department Mission (DM)

	DM1	DM2	DM3	DM4	DM5
PEO1	3	3	1	1	1
PEO2	1	2	0	3	1
PEO3	1	1	1	1	3
PEO4	2	2	1	1	3
Total	**7**	**8**	**3**	**6**	**8**

1- Low 2 – Medium 3-High

The development of vision, mission and programme educational objectives is tuned in line with the global and national standards and it is assured that the department vision and mission will facilitate in meeting the vision and mission of the University.

The Program Educational Objectives shall cover both technical and professional aspects of the expected achieve-Achievement in terms of technical skills required in the profession for which the program prepares students

- Achievements in terms of professional, ethical, and Communicational aspects required by the profession for which the program prepares students (team work, ethical behavior, effective communication, etc.)
- Achievements in terms of management and leadership skills (project managers, directors, CTOs, CEOs, etc.)
- Achievements in terms of life-long learning and continuous education (certifications, conferences and workshops attendance, etc.)
- Achievements in terms of advanced and graduate studies pursuing (graduate studies, research careers, etc.)

- Other aspects could be considered when defining educational objectives such as the ability to engage in entrepreneurship activities.

PROGRAMME OUTCOME (PO)

At the time of graduation, competency of the student is measured through the attainment of programme outcomes. The quantification of programme outcomes attainment is measured through the assessment of established course outcomes for each course.

PROGRAM OUTCOMES	
PO 1	Ability to apply knowledge of basic sciences, mathematics, probability and statistics, computer science and solve problems.
PO 2	Ability to model, analyse, design, visualize and realize physical systems orprocesses of increasing size and complexity
PO 3	An ability to understand, analyse and design efficient algorithms
PO 4	Development of soft skills and practicing professional ethics
PO 5	Develop and implement data analysis strategies based on theoretical principles, and detailed knowledge of the underlying data.
PO 6	An ability to analyze very large data sets in the context of real world problems and interpret results using data analytics.
PO 7	An ability to understand the interdisciplinary nature of data, information and communications.
PO 8	An ability to understand research methods used to collect and analyze data for decision making.
PROGRAM SPECIFIC OUTCOME	
PSO1	Able to become data scientist in Industry, Government and academia.
PSO2	Able to use the modern tools, techniques to apply in the multidisciplinary tasks and carry out research to solve the practical problems.

GRADUATE ATTRIBUTES

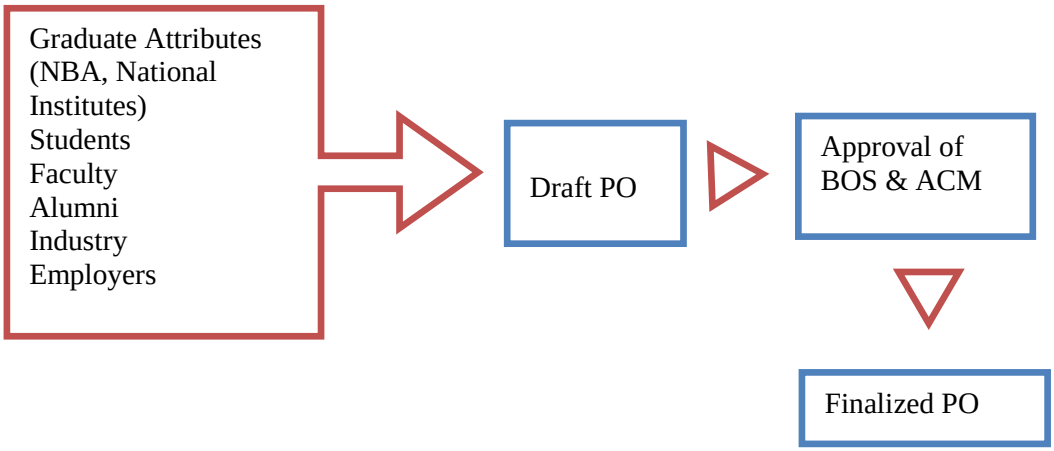
Graduates Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The GAs are examples of the attributes expected of a graduate from an accredited programme. The computing professional Graduate Attributes are derived from NBA and National Institutes.

1. **Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study.
2. **Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one‟s views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
3. **Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.
4. **Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.
5. **Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
6. **Research-related skills:** A sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.

7. **Cooperation/Team work**: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
8. **Scientific reasoning:** Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
9. **Reflective thinking:** Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
10. **Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
11. **Self-directed learning:** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
12. **Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.
13. **Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one‟s life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.
14. **Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
15. **Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal

development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

PO PROCESS ESTABILSHMENT



CORRELATION BETWEEN THE POS AND THE PEOS

Table: 1 Mapping of Program Educational Objectives (PEOs) with Program Outcomes (POs)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	Total
PEO 1	3	3	2	1	2	2	1	1	3	3	21
PEO 2	1	1	1	1	1	3	1	3	1	3	16
PEO 3	1	1	1	3	1	1	1	1	1	1	12
PEO 4	2	2	2	2	2	2	2	3	3	2	22
Total	7	7	6	7	6	8	5	8	8	9	71

1 - Low 2 – Medium 3 - High

Table :2 Mapping of Program Outcomes (POs) with Graduate Attributes (GAs)

GA	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PS O2	TOT AL
1. ***Disciplinary knowledge:*** **PO 1 PSO2**	3								3	3	9
2. ***Communication Skills:*** **PO4.**				3							3
3. ***Critical thinking:*** **PO2 PO3.**					3	1			2	2	8
4. ***Problem solving:*** **PO2 PO3 PO4 PSO 1 PSO2 PSO3.**	1	3							2	2	8
5. ***Analytical reasoning:*** **PO2 PO3 PO4.**					3	3			2	2	10
6. ***Research-related skills:*** **PO2 PO3 PO4PSO1 PSO 3**			1				1	3	2	3	10
7. ***Cooperation/Team work:*** **PO5.**				3					1	2	6
8. ***Scientific reasoning:*** **PO2 PO3 PO4.**		1				2	1	1	2	2	9
9. ***Reflective thinking:*** **PO6.**		3			3				2	2	10
10. ***Information/digital literacy:*** **PO 3, PSO 1.**	3								3	1	4

11. ***Self-directed learning:*****PO5 PO7.**				3				3	1	1	8
12. ***Multicultural competence:*****PO5.**							3		1	2	6
13. ***Moral and ethical awareness/reasoning :*** **PO6.**				3					1	1	5
14. ***Leadership readiness/qualities:*** **PO5.**				3					1	1	5
15. ***Lifelong learning:*****PO7.**		2			2	2		2	1	1	10

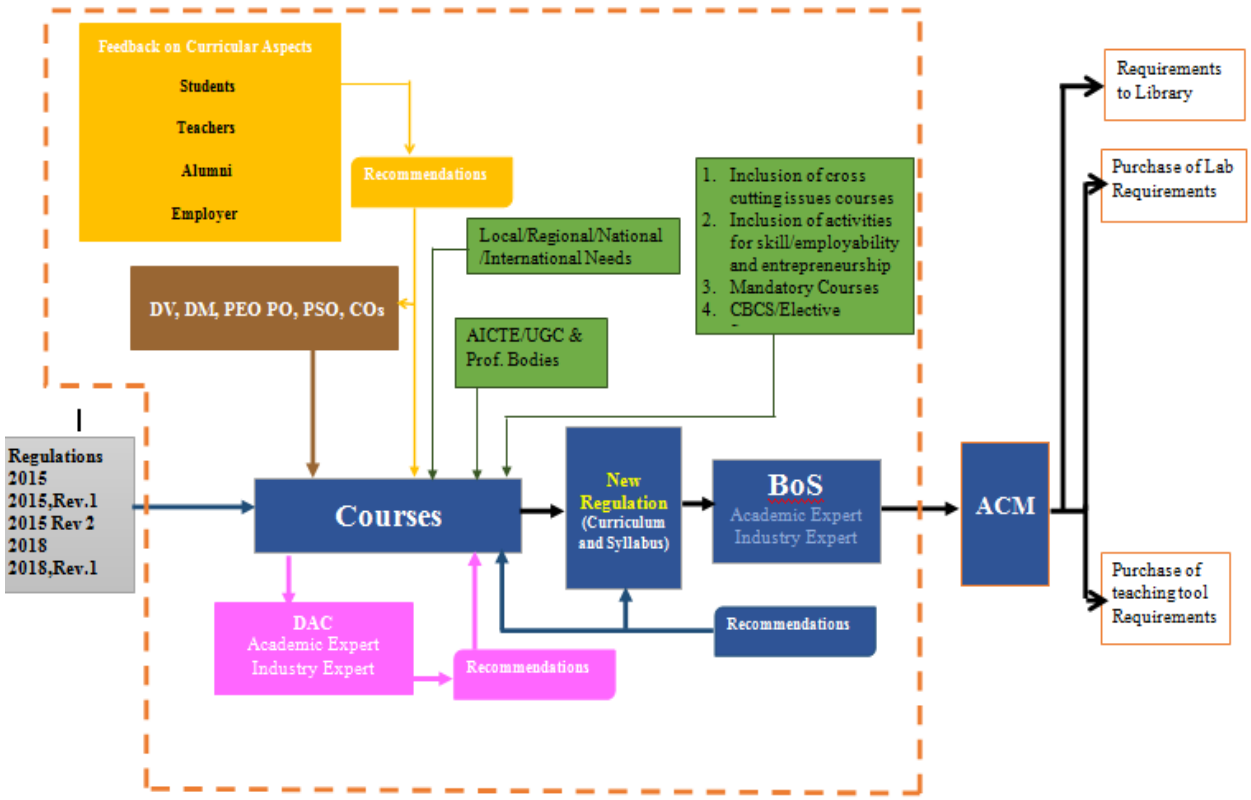
1- Slightly **2 – Supportive** **3 - Highly related**

CURRICULUM DEVELOPMENT PROCESS

1. (Start Here for new progrmme or when DV/DM/PEO expires) Develop PEO of the programme. Ensure its relation with Department Mission
2. Check for statutory body GAs. Derive POs, PSO with GAs and PEO into consideration.
3. Gather core courses and elective courses from statutory bodies) model syllabus /Profession bodies (Programme Specific Criteria and develop COs to fulfil the POs and PSOs. Note: Do the step with top 10 programmes from NIRF or QS ranking if there is no statutory bodies syllabus is not available.
4. Compare with existing (if there is) courses and update.
5. Develop course syllabus for each course selected in step 2 and 3 by specialist (Faculty Competency Matrix) in that area..
6. For revision of existing syllabus, Incorporate the actions taken in terms of curriculum intervention based on CO attainment, feedback from student, teacher, alumni and employer. Incorporate the suggestions given by academic and industrial expert during DAC and
7. Gather mandatory courses given by statutory bodies
8. Design (or fit given) additional courses which reflect University Vision and Mission.
9. Ensure presence of employability/entrepreneurship and skill development component in courses.

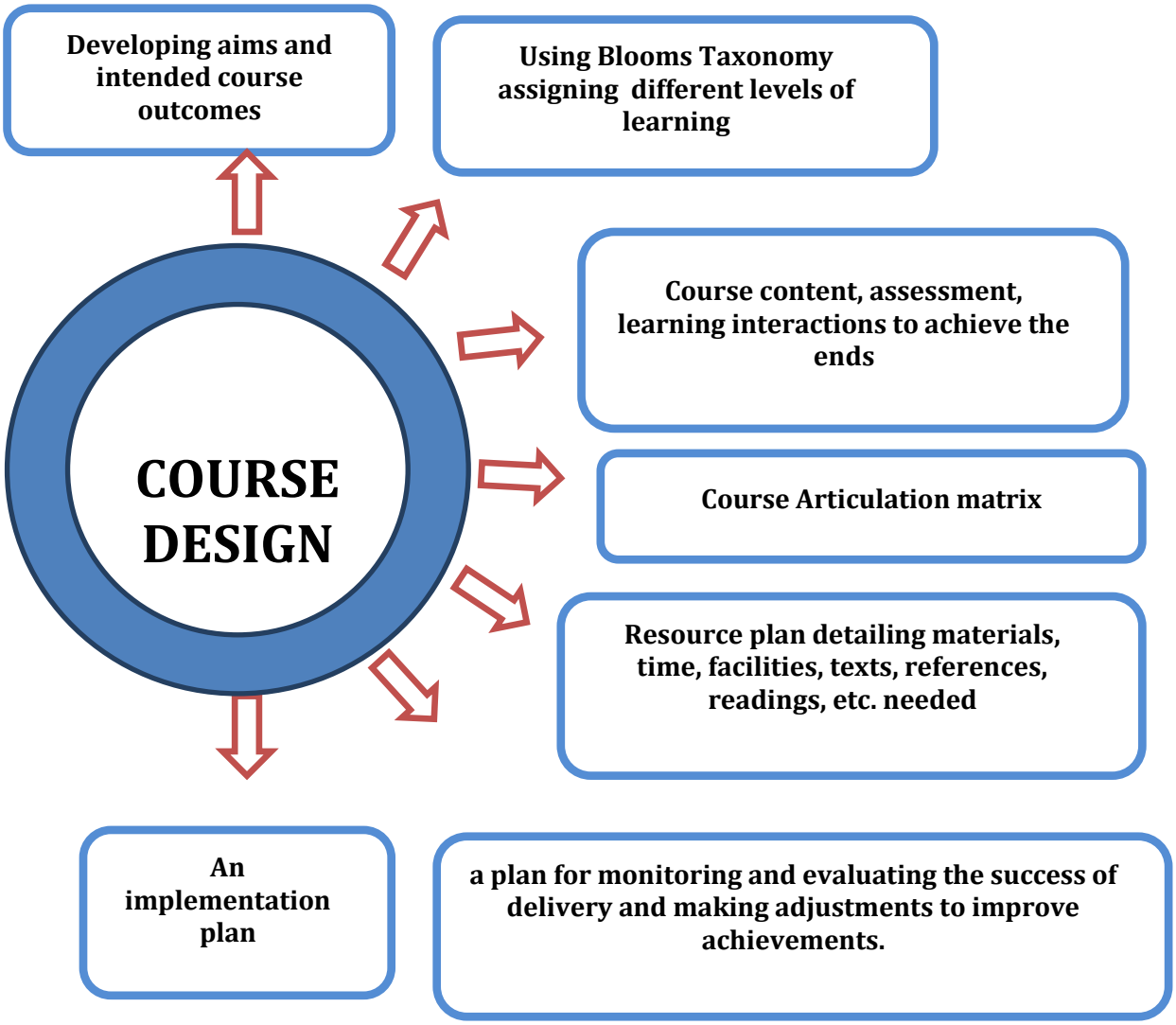
10. Ensure cross cutting courses available.
11. Compare the credit distribution with statutory bodies guidelines
12. Draw Course Articulation Matrix. If POs are not uniformly covered, go to step 3 and repeat.
13. Check for C P A distribution. If not as planned go to step 3 and repeat.
14. Present the curriculum and syllabus to Department Advisory Committee, Get the feedbacks and incorporate.
15. Present the curriculum and syllabus to BoS Get the feedbacks and incorporate
16. Present the curriculum and syllabus to ACM Get the feedbacks and incorporate
    a. Initiate augmentation of teaching learning tools and other infrastructure which are not present in the department/institute for new additions in this regulation

Curriculum Design and Development Process - Revision



COURSE DEVELOPMENT

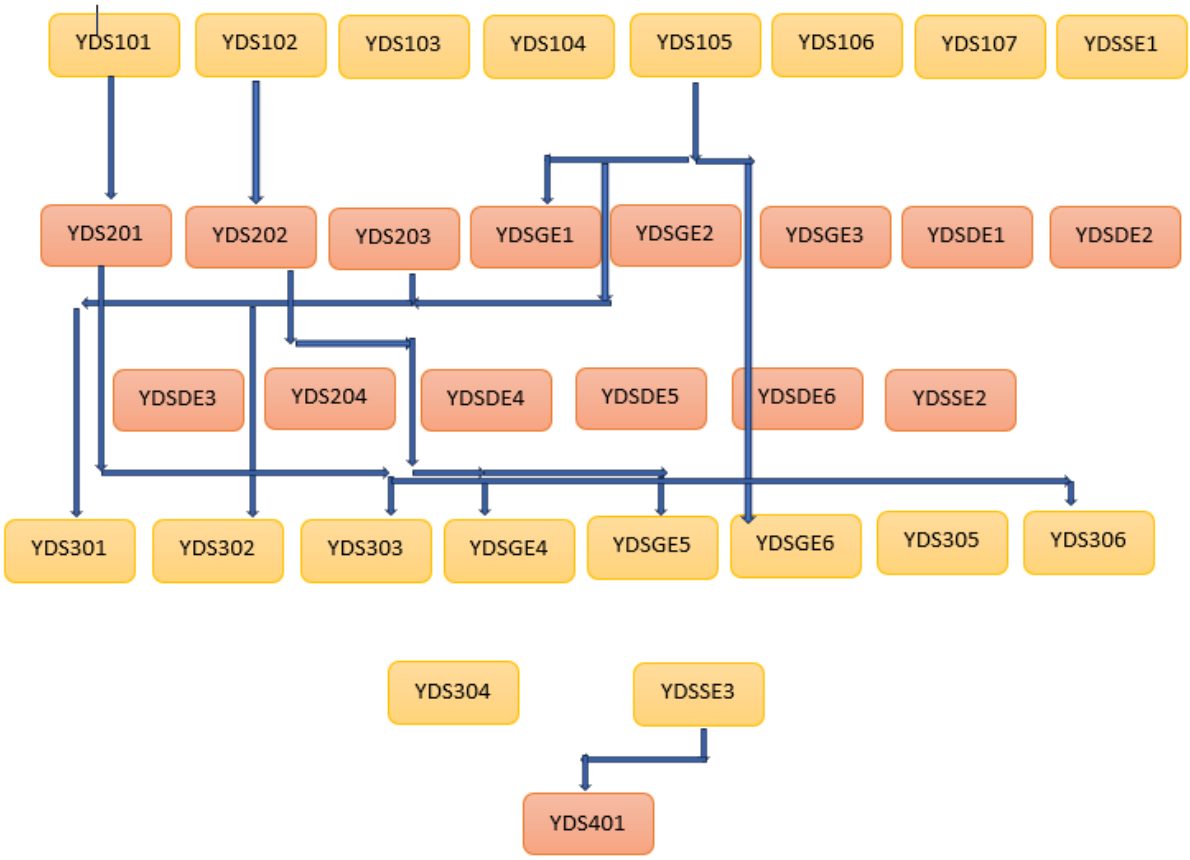
The following elements were developed by the faculty involved after interaction and discussions.



FACULTY ALLOTTED FOR COURSE DEVELOPMENT

S. No	Sem	Category	Code	Subject Name	Faculty Members
1.	I	DSC – 1	YDS101	Principles of Data Science	Dr. D. Ruby
2.	I	DSC – 2	YDS102	Advanced Statistical Methods – I	Dr. A. Muthamizh Selvan
3.	I	DSC – 3	YDS103	Python and R Programming	Dr. S. Arumugam
4.	I	DSC – 4	YDS104	Advanced Algorithms and Data Structures	Dr. V. Srithar
5.	I	DSC – 5	YDS105	Advanced Database Management Systems	Ms. T. Logesh
6.	I	DSC – 6 - Lab	YDS106	Python and R Programming Laboratory	Ms. P. Ranjani
7.	I	DSC – 7 – Lab	YDS107	Advanced Database Management Systems Laboratory	Ms. G. Umamaheswari
8.	I	SEC – 1	YDSSE1	Interpersonal and Delivering Skills	Ms. K. Nandhini
9.	II	DSC – 8	YDS201	Machine Learning Techniques	Ms. I.Epistle
10.	II	DSC – 9	YDS202	Advanced Statistical Methods – II	Dr. A. Muthamizh Selvan
11.	II	DSC – 10	YDS203	Big Data Analytics	Dr. J.Jeyachidra
12.	II	GEC – I	YDSGE*	Data and Information Security	Ms. R. Sivaranjani
				Block chain Technologies	Dr. S. Manimozhi
				Cryptography and Network Security	Ms. R. Manisha
13.	II	DSE – I	YDSDE*	Health Care Analytics	Ms. G. Praveena
				IoT Analytics	Ms. M. Umamaheswari
				Image and Video Analytics	Ms. R. Ragini
14.	II	DSC – 11 Lab	YDS204	Machine Learning Techniques Laboratory	Ms. M. Lavanya
15.	II	DSE – II Lab	YDSDE*	Health Care Analytics Laboratory	Ms. M. Swathi
				IoT Analytics Laboratory	Dr. G. Preethi
				Image and Video Analytics Laboratory	Mr. P.Karthik
16.	II	SEC – 2	YDSSE2	Cyber Security	Ms. K. Radhika
17.	III	DSC – 12	YDS301	Business Intelligence	Ms. K. Nandhini
18.	III	DSC – 13	YDS302	Exploratory Data Analysis and Visualization	Ms. G. Umamaheswari
19.	III	DSC – 14	YDS303	Deep Learning	Ms. I.Epistle
20.	III	GEC – II	YDSGE*	Digital Image Processing	Ms. T. Logesh
				Natural Language Processing	Ms. P. Ranjani
				Cloud and Edge Computing	Ms. R. Sivaranjani
21.	III	DSC – 16	YDS305	Business Intelligence Laboratory using Advanced Excel and Power BI	Dr. S. Manimozhi
22.	III	DSC – 17	YDS306	Deep Learning Laboratory	Ms. R. Manisha
23.	III	SEC – 3	YDSSE3	Research Ethics and Skills	Ms. G. Praveena
24.	IV	DSC – 18	YDS401	Review of Literature	Ms. M. Umamaheswari

PRE-REQUISITE COURSE CHART



M.Sc. Data Science

Detailed Curriculum (Regulation – 2023)

(Applicable to the students admitted from the Academic year 2023 - 2024)

Course Code	Course Name	Credits	Hours / Week				Max. Marks		
			L	T	P	Tot.	CIA	ESE	Tot.
SEMESTER – I									
YDS101	**DSC – 1 :** Principles of Data Science	**4**	3	1	---	**4**	50	50	100
YDS102	**DSC – 2 :** Advanced Statistical Methods - I	5	4	1	---	**5**	50	50	100
YDS103	**DSC – 3 :** Python and R Programming	**4**	3	1	---	**4**	50	50	100
YDS104	**DSC – 4 :** Advanced Algorithms and Data Structures	**3**	3	---	---	**3**	50	50	100
YDS105	**DSC – 5 :** Advanced Database Management Systems0	**3**	3	---	---	**3**	50	50	100
YDS106	**DSC – 6 - Lab :** Python and R Programming Laboratory	**2**	---	---	4	**4**	50	50	100
YDS107	**DSC – 7 - Lab :** Advanced Database Management Systems Laboratory	**2**	---	---	4	**4**	50	50	100
YDSSE1	**SEC – 1 :** Interpersonal and Delivering Skills	**2**	1	1	---	**2**	60	40	100
	Mentoring					**1**			
Total (Semester - I)		**25**	**17**	**4**	**8**	**30**	---	---	---
SEMESTER – II									
YDS201	**DSC – 8 :** Machine Learning Techniques	**4**	4	1	---	**5**	50	50	100
YDS202	**DSC – 9 :** Advanced Statistical Methods - II	**5**	4	1	---	**5**	50	50	100
YDS203	**DSC – 10 :** Big Data Analytics	**3**	3	---	---	**3**	50	50	100
YDSGE*	**GEC – I :** General Elective Course – I	**3**	3	---	---	**3**	50	50	100
YDSDE*	**DSE – I :** Discipline Specific Elective - I	**3**	3	---	---	**3**	50	50	100
YDS204	**DSC – 11 – Lab :**	**2**	---	---	4	**4**	50	50	100

Course	Course Name	Credits	Hours / Week				Max. Marks		
	Machine Learning Techniques Laboratory								
YDSDE*	**DSE – II Lab :** Discipline Specific Elective – II (Laboratory)	**2**	---	---	4	**4**	50	50	100
YDSSE2	**SEC – 2 :** Cyber Security	**3**	2	1	---	**3**	60	40	100
	Mentoring					**1**			
Total (Semester - II)		**25**	**18**	**3**	**8**	**30**	---	---	---
SEMESTER – III									
YDS301	**DSC – 12 :** Business Intelligence	**4**	3	1	---	**4**	50	50	100
YDS302	**DSC – 13 :** Exploratory Data Analysis and Visualization	**4**	4	1	---	**5**	50	50	100
YDS303	**DSC – 14 :** Deep Learning	**4**	3	1	---	**4**	50	50	100
YDS304	**DSC – 15 :** Mini Project	**3**	---	1	2	**3**	60	40	100
YDSGE*	**GEC – II :** General Elective Course – II	**3**	3	---	---	**3**	50	50	100
YDS305	**DSC – 16 :** Business Intelligence Laboratory using Advanced Excel and Power BI	**2**	---	---	4	**4**	50	50	100
YDS306	**DSC – 17 :** Deep Learning Laboratory	**2**	---	---	4	**4**	50	50	100
YDSSE3	**SEC – 3 :** Research Ethics and Skills	**2**	1	1	---	**2**	60	40	100
	Mentoring					**1**			
Total (Semester - III)		**24**	**14**	**5**	**10**	**30**	---	---	---
SEMESTER – IV									
YDS401	**DSC – 18 :** Review of Literature	**2**	---	---	---	---	60	40	100
YDS402	**DSC – 19 :** Major Project Work	**12**	---	---	---	---	60	40	100
Total (Semester - IV)		**14**	---	---	---	---	---	---	---

The following credits must be earned by the students within the course period									
OER	**Online Course** (Any one of the course from SWAYAM Platform offered through any Coordinator like NPTEL, NITTR, and IGNOU etc.)	**2**	---	---	---	---	---	---	---
VA	**Value Added Course**	**---**	---	---	---	---	---	---	---
	Mentor, Library	**---**	---	2	---	**2**	---	---	---
	Placement Activities	**---**	---	2	---	**2**	---	---	---
Grand Total (All Semesters)		**90**	---	---	--	---	---	---	---

General Elective Courses – I (GEC – I)

YDSGE1	Data and Information Security
YDSGE2	Block chain Technologies
YDSGE3	Cryptography and Network Security

General Elective Courses – II (GEC – II)

YDSGE4	Digital Image Processing
YDSGE5	Natural Language Processing
YDSGE6	Cloud and Edge Computing

Discipline Specific Electives – I (DSE – I)

YDSDE1	Health Care Analytics
YDSDE2	IoT Analytics
YDSDE3	Image and Video Analytics

Discipline Specific Electives – II (DSE – II) - Laboratory

YDSDE4	Health Care Analytics Laboratory
YDSDE5	IoT Analytics Laboratory
YDSDE6	Image and Video Analytics Laboratory

NOTE :

DSC – Department **S**pecific **C**ourse

GEC – Generic **E**lective **C**ourses

SEC – Skill **E**nhancement **C**ourse

DSE – **D**iscipline **S**pecific **E**lective

Summary

Total Number of courses proposed with the credits is given below:

S. No.	Type of Courses	Numbers	Total Credit
1	DSC	19	70
2	DSE	1	3
3	DSE - Lab	1	2
4	SEC	3	7
5	GEC	2	6
6	MOOC	1	2
	TOTAL	**27**	**90**

Total Credits = 90

Total Credit	DSC	DSE	DSE-Lab	SEC	GEC
90	70 78%	3 3.3%	2 2.2%	7 7.7%	6 6.6%

M.Sc. Data Science

Detailed Syllabus (Regulation – 2023)

(Applicable to the students admitted from the Academic year 2023 - 2024)

SEMESTER - I

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS101	PRINCIPLES OF DATA SCIENCE	4	4 : 0 : 0	3	1	---	4	50	50	100
Pre-requisite	Fundamentals of Data Science									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Remember*** and ***Understand*** the fundamental concepts of data science	Cognitive	K1
CO2	***Understand*** the tasks, Algorithms, Components and databases used in data science process	Cognitive	K2
CO3	***Describe*** the data science process; ***Explore*** and ***Visualize*** the data by various techniques and ***Evaluate*** the Models	Cognitive	K2
CO4	***Illustrate*** the recommendation engines and ***Discover*** the time Series forecasting systems	Cognitive	K2
CO5	***Understand*** and ***Apply*** the suitable feature selection and anomaly detection techniques	Cognitive	K2
CO6	***Apply*** suitable data science tools in various applications	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Module – I : Introduction to Data Science	12 Hrs
Data Science Definitions and Needs - Volume and Dimensions - C's and V's in Data Science - Venn diagram of Data science - Facets of Data - Data and Variable Types - Four Levels of Data - Data Science Process - Associated Fields - Classification of Data Science Tasks - Algorithms for Data Science - Business Intelligence and Data Science - Components of Data Science - Databases for Data Science.	
Module – II : Data Science Process and Evaluation	**12 Hrs**
Data - Causation Versus Correlation - Overview of Data Science Process - Data Preparation - Data Modeling - Applications - Knowledge - Objectives of Data Exploration - Datasets - Univariate and Multivariate Data Exploration - Univariate and Multivariate Data Visualization - Visualizing High Dimensional Data - Roadmap for New Data Exploration - Model Evaluation.	
Module – III : Recommendation and Forecasting Systems	**12 Hrs**
Recommendation Engines and its Needs - Types of Recommendation Engines - Collaborative Filtering - Content-Based Filtering - Hybrid Recommenders - Taxonomy of Time Series Forecasting - Machine Learning Methods for Time Series Forecasting - Performance Evaluation.	

Module – IV : Feature Selection and Anomaly Detection	12 Hrs
Classification of Feature Selection Methods - Principal Component Analysis - Information Theory Based Filtering - Chi-Square-Based Filtering - Wrapper Type Feature Selection. Anomaly Detection - Anomaly Detection Techniques - Distance Based Outlier Detection - Density Based Outlier Detection - Local Outlier Factor (LOF).	
Module – V : Data Science Tools and Applications	**12 Hrs**
Introduction to Data Science Tools - SAS - Apache Flink - Apache Spark - KNIME - BigML - Excel - RapidMiner - Tableau - Matplotlib - TensorFlow - Weka - Matlab. Applications of Data Science - Hands-on with RapidMiner - Collecting and Analyzing Twitter Data - Collecting and Analyzing YouTube Data.	

	Lecture	Tutorial	Practical	Total
	45	15	0	60

Reference Books

1. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare. (2022). *Fundamentals of Data Science*, First Edition, CRC Press.
2. Vijay Kotu and Bala Deshpande. (2019). *Data Science : Concepts and Practice*, Second Edition, Morgan Kaufmann.
3. Davy Cielen, Arno D. B. Meysman and Mohamed Ali. (2016). *Introducing Data Science : Big Data, Machine Learning, and more, using Python Tools*, Manning Publications Co., Island.
4. Sinan Ozdemir, (2016). *Principles of Data Science* Packet Publishing.
5. Sanjiv Ranjan Das, (2016). *Data Science : Theories, Models, Algorithms, and Analytics*, eBook.

Web References

1. MIT Course : *Statistical Thinking And Data Analysis*, https://ocw.mit.edu/courses/15-075j-statistical-thinking-and-data-analysis-fall-2011/download/
2. Alison Course : *Data Science - Regression and Clustering Models*, https://alison.com/course/data-science-regression-and-clustering-models
3. Udemy Course : *Data Science, Machine Learning, Data Analysis, Python & R*, https://www.udemy.com/course/data-science-machine-learning-data-analysis-python-r/
4. NPTEL Course : *Data Science For Engineers*, By Prof. Ragunathan Rengasamy, Prof. Shankar Narasimhan, IIT Madras, https://onlinecourses.nptel.ac.in/noc23_cs97/preview
5. Coursera : *Data Science Math Skills*, Offered by Duck University, https://www.coursera.org/learn/datasciencemathskills
6. Coursera : *Introduction to Data Science Specialization*, Offered by IBM, https://www.coursera.org/specializations/introduction-data-science

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	3	3	1	2	2	3	1	3	2
CO3	3	2	2	1	3	3	3	1	2	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	2	2
Total	**18**	**16**	**16**	**6**	**14**	**16**	**17**	**6**	**16**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS102	ADVANCED STATISTICAL METHODS – I	5	5 : 0 : 0	4	1	---	5	50	50	100
Pre-requisite	Linear Algebra, Fundamentals of Probability and Statistics									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Remember*** and ***understand*** the basics of Linear algebra	Cognitive	K1
CO2	***Understand*** and ***Apply*** the concepts of uncertainty and probability and its rules	Cognitive	K2
CO3	***Understand*** the descriptive statistics methods and ***Apply*** to visualize and summarize the data	Cognitive	K2
CO4	***Illustrate*** the significance of random variables and its probability distributions and functions	Cognitive	K2
CO5	***Understand*** and ***Apply*** the suitable variants of Discrete Probability Distributions	Cognitive	K2
CO6	***Apply*** suitable distribution and also to ***Generate*** random sample	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Basics of Linear Algebra and Probability	15 Hrs
Introduction to Linear Algebra - Linear, Matrix and Vector equations - Matrix operations - Vector Spaces and sub spaces - Eigen Values and Vectors - Basic Linear Transformations. Basic Concepts of Probability - Uncertainty - Axioms of Probability - Conditional Probability - Simple Problems - Independent Events - Bayes' Rule and Simple Applications.	
Module – II : Descriptive Statistics	**15 Hrs**
Frequency Table and Distribution - Histogram and Frequency Polygons - Relative Frequency Distributions - Cumulative Frequency Distributions - Frequency Curves - Measures of Central Tendency - Measures of Dispersion - Moments - Measures of Skewness and Kurtosis - Notion of Linear Correlation and Linear Regression.	
Module – III : Random Variables and Distributions	**15 Hrs**
Random Variables - Independent, Discrete and Continuous Random Variables, Probability Distributions - Distribution Functions - Probability Distributions Functions - Joint Distributions - Marginal and Conditional Distributions - Mathematical Expectation - Variance and Covariance.	
Module – IV : Discrete Probability Distributions	**15 Hrs**
Density and Mass Functions - Discrete Probability Distributions - Bernoulli Distribution - Multinoulli Distribution - Binomial Distribution - Multinomial Distribution Poisson Distribution.	
Module – V : Continuous Probability Distributions	**15 Hrs**
Continuous Probability Distributions - Normal Distribution - Uniform Distribution - Chi-square Distribution - Gamma Distribution - F Distribution - Student-t Distribution - Exponential Distribution - Random Number Generation in data simulation.	

Lecture	Tutorial	Practical	Total
60	15	0	75

Reference Books

1. David C. Lay, Steven R. Lay, Judi. J. Mcdonald. (2016). *Linear Algebra and its Applications*, Fifth Edition, Pearson.
2. Montgomery, D. C., and Runger, G. C. (2018). *Applied Statistics and Probability for Engineers*, Seventh Edition, John Wiley & Sons, Inc.
3. Bruce, P., Bruce, A., and Gedeck, P. (2020). *Practical Statistics for Data Scientists*, Second Edition, O'Reilly Media, Inc.
4. Spiegel, M. R., Schiller, J. J., and Alu Srinivasan, R. (2013). *Probability and Statistics*, Fourth Edition, Schaum's Outline Series, McGraw Hill Companies, Inc.
5. Carlos Fernandez-Granda. (2017). *Probability and Statistics for Data Science*, New York University.

Web References

1. NPTEL Course : *Linear Algebra* by Prof. A.K. Lal, IIT Kanpur, https://nptel.ac.in/courses/111104137
2. NPTEL Course : *Introduction to probability and Statistics*, by Prof. G. Srinivasan, IIT Madras, https://nptel.ac.in/courses/111106112
3. NPTEL Course : *Descriptive Statistics with R Software*, by Prof. Shalabh, IIT Kanpur, https://nptel.ac.in/courses/111104120
4. NPTEL Course : *Probability and Distributions*, by Prof. Neeraj Misra, IIT Kanpur, https://nptel.ac.in/courses/111104032

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	3	3	1	2	2	3	1	3	2
CO3	3	2	2	1	3	3	3	1	3	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**16**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS103	PYTHON and R PROGRAMMING	4	4 : 0 : 0	3	1	---	4	50	50	100
Pre-requisite	Basic Programming and Fundamentals of Data Science									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Remember*** the essential concepts in python programming and ***Apply*** for different problems	Cognitive	K1
CO2	***Understand*** the NumPy libraries and ***Apply*** to handle the data	Cognitive	K2
CO3	***Understand*** the pandas libraries and ***Apply*** to handle the data	Cognitive	K2
CO4	***Recognize*** the pandas and Matplotlib libraries and ***Apply*** real time problems in data visualization	Cognitive	K2
CO5	***Remember*** and ***Apply*** the R programming essentials for data science problems	Cognitive	K1
CO6	***Illustrate*** and ***Apply*** the R programming data visualization and transformations	Cognitive	K2

* **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Essentials of Python Programming — 12 Hrs

Introduction to Python - Features of Python - Python Interpreter and Running Structure - Libraries for Data Analysis - Variables, Values and Data Types - Data Structures and Sequences - Functions - Files - Exception Handling - Object Oriented Paradigms.

Module – II : Data Handling in Python — 12 Hrs

Numerical Python (NumPy) arrays - Multidimensional Array Computations - Universal Functions - Array Oriented Programming - File I/O - Linear Algebraic Functions - Random Functions and Walks.

Introduction to pandas Data Structures - Data Manipulation with pandas Objects - pandas Objects for statistical methods - Reading and Writing the Data - Handling Missing Data - Basic Data Transformations

Module – III : Data Aggregation and Visualization in Python — 12 Hrs

Basic Data Wrangling - Basic Data Aggregation - Working with Time Series - High Performance of pandas.

Visualization with Matplotlib - Simple Line Plots - Simple Scatter Plots - Visualizing Errors - Density and Contour Plots - Histograms, Binning and Density - Three Dimensional plotting in Matplotlib.

Module – IV : R Programming Essentials for Data Analysis — 12 Hrs

Introduction to R - Features of R - Data Types - Pipes - Vector Arithmetics - Indexing - Basic Plots - Conditional Expressions - Functions - Loops - Iterations and Recursions - Import Data - Manipulating Data Frames and Data Tables - Sorting Data Frames and Data Tables.

Module – V : Data Visualization and Transformation with R — 12 Hrs

Basic Statistical Computing - Data Wrangling : Tibble, Tidy - Visualization with ggplot2 - Visualizing Data Distributions - Data Transformation with dplyr - Exploratory Data Analysis.

	Lecture	Tutorial	Practical	Total
	45	15	0	60

Reference Books

1. Wes McKinney. (2022). *Python for Data Analysis*, Third Edition, O'Reilly.
2. Allen B. Downey. (2021). *Think Python*, Second Edition, O'Reilly.
3. Jake Vanderplas. (2022). *Python Data Science Handbook: Essential Tools for Working with Data*, Second Edition, O'Reilly.
4. Hadley Wickham, Garrett Grolemund. (2023). *R for Data Science*, Second Edition, O'Reilly.
5. Rafael A. Irizarry. (2019). Introduction to Data Science : Data Analysis and Prediction Algorithms with R.

Web References

1. NPTEL Course : *Python for Data Science* by Prof. Ragunathan Rengasamy, IIT Madras, https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. Couresera: *Applied Data Science with Python*, https://www.coursera.org/specializations/data-science-python
3. Coursera – Google : *Crash Course on Python*, https://www.coursera.org/learn/python-crash-course
4. Udemy : *Statistics for Data Analysis Using R*, https://www.udemy.com/course/statistics-using-r/
5. Coursera – Google : *Data Analysis with R Programming*, https://www.coursera.org/learn/data-analysis-r
6. Coursera – IBM : *Data Analysis with R*, https://www.coursera.org/learn/data-analysis-r

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	3
CO2	3	2	2	1	3	3	3	1	2	3
CO3	3	2	2	1	3	3	3	1	2	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	2	3
Total	**18**	**15**	**15**	**6**	**15**	**17**	**17**	**6**	**15**	**18**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS104	ADVANCED ALGORITHMS and DATA STRUCTURES	4	4 : 0 : 0	3	1	---	4	50	50	100
Pre-requisite	Basics of Linear Algebra, Algorithms and Data Structure									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Remember*** and ***Understand*** the vital concepts and notations of algorithms and its performance notations	Cognitive	K1
CO2	***Interpret*** the ***Utilize*** the appropriate data structures while developing algorithms	Cognitive	K2
CO3	***Understand*** and ***Employ*** the advanced recursive techniques in algorithms	Cognitive	K2
CO4	***Cognize*** the advanced design and analysis approaches to develop the effective and efficient algorithm development	Cognitive	K2
CO5	***Analyze*** the behaviour and performance of given algorithms, referring to their strengths and weaknesses	Cognitive	K4
CO6	***Refer*** and ***Apply*** polynomial and non-polynomial solutions for new problems	Cognitive	K3

* **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Role of Algorithms In Computing	12 Hrs
Introduction to Algorithms - Psuedo Codes - Efficiency of algorithms, Apriori analysis, Growth of Functions - Asymptotic Notations - Space complexity and Time complexity - Designing Algorithms - Elementary Data Structures - Array based Data Structures - Trees - Dictionaries - Priority Queues Hash Tables - Sets and Disjoint Set Union - Graphs.	
Module – II : Advanced Recursive Analysis	**12 Hrs**
Divide and Conquer - Binary Search - Finding the Maximum And Minimum - Merge Sort - Quick Sort - Selection Sort - Strassen's Matrix Multiplications - Quick Hull Algorithm.	
Module – III : Advanced Design and Analysis Techniques	**12 Hrs**
Elements of Dynamic - Programming Greedy Method - Knapsack Problem - Job Sequencing with Deadlines - Minimum Cost Spanning Trees - Single Source Shortest Paths - All-Pairs Shortest Paths - Aggregate analysis.	
Module – IV : Backtracking Analysis	**12 Hrs**
Binary Tree Traversal and Search Techniques - Techniques for Graphs (BFS and DFS) - Connected Components and Spanning Trees - Backtracking - N-Queens problem - Sum of Subsets - Hamiltonian Cycles - Knapsack Problem - Branch and Bound. - - Traveling Salesman problem.	
Module – V : NP-Completeness and Approximations	**12 Hrs**
Polynomial Time – Polynomial Time Verification - NP Complete Problems - Vertex Cover Problem - Assignment problem - Traveling Salesman problem - Job Scheduling Problem.	

Lecture	Tutorial	Practical	Total
45	15	0	60

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein Wes McKinney. (2022). *Introduction to Algorithms*, Fourth Edition, MIT Press.
2. Anany Levitin. (2017). *Introduction to the Design and Analysis of Algorithms*, Third Edition, Pearson Education.
3. Robert Sedgewick and Kevin Wayne. (2015). *Algorithms*, Fourth Edition, Pearson Education, Inc.
4. Steven S. Skiena. (2020). *The Algorithm Design Manual*, Third Edition, Springer.
5. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran. (2019). *Computer Algorithms/C++*, Second Edition, Orient Blackswan.
6. Dr. S. Sridhar. (2014). *Design and Analysis of Algorithms*, Oxford University Press.
7. Marcello La Rocca. (2021). *Advanced Algorithms and Data Structures*, Manning Shelter, Island.

Web References

1. NPTEL Course : *Python for Data Science* by Prof. Ragunathan Rengasamy, IIT Madras, https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. Couresera: *Applied Data Science with Python*, https://www.coursera.org/specializations/data-science-python
3. Coursera – Google : *Crash Course on Python*, https://www.coursera.org/learn/python-crash-course
4. Udemy : *Statistics for Data Analysis Using R*, https://www.udemy.com/course/statistics-using-r/
5. Coursera – Google : *Data Analysis with R Programming*, https://www.coursera.org/learn/data-analysis-r
6. Coursera – IBM : *Data Analysis with R*, https://www.coursera.org/learn/data-analysis-r

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	3	3	1	2	2	3	2	3	2
CO2	2	3	3	1	2	2	3	2	3	2
CO3	2	2	2	1	3	3	3	2	2	3
CO4	2	2	2	1	3	3	2	2	3	3
CO5	2	3	3	1	2	3	3	2	3	3
CO6	2	3	3	1	2	3	3	2	2	2
Total	**12**	**16**	**16**	**6**	**14**	**16**	**17**	**12**	**16**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS105	ADVANCED DATABASE MANAGEMENT SYSTEMS	4	4 : 0 : 0	3	1	---	4	50	50	100
Pre-requisite	Basic Algebra, Data Structures and Database System Concepts									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Describe*** the need of real time database management and ***Contrast*** the evolution of database development process	Cognitive	K1
CO2	***Illustrate*** and ***Implement*** the database models and design	Cognitive	K1
CO3	***Discover*** and ***Device*** the various database languages	Cognitive	K3
CO4	***Interpret*** and ***Correlate*** The data consistency and different database architectures	Cognitive	K2
CO5	***Discover*** and ***Defend*** the post relational database technologies	Cognitive	K2
CO6	***Understand*** and ***Apply*** the non-relational database technologies	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Data Management	**12 Hrs**
Information Systems and Databases - Relationship Between Information and Data - Managing Data is a Business Issue – Database Architecture of an Information System – Overview of the Database Development Process – SQL Databases – Big Data – No SQL Databases – Organizing of Data Management.	
Module – II : Data Modeling	**12 Hrs**
Data Analysis to Database – The Entity-Relationship Model – Implementation in the Relational Model – Implementation in the Graph Model – Enterprise wide Data Architecture – Formula for Database Design.	
Module – III : Database Languages	**12 Hrs**
Interacting with Databases – Relational Algebra – Relationally Complete Languages – Graph based Languages – Embedded Languages – Handling NULL Values – Integrity Constraints – Data Protection Issues.	
Module – IV : Data Consistency and System Architecture	**12 Hrs**
Multi-user Operation – Data Transaction – Consistency in Massive Distributed Data – Comparing ACID and BASE – Processing of Homogeneous and Heterogeneous Data – Storage and Access Structure – Layered Architecture – Use of Different Storage Structures.	
Module – V : Post-Relational and NoSQL Databases	**12 Hrs**
Post-Relational Databases: Limits of SQL – Federated Databases – Temporal Databases – Multidimensional Databases – Data Warehouse – Object-Relational Databases – Knowledge Databases – Fuzzy Databases. NoSQL Databases : Development of Non-relational Technologies – Key-Value Stores – Column-Family Stores – Document Stores – XML Databases – Graph Databases.	

Lecture	Tutorial	Practical	Total
45	15	0	60

Reference Books

1. Andreas Meier and Michael Kaufmann. (2019). *SQL & NoSQL Databases : Models, Languages, Consistency Options and Architectures forBig Data Management*, Eighth Edition, Springer Vieweg.
2. Keith Gordon. (2022). *Principles of Data Management*, Third Edition, British Computer Society Learning & Development Ltd.
3. Oscar Diaz and Mario Piattini. (2000). *Advanced Database Technology and Design*, IEEE - Artech.
4. Abraham Silberschatz, Henry F Korth, andS Sudarshan. (2015). *Database System Concepts*, Sixth Edition, McGraw-Hill International.
5. Ramez Elmasri, and Shamkant B Navathe. (2017). *Fundamental of Database Systems*, Seventh Edition, Pearson Education.
6. C.J. Date, A. Kannan, and S. Swamynathan. (2016). *An Introduction to Database Systems*, Eighth Edition, Pearson Education.
7. Ian Robinson, Jim Webber and Emil EifremGraph Databases, Second Edition, O'Reilly Media.

Web References

1. SQL- and NoSQL-Databases, https://sql-nosql.org/en/tutorial/
2. Couresera - Google : *Foundations: Data, Data, Everywhere*, https://www.coursera.org/learn/foundations-data
3. Couresera - Project : *Database Creation and Modeling using MYSQL Workbench*, https://www.coursera.org/projects/database-creation-and-modeling-using-mysql-workbench
4. Couresera Project : *Advanced Relational Database and SQL*, https://www.coursera.org/projects/advanced-rdb-sql
5. Alison : *Advanced Diploma in Database Systems*, https://alison.com/course/advanced-diploma-in-database-systems
6. Udemy : *The Complete SQL and MySQL Course - From Beginner to Expert*, https://www.udemy.com/course/introduction-to-sql23/
7. Udemy : *MySQL and MySQL Workbench For beginners*, https://www.udemy.com/course/mysql-and-mysql-workbench-for-beginners/

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	2	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	2	1	2	3	3	1	3	3
CO5	3	3	2	1	2	3	3	1	3	2
CO6	3	3	2	1	2	3	3	1	3	2
Total	**18**	**16**	**12**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS106	PYTHON and R PROGRAMMING LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100
Pre-requisite	Basic Python and R Programming, Process of Data Science									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Apply*** the basics in python programming in different problems	Cognitive	K3
CO2	***Apply*** the NumPy and pandas libraries to handle the data	Cognitive	K3
CO3	***Apply*** the pandas and Matplotlib libraries for data visualization	Cognitive	K3
CO4	***Apply*** the R programming essentials for data science problems	Cognitive	K3
CO5	***Apply*** the R programming data visualization and transformations	Cognitive	K3
CO6	***Apply*** the R programming to deal the missing values	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Python program to demonstrate the control and iterative statements	2
2	Python program using dictionaries	2
3	Python program to print the first n-row of Pascal's triangle	2
4	Python program to demonstrate various types of accessing the string	2
5	Python program to demonstrate operators	2
6	Python program to demonstrate lists and tuples	2
7	Python program to demonstrate functions and methods	4
8	Programs using NumPy	4
9	Programs using Pandas	4
10	Implementation of Maclaurin series	4
11	Programs using Seaborn	4
12	Programs using Matplotlib	4
13	R program to demonstrate vector manipulations	2
14	R program to demonstrate matrix and array operations	2
15	Operations using data frame in R	2
16	R program to implement the functions	2
17	Drawing scatter plot, box plot, violin plot, dot plot, bar plot, line plot	4
18	R program to implement the geometric shapes	4
19	R program to implement data transformations	4
20	R program for finding missing values	4

Lecture	Tutorial	Practical	Total

	---	---	60	60

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	3	3	1	2	2	3	1	3	3
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	3	3
Total	**17**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**18**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS107	ADVANCED DATABASE MANAGEMENT SYSTEMS LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100
Pre-requisite	MySQL Workbench and Neo4j									

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Recall*** database models and develop database management skills	Cognitive	K3
CO2	***Relate*** the data transactions and data normalization techniques	Cognitive	K3
CO3	***Discover*** data table creation and it operational methods	Cognitive	K3
CO4	***Apply*** the flow control stock maintenance procedures	Cognitive	K3
CO4	***Use*** the NoSQL databases concepts in various scenarios	Cognitive	K3
CO5	***Transfer*** the ideas on how to design databases with Workbench and Cypher	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Database Creation and Data Definition Operations	4
2	Querying in the Database	4
3	Transaction Management	4
4	Normalization	4
5	Mail Table Creation and Retrieval of Information	4
6	View Creation and Manipulation	4
7	Table Creation and Manipulation	4
8	Flow Control Management	4
9	Cursors, Joins, Triggers and Functions	4
10	Stored Procedure and Stock Maintenance	4
11	NoSQL - Key Value Store	4
12	NoSQL - Column Database	4
13	NoSQL - Graph Database	4
14	NoSQL - Document Database	4
15	Working NoSQL with Workbench and Cypher	4
	Lecture / **Tutorial** / **Practical**	**Total**

	---	---	60	60

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSSE1	INTERPERSONAL and DELIVERING SKILLS	2	2 : 0 : 0	1	1	---	2	60	40	100
Pre-requisite	Basic English Communication									

Course Outcomes *On successful completion of this course, the students will able to :*		Domain	Level
CO1	***Communicate*** in clear, concise and correct manner in social and academic contexts	Cognitive	K3
CO2	***Improve*** listening comprehension and critical thinking ability	Cognitive	K3
CO3	***Write*** different types of reports and SoP with better interpretative, summarizing and editing techniques	Cognitive	K3
CO4	***Prepare*** an effective resume and interpret the skills	Cognitive	K3
CO5	***Gain*** the productive professional skills through intra and inter group discussion skills	Cognitive	K3
CO6	***Acquire*** productive professional and technical communication skills to the face interviews for employment	Cognitive	K3

* **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Career Goals and Interpersonal Skills	**06 Hrs**
Short term and long term career goals - Activity : SWOT Analysis / Comprehending speeches. Interpersonal Communication in/with Groups (Corporate Etiquette : Journey from Campus to Corporate) - Activity : Role Plays/Mime/Skit.	
Module – II : Listening and Reading Skills	**06 Hrs**
Listening to Documentary - Activity : Critically evaluate / Review a documentary / TED Talk. Skimming, Scanning, Intensive & Extensive reading - Activity : Reading News Papers/Magazines/Scientific Texts.	
Module – III : Report Writing and Editing Skills	**06 Hrs**
Language and mechanics of writing report - Activity : Writing a Report/Mini Project. Summarizing the report - Activity: Abstract, Executive Summary, Digital Synopsis. Proof Reading Sequencing - Activity: Editing any given text.	
Module – IV : Interpreting and Presentation Skills	**06 Hrs**
Interpret data in tables and graphs - Activity : Transcoding. Résumé Writing - Activity: Prepare an Electronic Résumé. Oral Presentation using digital tools - Activity : Oral presentation on the given topic using appropriate non-verbal cues	
Module – V : Interview and Professional Skills	**06 Hrs**
Intragroup interaction (avoid, accommodate, compete, compromise, collaborate) - Activity : Group discussion on a given topic. Placement/Job Interview - Activity: Mock Interview. Conflict Management & Decision Making - Activity: Case analysis of a challenging Scenario.	

	Lecture	Tutorial	Practical	Total

	15	**15**	**0**	**30**

Reference Books

1. Uma Narula. (2019). *Development Communication: Theory and Practice*, Revised Edition, Har-Aanad Publication.
2. Annette Capel and Wendy Sharp. (2013). *Cambridge English: Objective First*, Fourth Edition, Cambridge University Press.
3. Emma Sue-Prince. (2013). *The Advantage: The 7 Soft Skills You Need to Stay One Step Ahead*, First Edition, FT Press.
4. Wood, J. T. (2016). *Communication in Our Lives*, Cengage Learning, Boston, USA.
5. Anderson, C. (2016). *TED Talks : The Official TED Guide to Public Speaking*, First Edition, Boston, Houghton Mifflin, New York.
6. Kuhnke, E. (2015). *Communication Essentials for Dummies*, First Edition. John Wiley & Sons.
7. *Reference and Practice Book for Advanced Learners of English*, (2013). Third Edition. Cambridge University Press. UK.

Web References

1. NPTEL Course : *Introduction to Professional Scientific Communication*, By Prof. S. Ganesh, IIT Kanpur, https://onlinecourses.nptel.ac.in/noc23_bt09/preview
2. NPTEL Course : *Communication Skills*, By Dr. T. Ravichandran, IIT Kanpur, https://nptel.ac.in/courses/109104031

COs vs POs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	1	3	1	3	3	3	---	---
CO2	2	1	1	3	1	3	3	3	---	---
CO3	2	3	2	3	2	3	3	3	---	---
CO4	2	3	2	3	2	3	3	3	---	---
CO5	2	3	3	3	1	3	3	3	---	---
CO6	2	3	3	3	1	3	3	3	---	---
Total	**12**	**14**	**12**	**18**	**8**	**18**	**18**	**18**	---	---

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

SEMESTER - II

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS201	MACHINE LEARNING TECHNIQUES	4	4 : 0 : 0	4	1	---	5	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***List*** out the fundamental issues and perspectives of machine learning	Cognitive	K1
CO2	***Define*** the framework for building machine learning systems	Cognitive	K1
CO3	***Compare*** various linear models to find a best-fit line through a set of data points	Cognitive	K2
CO4	***Apply*** make use of genetic algorithms as a tool for feature selection in machine learning	Cognitive	K3
CO5	***Examine*** various dimensionality reduction techniques to reduce the number of input variables in the datasets	Cognitive	K4
CO6	***Explain*** and construct the graphical models to exhibit the conditional dependence structure between random variables	Cognitive	K5

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Introduction	**12 Hrs**
Introduction to Machine Learning: History and Evolution - Artificial Intelligence Evolution - Different Forms - Machine Learning Categories: Frameworks for Building Machine Learning Systems- Machine Learning Python Packages - Data Analysis Packages - Machine Learning Core Libraries	
Module – II : Fundamentals of Machine Learning	**12 Hrs**
Fundamentals of Machine Learning: Scales of Measurement - Feature Engineering - Exploratory Data Analysis - Supervised Learning:-Regression - Supervised Learning:- Classification - Unsupervised Learning Process Flow	
Module – III : Diagnosis and Tuning	**12 Hrs**
Model Diagnosis and Tuning: Optimal Probability Cutoff Point - Rare Event or Imbalanced Dataset - Bias and Variance - K-Fold Cross-Validation - Stratified K-Fold Cross-Validation - Ensemble Methods - Bagging - Boosting - Ensemble Voting - Stacking - Hyper parameter Tuning	
Module – IV : Machine Learning Analysis	**12 Hrs**
Machine Learning Analysis: How to load Machine Learning Data - Understand Your Data with Descriptive Statistics - Understand Your Data with Visualisation - Prepare Your Data for Machine Learning - Feature Selection for Machine Learning	
Module – V : Machine Learning Projects	**12 Hrs**
Machine Learning Projects: Your first Machine Learning Projects in Python Step-By-Step - Regression Machine Learning Case Study Project - Binary Classification Machine Learning Case Study Projects	

Lecture	Tutorial	Practical	Total
45	15	0	60

Reference Books

1. Swamynathan, Manohar. Mastering Machine Learning with Python in Six Steps: A Practical Implementation Guide to Predictive Data Analytics Using Python. United States, Apress, 2019
2. Machine Learning Mastery With Python: Understand Your Data, Create Accurate Models, and Work Projects End-to-End. N.p., Machine Learning Mastery, 2016.

Web References

1. Oliver Theobald, "Machine Learning for Absolute Beginners: A Plain English Introduction", Third Edition, Independently Published, 2021.
2. Henderson, Matt. Machine Learning for Beginners 2019: The Ultimate Guide to Artificial Intelligence, Neural Networks, and Predictive Modelling (Data Mining Algorithms & Applications for Finance, Business & Marketing), Charlotte Publishing. 2019.
3. Fmello, Rodrigo, and AntonelliPonti, Moacir. "Machine Learning: A Practical Approach on the Statistical Learning Theory", Springer International Publishing, 2018.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	3
Co2	3	3	3	1	2	2	3	1	3	3
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
Total	**18**	**16**	**16**	**6**	**14**	**16**	**16**	**6**	**18**	**18**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS202	ADVANCED STATISTICAL METHODS - II	5	5 : 0 : 0	4	1	---	5	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Remember*** and ***Understand*** the fundamental concepts of data science	Cognitive	K1
CO2	***Describe*** the data science process	Cognitive	K1
CO3	***Explore*** and ***Visualize*** the data by various techniques and ***Evaluate*** the Models	Cognitive	K2
CO4	***Illustrate*** the recommendation engines and ***Discover*** the time Series forecasting systems	Cognitive	K2
CO5	***Understand*** and ***Apply*** the suitable feature selection and anomaly detection techniques	Cognitive	K2
CO6	***Apply*** suitable data science tools in various applications	Cognitive	K2

* **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Introduction to Data Science	**15 Hrs**

Data Science Definitions and Needs - Volume and Dimensions - C's and V's in Data Science - Venn diagram of Data science - Facets of Data - Data and Variable Types - Four Levels of Data - Data Science Process - Associated Fields - Classification of Data Science Tasks - Algorithms for Data Science - Business Intelligence and Data Science - Components of Data Science - Databases for Data Science.

Module – II : Data Science Process and Evaluation	**15 Hrs**

Data - Causation Versus Correlation - Overview of Data Science Process - Data Preparation - Data Modeling - Applications - Knowledge - Objectives of Data Exploration - Datasets - Univariate and Multivariate Data Exploration - Univariate and Multivariate Data Visualization - Visualizing High Dimensional Data - Roadmap for New Data Exploration - Model Evaluation.

Module – III : Recommendation and Forecasting Systems	**15 Hrs**

Recommendation Engines and its Needs - Types of Recommendation Engines - Collaborative Filtering - Content-Based Filtering - Hybrid Recommenders - Taxonomy of Time Series Forecasting - Machine Learning Methods for Time Series Forecasting - Performance Evaluation.

Module – IV : Feature Selection and Anomaly Detection	**15 Hrs**

Classification of Feature Selection Methods - Principal Component Analysis - Information Theory Based Filtering - Chi-Square-Based Filtering - Wrapper Type Feature Selection. Anomaly Detection - Anomaly Detection Techniques - Distance Based Outlier Detection - Density Based Outlier Detection - Local Outlier Factor (LOF).

Module – V : Data Science Tools and Applications	**15 Hrs**

Introduction to Data Science Tools - SAS - Apache Flink - Apache Spark - KNIME - BigML - Excel - RapidMiner - Tableau - Matplotlib - TensorFlow - Weka - Matlab. Applications of Data Science - Hands-on with RapidMiner - Collecting and Analyzing Twitter Data - Collecting and Analyzing YouTube Data.

	Lecture	Tutorial	Practical	Total
	60	15	0	75

Reference Books

1. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare. (2022). *Fundamentals of Data Science*, First Edition, CRC Press.
2. Vijay Kotu and Bala Deshpande. (2019). *Data Science : Concepts and Practice*, Second Edition, Morgan Kaufmann.
3. Davy Cielen, Arno D. B. Meysman and Mohamed Ali. (2016). *Introducing Data Science : Big Data, Machine Learning, and more, using Python Tools*, Manning Publications Co., Island.
4. Sinan Ozdemir, (2016). *Principles of Data Science* Packet Publishing.
5. Sanjiv Ranjan Das, (2016). *Data Science : Theories, Models, Algorithms, and Analytics*, eBook.

Web References

1. MIT Course : *Statistical Thinking And Data Analysis*, https://ocw.mit.edu/courses/15-075j-statistical-thinking-and-data-analysis-fall-2011/download/
2. Alison Course : *Data Science - Regression and Clustering Models*, https://alison.com/course/data-science-regression-and-clustering-models
3. Udemy Course : *Data Science, Machine Learning, Data Analysis, Python & R*, https://www.udemy.com/course/data-science-machine-learning-data-analysis-python-r/
4. NPTEL Course : *Data Science For Engineers*, By Prof. Ragunathan Rengasamy, Prof. Shankar Narasimhan, IIT Madras, https://onlinecourses.nptel.ac.in/noc23_cs97/preview
5. Coursera : *Data Science Math Skills*, Offered by Duck University, https://www.coursera.org/learn/datasciencemathskills
6. Coursera : *Introduction to Data Science Specialization*, Offered by IBM, https://www.coursera.org/specializations/introduction-data-science

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	3	1	3	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**15**	**15**	**6**	**15**	**17**	**17**	**6**	**18**	**16**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS203	BIG DATA ANALYTICS	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** about basics of Big Data, Technologies and Applications in various domains.	Cognitive	K2
CO2	***Understand*** cloud and big data and its applications	Cognitive	K2
CO3	***Understand*** the foundations of Hadoop and Hadoop Distributed File System. Design of HDFS and file-based data structures.	Cognitive	K2
CO4	***Analyze*** the working of Map Reduce and YARN for job scheduling.	Cognitive	K2
CO5	***Evaluate*** the need and fundamentals of HBase. Apply the Cassandra data model for different applications. Understand the basic commands in HiveQL, Pig and Pig Latin	Cognitive	K2
CO6	***Analyze*** the basic concepts and need for Graph databases, create databases and retrieve records using Neo4j. Understand the data visualization and its need.	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I Introduction to Big Data	**12 Hrs**
Introduction: What is big data – why big data – convergence of key trends - unstructured data – industry examples of big data – Web analytics - big data and marketing – fraud and big data - risk and big data – credit risk management – big data and algorithmic trading - big data and healthcare – big data in medicine – advertising and big data – big data technologies - cloud and big data– mobile business intelligence – crowd sourcing analytics.	
Module – II Hadoop	**12 Hrs**
History of Hadoop - The Hadoop Distributed File System – components of Hadoop - Analyzing the Data with Hadoop - Design of HDFS – HDFS concepts - Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures.	
Module – III MapReduce	**12 Hrs**
MapReduce: MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution –MapReduce types – input formats – output formats.	
Module – IV Hadoop Eco System	**12 Hrs**
HBase – data model and implementations – HBase clients – HBase examples. Cassandra – Cassandra data model –Cassandra examples – Cassandra clients –Hadoop integration. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation –HiveQL queries-case study.	
Module – V Graph Databases	**12 Hrs**
Introduction - Neo4J - Key concept and characteristics -Modeling data for neo4j - Importing data into neo4j - visualizations - neo4j - Cypher Query Language –data visualization.	

	Lecture	Tutorial	Practical	Total
	45	15	0	60

Reference Books

1. Daimi, Kevin, Hamid R. Arabnia, Principles of Data Science. Ed. Springer, 2020.
2. SinanOzdemir, Principles of Data Science: Mathematical Techniques and Theory to Succeed in Data-Driven Industries, Packt Publishing Limited, 2016.
3. Rik Van Bruggen, Learning Neo4j, Second Edition, PacktPubishers, 2014
4. Michael Minelli, Michelle Chambers, Ambiga Dhiraj, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley, 2013
5. Prateek Joshi, "Artificial Intelligence with Python", Packt Publishing, 2017

Web References

1. https://onlinecourses.swayam2.ac.in/cec21_cs08/preview
2. https://www.tutorialspoint.com/artificial_intelligence/index.htm
3. https://www.coursera.org/learn/introduction-to-ai
4. https://www.udacity.com/course/intro-to-artificial-intelligence--cs271

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	3	3	1	2	2	3	1	3	2
CO3	3	2	2	1	3	3	3	1	3	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**16**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSGE1	GEC – I DATA AND INFORMATION SECURITY	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the basics of data and information security	Cognitive	K1
CO2	***Understand*** the concept of SDLC	Cognitive	K1
CO3	***Understand*** the legal, ethical and professional issues in information security	Cognitive	K2
CO4	***Understand*** the various authentication schemes to simulate different applications.	Cognitive	K2
CO5	***Understand*** various security practices and system security standards	Cognitive	K2
CO6	***Understand*** the Web security protocols for E-Commerce applications	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : INTRODUCTION	**9**
History, What is Information Security. Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC	
Module - II : SECURITY INVESTIGATION	**9**
Need for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues - An Overview of Computer Security - Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies	
Module - III: DIGITAL SIGNATURE AND AUTHENTICATION	**9**
Digital Signature and Authentication Schemes: Digital signature-Digital Signature Schemes and their Variants- Digital Signature Standards-Authentication: Overview- Requirements Protocols - Applications - Kerberos -X.509 Directory Services	
Module - IV: E-MAIL AND IP SECURITY	**9**
E-mail and IP Security: Electronic mail security: Email Architecture -PGP – Operational Descriptions- Key management- Trust Model- S/MIME.IP Security: Overview- Architecture - ESP, AH Protocols IPSec Modes – Security association - Key management.	
Module - V: WEB SECURITY	**9**
Web Security: Requirements- Secure Sockets Layer- Objectives-Layers -SSL secure communication-Protocols - Transport Level Security. Secure Electronic Transaction- Entities	

DS Verification-SET processing.

Lecture	Tutorial	Practical	Total
45	0	0	45

Reference Books

1. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare. (2022). *Fundamentals of Data Science*, First Edition, CRC Press.
2. Vijay Kotu and Bala Deshpande. (2019). *Data Science : Concepts and Practice*, Second Edition, Morgan Kaufmann.
3. Davy Cielen, Arno D. B. Meysman and Mohamed Ali. (2016). *Introducing Data Science : Big Data, Machine Learning, and more, using Python Tools*, Manning Publications Co., Island.
4. Sinan Ozdemir, (2016). *Principles of Data Science* Packet Publishing.
5. Sanjiv Ranjan Das, (2016). *Data Science : Theories, Models, Algorithms, and Analytics*, eBook.

Web References

1. MIT Course : *Statistical Thinking And Data Analysis*, https://ocw.mit.edu/courses/15-075j-statistical-thinking-and-data-analysis-fall-2011/download/
2. Alison Course : *Data Science - Regression and Clustering Models*, https://alison.com/course/data-science-regression-and-clustering-models
3. Udemy Course : *Data Science, Machine Learning, Data Analysis, Python & R*, https://www.udemy.com/course/data-science-machine-learning-data-analysis-python-r/
4. NPTEL Course : *Data Science For Engineers*, By Prof. Ragunathan Rengasamy, Prof. Shankar Narasimhan, IIT Madras, https://onlinecourses.nptel.ac.in/noc23_cs97/preview
5. Coursera : *Data Science Math Skills*, Offered by Duck University, https://www.coursera.org/learn/datasciencemathskills
6. Coursera : *Introduction to Data Science Specialization*, Offered by IBM, https://www.coursera.org/specializations/introduction-data-science

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	2	1	2	2	3	1	3	2
CO2	3	3	2	1	2	2	3	1	3	2
CO3	3	2	2	1	3	3	3	1	3	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	2	1	2	3	3	1	3	3
CO6	3	3	2	1	2	3	3	1	3	2
Total	**18**	**16**	**12**	**6**	**14**	**16**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSGE2	GEC – I BLOCK CHAIN TECHNOLOGIES	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Remember*** and ***Understand*** the fundamental concepts of data science	Cognitive	K1
CO2	***Describe*** the data science process;	Cognitive	K2
CO3	***Explore*** and ***Visualize*** the data by various techniques and ***Evaluate*** the Models	Cognitive	K2
CO4	***Illustrate*** the recommendation engines and ***Discover*** the time Series forecasting systems	Cognitive	K2
CO5	***Understand*** and ***Apply*** the suitable feature selection and anomaly detection techniques	Cognitive	K2
CO6	***Apply*** suitable data science tools in various applications	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Introduction to Data Science	**9 Hrs**
Data Science Definitions and Needs - Volume and Dimensions - C's and V's in Data Science - Venn diagram of Data science - Facets of Data - Data and Variable Types - Four Levels of Data - Data Science Process - Associated Fields - Classification of Data Science Tasks - Algorithms for Data Science - Business Intelligence and Data Science - Components of Data Science - Databases for Data Science.	
Module – II : Data Science Process and Evaluation	**9 Hrs**
Data - Causation Versus Correlation - Overview of Data Science Process - Data Preparation - Data Modeling - Applications - Knowledge - Objectives of Data Exploration - Datasets - Univariate and Multivariate Data Exploration - Univariate and Multivariate Data Visualization - Visualizing High Dimensional Data - Roadmap for New Data Exploration - Model Evaluation.	
Module – III : Recommendation and Forecasting Systems	**9 Hrs**
Recommendation Engines and its Needs - Types of Recommendation Engines - Collaborative Filtering - Content-Based Filtering - Hybrid Recommenders - Taxonomy of Time Series Forecasting - Machine Learning Methods for Time Series Forecasting - Performance Evaluation.	
Module – IV : Feature Selection and Anomaly Detection	**9 Hrs**
Classification of Feature Selection Methods - Principal Component Analysis - Information Theory Based Filtering - Chi-Square-Based Filtering - Wrapper Type Feature Selection. Anomaly Detection - Anomaly Detection Techniques - Distance Based Outlier Detection - Density Based Outlier Detection - Local Outlier Factor (LOF).	
Module – V : Data Science Tools and Applications	**9 Hrs**

Introduction to Data Science Tools - SAS - Apache Flink - Apache Spark - KNIME - BigML - Excel - RapidMiner - Tableau - Matplotlib - TensorFlow - Weka - Matlab. Applications of Data Science - Hands-on with RapidMiner - Collecting and Analyzing Twitter Data - Collecting and Analyzing YouTube Data.

Lecture	Tutorial	Practical	Total
45	0	0	45

Reference Books

1. Michael E Whitman and Herbert J Mattord, "Principles of Information Security, Course Technology, 6th Edition, 2017.
2. Stallings William. Cryptography and Network Security: Principles and Practice, Seventh Edition, Pearson Education, 2017.

Web References

1. Harold F. Tipton, Micki Krause Nozaki,, "Information Security Management Handbook, Volume 6, 6th Edition, 2016.
2. Stuart McClure, Joel Scrambray, George Kurtz, "Hacking Exposed", McGraw- Hill, Seventh Edition, 2012.
3. Matt Bishop, "Computer Security Art and Science, Addison Wesley Reprint Edition, 2015
4. Behrouz A Forouzan, Debdeep Mukhopadhyay, Cryptography And network security, 3rd Edition, . McGraw-Hill Education, 2015.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	2	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	3	1	3	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	2	3
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**15**	**15**	**6**	**15**	**17**	**17**	**6**	**16**	**16**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSGE3	GEC – I CRYPTOGRAPHY AND NETWORK SECURITY	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Recall*** the fundamentals of networks security, security architecture, threats and vulnerabilities	Cognitive	K1
CO2	***Remember*** mechanism of OSI architecture	Cognitive	K1
CO2	***Explain*** Symmetric Encryption principles and Message Confidentiality	Cognitive	K2
CO3	***Understand*** use of various Public-key Cryptography techniques for secure data transmission	Cognitive	K2
CO4	***Analyze*** essential approaches and techniques to ensure IP security and network management security	Cognitive	K2
CO5	***Assess and build*** the various Message Authentication and Hash Functions to provide message authentication	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Introduction to cryptography	**9**
Introduction to cryptography: Security trends – Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple Levels, Security Policies – Model of network security – Security attacks, services and mechanisms OSI security architecture - Classical encryption techniques: substitution techniques, transposition techniques, steganography Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.	
Module- II : Symmetric Encryption and Message Confidentiality	**9**
Symmetric Encryption and Message Confidentiality: Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Stream Ciphers and RC4, Cipher Block Modes of Operation, Location of Encryption Devices, Key Distribution - Confidentiality Using Symmetric Encryption - Placement of Encryption Function - Traffic Confidentiality - Key Distribution - Random Number Generation.	
Module - III: Public-key Cryptography	**9**
Public-key Cryptography: Public-Key Cryptography Principles, Public-Key Cryptography Algorithms, Digital Signatures, Key Management	
Module - IV: Message Authentication and Hash Functions	**9**
Message Authentication and Hash Functions: Authentication Requirements - Authentication Functions - Message Authentication Codes - Hash Functions - Security of Hash Functions and Macs - Authentication Applications - Kerberos, x.509 Authentication Service, Public Key Infrastructure. Electronic Mail Security: Pretty Good Privacy (PGP), S/MIM	
Module - V: IP Security	**9**

IP Security: IP Security Over view, IP Security Architecture, Authentication Header, Encapsulating Security Payload, and Combining Security Associations. Web Security: Web Security Considerations, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET). Network Management Security: Basic Concepts of SNMP, SNMPv1 Community Facility, SNMPv3

	Lecture	Tutorial	Practical	Total
	45	0	0	45

Reference Books

1. Stallings William, "Cryptography and Network Security - Principles and Practice", Pearson Education India, 2017.

Web References

1. Ajay Kumar, Dr S.Bose, "Cryptography and Network Security", Pearson Education India,2017
2. Manoj Kumar, "Cryptography and Network Security", Krishna Prakashan Media,2012
3. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security (SIE)",Tata McGraw Hill Education Private Limited,2011.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	3	3	1	2	2	3	1	3	2
CO3	3	2	2	1	3	3	3	1	3	3
CO4	3	2	2	1	3	3	2	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**16**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSDE1	DSE – I HEALTH CARE ANALYTICS	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the different formats of healthcare data, resources and its challenges while processing it	Cognitive	K2
CO2	***Analysis*** of healthcare data from various data sources like imaging, sensing, signalling and genomic data	Cognitive	K4
CO3	***Apply*** analytics in natural language clinical text, biomedical literature and social media text for decision making in healthcare services.	Cognitive	K3
CO4	***Apply*** clinical predictive models to healthcare data to provide health outcomes in relevant populations of interest.	Cognitive	K3
CO5	***Apply*** analytics on public health research		K3
CO6	***Understand*** and apply the relevant data analytic models to build decision support systems for healthcare domain	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : INTRODUCTION TO HEALTHCARE ANALYSIS	**9**
Introduction to Healthcare Data Analytics- Applications and practical systems for Healthcare – Resources for healthcare data analytics - Electronic Health Records - Components of HER - Coding Systems - Benefits of EHR- Barrier to Adopting HER Challenges- Phenotyping Algorithms	
Module - II : HEALTHCARE DATA SOURCES AND ANALYSIS	**9**
Biomedical Image Analysis: Imaging Modalities – Object detection – Segmentation - Mining of Sensor Data in Healthcare: Challenges – Sensor data mining applications – Nonclinical healthcare applications – Biomedical Signal Analysis- Genomic Data Analysis for Personalized Medicine – Types of computational genomics.	
Module - III: HEALTH CARE ANALYTICS	**9**
Natural Language Processing and Data Mining for Clinical Text- Challenges in processing in clinical reports – Clinical applications - Mining the Biomedical literature – Named entity recognition and extraction - Social Media Analytics for Healthcare – analytics on public health research	
Module - IV: ADVANCED DATA ANALYTICS ON HEALTHCARE	**9**
Advanced Data Analytics for Healthcare: Review of Clinical Prediction Models- Temporal Data 55 Mining for Healthcare Data- Visual Analytics for Healthcare- Predictive Models for Integrating Clinical and Genomic Data- Information Retrieval for Healthcare- Privacy-Preserving Data Publishing Methods in Healthcare	
Module - V: CASE STUDIES: HEALTHCARE APPLICATIONS	**9**
Applications: Applications and Practical Systems for Healthcare– Data Analytics for Pervasive	

Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems- Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.				
	Lecture	**Tutorial**	**Practical**	**Total**
	45	**0**	**0**	**45**
Reference Books				
1. Chandan K.Reddy, Charu C. Aggarwal, "Health Care data Analysis", First edition, CRC, 2015.				
2. Vikas Kumar, "Health Care Analysis Made Simple", Packt Publishing, 2018.				
Web References				
1. Nilanjan Dey, Amira Ashour, Simon James Fong, Chintan Bhatl, "Health Care Data Analysis and Management, First Edition, Academic Press, 2018				
2. Hui Jang, Eva K.Lee, "HealthCare Analysis : From Data to Knowledge to Healthcare Improvement", First Edition, Wiley, 2016.				
3. Kulkarni, Siarry, Singh, Abraham, Zhang, Zomaya, Baki, "Big Data Analytics in HealthCare", Springer, 2020.				
E- References				
4. https://www.coursera.org/courses?query=healthcare%20analytics				

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	3
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**16**	**16**	**6**	**18**	**16**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSDE2	DSE – I IoT ANALYTICS	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the concepts and techniques of IoT Data Analytics Lifecycle	Cognitive	K2
CO2	***Understand*** Machine Learning Application in IoT.	Cognitive	K2
CO3	***Develop*** cognitive IoT solutions, leveraging artificial intelligence and data science	Cognitive	K5
CO4	***Examine*** concepts of cloud based IoT, big data and IoT in various domains	Cognitive	K3
CO5	***Understand*** the propose new strategies for organizations to optimize cost benefits using IoT data.	Cognitive	K2
CO6	***Explore*** end-to-end data science industry use cases using the data analytics lifecycle.	Cognitive	K4

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Introduction to Internet of Things and Analytics	**9**
Introduction to Internet of Things (IoT): Concepts and Definition of IoT – IoT Devices - IoT Networking Connectivity Protocols – IoT Data Messaging Protocols – MQTT, CoAP. IoT Analytics: Data vs big data- Challenges of IoT Analytics Applications - IoT Analytics Lifecycle and Techniques.	
Module - II : IoT Cloud and Big Data Integration	**9**
IoT Cloud and Big Data Integration: Cloud based IoT platform – Data Analytics for IoT – Data Collection – WAZIUP software Platform – Ikaas Software Platform - Elastic analytics concepts – designing for scale – Cloud security and analytics – AWS overview - AWS key services for IoT analytics.	
Module - III: Strategies and Techniques in Data Collection	**9**
Strategies and Techniques in Data collection: Designing Data Processing for Analytics – Applying Big Data to Storage – Apache Spark for IoT Data Processing - Solving Industry Specific Problems	
Module - IV: Geospatial Analytics to IoT Data	**9**
Geospatial Analytics to IoT Data: Basics – Vector and Raster Based Methods – Processing Geospatial Data. Data Science for IoT Analytics – Machine Learning Basic – Forecasting IoT data using ARIMA – Deep learning with IoT data	
Module - V: Applications & Case Studies	**9**
Applications & Case Studies: Data Analysis in Smart Building – Internet of Things Analytics for Smart Cities – IoT Analytics: From Data Collection to Deployment and Operationalization	

Lecture	Tutorial	Practical	Total
45	0	0	45

Reference Books
1. Andrew Minteer, Analytics for the Internet of things, Packt publishing, 2017
2. John Soldatos, Building Blocks for IoT Analytics, River Publishers, 2016.
Web References
1. Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things: Principles and Paradigms, Elsevier, 2016.
2. R. Chandrasekaran, Essentials of Cloud computing, 2nd Edition, Chapman and Hall/CRC, 2015.
3. Amita Kapoor, Hands on Artificial intelligence for IoT, 1st Edition, Packt Publishing, 2019

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	3	3	1	2	2	3	2	3	2
CO2	1	3	3	1	2	2	3	2	3	2
CO3	2	2	2	1	3	3	3	2	3	3
CO4	1	2	2	1	3	3	2	2	3	3
CO5	1	3	3	1	2	3	3	2	3	3
CO6	1	3	3	1	2	3	3	2	3	2
Total	**7**	**16**	**16**	**6**	**14**	**16**	**17**	**12**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSDE3	DSE – I IMAGE AND VIDEO ANALYTICS	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the basics of image processing techniques for computer vision and video analysis	Cognitive	K1
CO2	***Explain*** the techniques used for image pre-processing.	Cognitive	K2
CO3	***Develop*** various object detection techniques	Cognitive	K2
CO4	***Understand*** the various face recognition mechanisms.	Cognitive	K2
CO5	***Illustrate*** on deep learning-based video analytics.	Cognitive	K2
CO6	***Summarize*** the concept on RestNet	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : INTRODUCTION	**9**
Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.	
Module - II : IMAGE PRE-PROCESSING	**9**
Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi-speralct images - Local pre-processing in the frequency domain - Line detection by local pre-processing operators - Image restoration.	
Module - III: OBJECT DETECTION USING MACHINE LEARNING	**9**
Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) –Deep Learning Architectures-R-CNN-Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures	
Module - IV: FACE RECOGNITION AND GESTURE RECOGNITION	**9**
Face Recognition-Introduction-Applications of Face Recognition-Process of Face RecognitionDeepFace solution by Facebook-FaceNet for Face Recognition- Implementation using FaceNetGesture Recogn	
Module - V: VIDEO ANALYTICS	**9**
Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem-RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture-Improvement in Inception v2-Video analytics-RestNet and Inception v3.	

Lecture	Tutorial	Practical	Total
45	0	0	45

Reference Books
Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4nd edition, Thomson Learning, 2013.
Vaibhav Verdhan,(2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras,Apress 2021(UNIT-III,IV and V)
Web References
1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited,2011
2. Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.
3. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003.
4. E. R. Davies, (2012), "Computer & Machine Vision", Fourth Edition, Academic Press.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS204	MACHINE LEARNING TECHNIQUES LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Apply*** the basics in python programming in different problems	Cognitive	K3
CO2	***Apply*** the NumPy and pandas libraries to handle the data	Cognitive	K3
CO3	***Apply*** the pandas and Matplotlib libraries for data visualization	Cognitive	K3
CO4	***Apply*** the R programming essentials for data science problems	Cognitive	K3
CO5	***Apply*** the R programming data visualization and transformations	Cognitive	K3
CO6	***Apply*** the R programming transformation	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Implementation of k-nearest neighbors' classification	7
2	Extraction of data from database	7
3	Implementation of linear regression	7
4	Implementation of Naïve bayes theorem to classify the English text	7
5	Implementation of ID3 –Algorithm	7
6	Implementation of Support Vector Machine algorithm	7
7	Implementation of k – means algorithm	7
8	Implementation of hierarchical clustering	11
	Mr.J.Sengathir, Industry Expert Suggested to include Ex. No. 7 & 8.	

Lecture	Tutorial	Practical	Total
---	---	**60**	**60**

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Grade Scale : 01 - 06 → 1 | 06 - 09 → 2 | 09 - 15 → 3

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot
YDSDE4	HEALTH CARE ANALYTICS LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Apply*** MapReduce programs for processing big data.	Cognitive	K3
CO2	***Realize*** storage of big data using MongoDB	Cognitive	K4
CO3	***Analyze*** big data using machine learning techniques such as Decision tree classification and clustering.	Cognitive	K4
CO4	***Apply*** the clustering techniques to implement the program by SPARK	Cognitive	K3
CO5	***Apply*** the Mongo DB for solving problems	Cognitive	K3
CO6	***Apply*** the Hadoop concept on datasets	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Install, configure and run python, numPy and Pandas	7
2	Install, configure and run Hadoop and HDFS.	7
3	Visualize data using basic plotting techniques in Python	7
4	Implement NoSQL Database Operations: CRUD operations, Arrays using MongoDB).	7
5	Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB.	7
6	Implement word count / frequency programs using MapReduce	7
7	Implement a MapReduce program that processes a dataset.	7
8	Implement clustering techniques using SPARK.	7
9	Implement an application that stores big data in MongoDB / Pig using Hadoop / R.	4

Lecture	Tutorial	Practical	Total
---	---	**60**	**60**

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSDE5	IoT ANALYTICS LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Apply*** the IOT concept on temperature sensor interfacing	Cognitive	K3
CO2	***Apply*** the Motor driver Interfacing	Cognitive	K3
CO3	***Apply*** the Reading Analog Voltage	Cognitive	K3
CO4	***Apply*** IoT using Raspberry Pi	Cognitive	K3
CO5	***Apply*** Camera interface using Raspberry Pi	Cognitive	K3
CO6	***Apply*** IOT on real time application case studies	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Node MCU/ESP 32 - Temperature Sensor Interfacing (LM35) - Bluetooth Interfacing (HC05)- Motor driver Interfacing (L298) -LCD Interfacing (HD44780)	10
2	IMPLEMENTATION OF IoT using BLYNK/CAYENNE - –Installation and Activation - Blinking an LED -Reading Analog Voltage - LCD Interfacing (HD44780) -Project	10
3	IMPLEMENTATION OF IoT using Google Assistant – Arest server - Creating own server – Project	10
4	IMPLEMENTATION OF IoT using Raspberry Pi & Python Programming: - LCD Interfacing (HD44780) - Motor driver Interfacing (L298) – Camera interface	10
5	Real Time Applications **Dr.V.Adithya Pothan Raj, Industry Expert suggested this Ex.No. 5**	20

Lecture	Tutorial	Practical	Total
---	---	**60**	**60**

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	3	3	1	2	2	3	2	3	2
CO2	2	2	2	1	3	3	3	2	3	3
CO3	1	2	2	1	3	3	2	2	3	3
CO4	1	3	3	1	2	3	3	2	3	3
CO5	1	3	3	1	2	3	3	2	3	2
CO6	1	3	3	1	2	3	3	2	3	2
Total	**7**	**16**	**16**	**6**	**14**	**17**	**17**	**12**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot
YDSDE6	IMAGE and VIDEO ANALYTICS LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Apply*** the basics programs using MATLAB	Cognitive	K3
CO2	***Apply*** the DFT image analysis	Cognitive	K3
CO3	***Apply*** the transforms and histogram	Cognitive	K3
CO4	***Apply*** the filtering methods	Cognitive	K3
CO5	***Apply*** the Morphological operations	Cognitive	K3
CO6	***Apply*** the different color models	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Image sampling and quantization	5
2	Analysis of spatial and intensity resolution of images.	5
3	Intensity transformation of images	5
4	DFT analysis of images	5
5	Transforms (Walsh, Hadamard, DCT, Haar)	5
6	Histogram Processing	5
7	Image Enhancement-Spatial filtering	5
8	Image Enhancement- Filtering in frequency domain	5
9	Image segmentation – Edge detection, line detection and point detection	5
10	Basic Morphological operations	5
11	Basic Thresholding functions	5
12	Analysis of images with different color models.	5

Lecture	Tutorial	Practical	Total
---	---	60	60

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSSE2	SEC – 2 CYBER SECURITY	3	3 : 0 : 0	2	1	---	3	60	40	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will able to :*		Domain	Level
CO1	***Understand*** about the Cyberwarfare and necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.	Cognitive	K2
CO2	***Analyze*** how report these crimes through the prescribed legal and Government channels.	Cognitive	K3
CO3	***Analyze*** about Social Media Scams & Frauds	Cognitive	K3
CO4	***Understand*** other countries and legal and ethical aspects related to new technologies.	Cognitive	K2
CO5	***Understand*** data privacy and security issues related to Social media platform	Cognitive	K2
CO6	***Understand*** cyber security audit and compliance	Cognitive	K2

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Overview of Cyber security	**9**
Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies	
Module - II : Cyber crimes	**9**
Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cybersquatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake newscyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies	
Module - III: Cyber Law	**9**
Cyber crime and legal landscape around the world, IT Act,2000 and its amendments. Limitations of IT Act, 2000. Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies	
Module - IV: Data Privacy and Data Security	**9**
Defining data, meta-data, big data, nonpersonal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data	

Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues				
Module - V: Compliance and Governance				**9**
Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy				
	Lecture	**Tutorial**	**Practical**	**Total**
	30	**15**	**0**	**45**
Reference Books				
1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.,				
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.				
Web References				
1. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.				
2. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.				
3. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication				
4. Auditing IT Infrastructures for Compliance by Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning				

COs vs POs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	1	1	3	3	3	---	---
CO2	1	1	1	1	1	3	3	3	---	---
CO3	1	1	1	1	1	3	3	3	---	---
CO4	2	3	2	3	2	3	3	3	---	---
CO5	2	3	2	3	2	3	3	3	---	---
CO6	2	3	3	3	1	3	3	3	---	---
Total	**08**	**11**	**09**	**11**	**07**	**15**	**15**	**15**	---	---

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

SEMESTER - III

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS301	BUSINESS INTELLIGENCE	4	4 : 0 : 0	3	1	---	4	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Recall*** the concepts and components of Business Intelligence (BI)	Cognitive	K1 - K2
CO2	***Interpret*** the data provisioning in BI to fetch the desired data from the source to the target system	Cognitive	K1 - K2
CO3	***Apply*** the data visualization in Business Intelligence to translate the information into a visual context	Cognitive	K3 - K4
CO4	***Analyze*** large sets of data through process analysis in BI	Cognitive	K2 - K4
CO5	***Evaluate*** and construct BI tools critically to support the strategic decision-making of an organization	Cognitive	K2 - K5
CO6	***Analyze*** about Business Process Compliance	Cognitive	K2 - K5

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Introduction to Business Intelligence	**12**
Introduction to Business Intelligence: Definition– Putting Business Intelligence into Context – Task and Analysis Format	
Module - II : Modelling in Business Intelligence	**12**
Modelling in Business Intelligence: Models and Modelling in Business Intelligence – Logical and Algebraic Structure – Graph Structure – Analytical |Structure – Models and Data	
Module - III: Data Provisioning	**12**
Data Provisioning: Data Collection and Description – Data Extraction – Transactional Data Towards Analytical Data – Scheme and Data Integration	
Module - IV: Data Description and Visualization	**12**
Data Description and Visualization: Description and visualization for Business process – Description and visualization of data in customer perspective -Basic Visualization Technique - Reporting	
Module - V: Process Analysis	**12**
Process Analysis: Business process analysis and Simulation – Process performance Management and Warehousing – Process Mining – Business Process Compliance – Evaluation Assessment	

Lecture	Tutorial	Practical	Total
45	15	0	60

Reference Books

1. Grossmann, Wilfried, and Rinderle-Ma, Stefanie. Fundamentals of Business Intelligence. Belgium, Springer Berlin Heidelberg, 2015.
2. Olszak, Celina M, "Business Intelligence and Big Data: Drivers of Organizational Success". United States, CRC Press, 2020
3. King, David, et al. Business Intelligence, Analytics, and Data Science: A Managerial Perspective. Germany, Pearson, 2017
4. Brijs, Bert. "Business Analysis for Business Intelligence", CRC Press, 2016.

Web References

1. VSP RAO, Human Resource Management, 3rd Edition, Excel Books, 2010.
2. Mahadevan B, "Operations Management -Theory and Practice",3rd Edition, Pearson Education,2018.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**18**	**18**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS302	EXPLORATORY DATA ANALYSIS and VISUALIZATION	4	4 : 0 : 0	4	1	---	5	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the fundamentals of exploratory data analysis.	Cognitive	K2
CO2	***Implement*** the data visualization using Matplotlib.	Cognitive	K3
CO3	***Implement*** the data visualization using Matplotlib.	Cognitive	K3
CO4	***Apply*** bivariate data exploration and analysis.	Cognitive	K3
CO5	***Use*** Data exploration and visualization techniques for multivariate and time series data.	Cognitive	K3
CO6	***Analyz***e the Time-based indexing	Cognitive	K4

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : EXPLORATORY DATA ANALYSIS	**12**
EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA - Visual Aids for EDA- Data transformation techniques-merging database, reshaping and pivoting, Transformation techniques - Grouping Datasets - data aggregation – Pivot tables and cross-tabulations.	
Module - II : VISUALIZING USING MATPLOTLIB	**12**
mporting Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.	
Module - III: UNIVARIATE ANALYSIS	**12**
Introduction to Single variable: Distributions and Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality - Smoothing Time Series.	
Module - IV: BIVARIATE ANALYSIS	**12**
Relationships between Two Variables - Percentage Tables - Analyzing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines – Transformations.	
Module - V: MULTIVARIATE AND TIME SERIES ANALYSIS	**12**
Introducing a Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond - Longitudinal Data – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling.	

	Lecture	Tutorial	Practical	Total

	45	**15**	**0**	**60**

Reference Books

1. Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”, Packt Publishing, 2020. (Unit 1)
2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", Oreilly, 1st Edition, 2016. (Unit 2)
3. Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008. (Unit 3,4,5)

Web References

1. Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017
2. Claus O. Wilke, “Fundamentals of Data Visualization”, O’reilly publications, 2019.
3. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, 2nd Edition, CRC press, 2015.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS303	DEEP LEARNING	4	4 : 0 : 0	3	1	---	1	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the deep learning concepts and apply for different problems	Cognitive	K2
CO2	***Design*** and apply Convolutional and Recurrent Neural Networks	Cognitive	K2
CO3	***Understand*** and evaluate different deep learning architectures	Cognitive	K2
CO4	***Design*** and create deep learning applications	Cognitive	K2
CO5	***Analyze*** the role of deep learning models in image processing	Cognitive	K3
CO6	***Use*** of Different Storage Structures	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module – I : Basics of Neural Networks	**12 Hrs**
Basics of neural networks - Basic concept of Neurons – Perceptron Algorithm – Feed Forward and Back Propagation Networks	
Module – II : Introduction To Deep Learning	**12 Hrs**
Introduction to deep learning - Feed Forward Neural Networks – Gradient Descent – Back Propagation Algorithm – Vanishing Gradient problem – Mitigation – RelU Heuristics for Avoiding Bad Local Minima – Heuristics for Faster Training – Nestors Accelerated Gradient Descent – Regularization – Dropout	
Module – III : Convolutional & Recurrent Neural Network	**12 Hrs**
Convolutional neural networks - Kernel Filters – Multiple Filters - CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning - Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN application	
Module – IV: Deep Learning Architectures	**12 Hrs**
LSTM, GRU, Encoder/Decoder Architectures – Autoencoders – Standard- Sparse – Denoising – Contractive- Variational Autoencoders – Adversarial Generative Networks – Autoencoder and DBM	
Module – V: Applications of Deep Learning	**12 Hrs**
Multi-user Operation – Data Transaction – Consistency in Massive Distributed Data – Comparing ACID and BASE – Processing of Homogeneous and Heterogeneous Data – Storage and Access Structure – Layered Architecture – Use of Different Storage Structures.	

Lecture	Tutorial	Practical	Total
45	15	0	60

Reference Books

1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.

2. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

Web References

1. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
2. Phil Kim, “Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence”, Apress , 2017.
3. Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018. 4Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.
4. Joshua F. Wiley, “R Deep Learning Essentials”, Packt Publications, 2016.

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSGE4	GEC – II DIGITAL IMAGE PROCESSING	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Recall*** the Digital Image Fundamentals	Cognitive	K1
CO2	***Summarize*** the filtering in the frequency domain.	Cognitive	K2
CO3	***Interpret*** Image restoration and reconstruction	Cognitive	K3
CO4	***Examine*** the various image transformation techniques	Cognitive	K4
CO5	***Assess*** the color image processing.	Cognitive	K5
CO6	***Design*** the color image processing.	Cognitive	K4

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Introduction	**9**
Digital Image Processing: Introduction - The Origins of Digital Image Processing - Examples of Fields that Use Digital Image Processing - Fundamental Steps in Digital Image Processing - Components of an Image Processing System - Digital Image Fundamentals: Elements of Visual Perception - Light and the Electromagnetic Spectrum. Image Sensing and Acquisition - Image Sampling and Quantization - Some Basic Relationships Between Pixels - An Introduction to the Mathematical Tools Used in Digital Image Processing	
Module - II : Frequency Domain	**9**
Filtering in the Frequency Domain: Background - Preliminary Concepts - Sampling and the Fourier Transform of Sampled Functions - The Discrete Fourier Transform of One Variable - Extensions to Functions of Two Variables - Some Properties of the 2-D DFT and IDFT - The Basics of Filtering in the Frequency Domain - Image Smoothing Using Lowpass Frequency Domain Filters - Image Sharpening Using Highpass Filters - Selective Filtering - The Fast Fourier Transform.	
Module - III: Image Restoration and Reconstruction	**9**
Image Restoration and Reconstruction: Noise Models - Restoration in the Presence of Noise Only Spatial Filtering - Periodic Noise Reduction Using Frequency Domain Filtering - Linear, Position-Invariant Degradations - Estimating the Degradation Function - Inverse Filtering - Minimum Mean Square Error (Wiener) Filtering - Constrained Least Squares Filtering - Geometric Mean Filter	
Module - IV: Wavelet and Other Image Transforms	**9**
Wavelet and Other Image Transforms: Matrix-based Transforms – Correlation - Basis Functions in the Time-Frequency Plane - Basis Images - Fourier-Related Transforms - Walsh-Hadamard Transforms - Slant Transform - Haar Transform - Wavelet Transforms	
Module - V: Color Image Processing	**9**

Color Image Processing: Color Fundamentals - Color Models - Pseudocolor Image Processing - Basics of Full-Color Image Processing - Color Transformations - Color Image Smoothing and Sharpening - Using Color in Image Segmentation - Noise in Color Images - Color Image Compression

	Lecture	Tutorial	Practical	Total
	45	0	0	45

Reference Books

1. Rafael Gonzalez, Richard E. Woods, "Digital Image Processing", Fourth Edition, PHI/Pearson Education, 2018.

Web References

1. Digital Image Processing using Matlab, Rafeal C. Gonzalez, Richard E. Woods, Steven L. Eddins, Pearson Education.
2. Introduction to Image Processing & Analysis-JohnC.Russ, J.ChristianRuss, CRC Press, 2010
3. Digital Image Processing with MATLAB & Labview - Vipula Singh Elsevier

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	2	3
CO3	3	2	1	1	3	3	2	1	3	3
CO4	3	3	3	1	1	3	3	1	3	3
CO5	2	3	3	1	2	3	3	1	1	2
CO6	2	3	3	1	2	3	3	1	1	2
Total	**16**	**16**	**15**	**6**	**13**	**17**	**17**	**6**	**13**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSGE5	GEC – II NATURAL LANGUAGE PROCESSING	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Define*** the Linear Text Classification of NLP	Cognitive	K1
CO2	***Demonstrate*** the Nonlinear classification	Cognitive	K2
CO3	***Identify*** the various Language Models of NLP	Cognitive	K1
CO4	***Analyze*** and Apply the Formal Language Theory	Cognitive	K4
CO5	***Explain*** and formulate the Logical Semantics Predicate argument Semantics	Cognitive	K2
CO6	***Evaluate*** Predicate argument Semantics	Cognitive	K5

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : NLP Introduction	**9**
NLP Introduction: Natural Language Processing and Its Neighbours – Three Themes in NLP - Linear Text Classification: The bag of words – Naïve Bayes – Discriminative Learning – Loss Functions and Large-margin Classification – Logistic Regression – Optimization	
Module - II : Nonlinear Classification	**9**
Nonlinear Classification: Feedforward Neural Network – Designing Neural Network – Learning Neural Network – Conventional Neural Network - Linguistic Applications of Classification: Sentiment and Opinion Analysis – Word Sense Disambiguation – Design Decisions for Text Classification – Evaluating Classifier – Building Datasets.	
Module - III: Language Models	**9**
Language Models: N-Gram Language Models – Smoothing and Discounting – Recurrent Neural Network Models – Evaluating Language Models – Out of Vocabulary Words - Sequence Labeling: Sequence Labeling as Classification – Structure Prediction – The Viterbi Algorithm – Hidden Markov Model.	
Module - IV: Formal Language Theory	**9**
Formal Language Theory: Regular Languages – Context Free Languages - Context Free Parsing: Deterministic Bottom up Parsing – Ambiguity – Weighted Context Free Grammars – Learning Weighted Context Free Grammars – Grammar Refinement	
Module - V: Logical Semantics	**9**
Logical Semantics: Meaning and Denotation – Logical Representation of Meaning – Semantic Parsing and the Lambda Calculus – Learning Semantic Parsers - PredicateArgument Semantics: Semantic Roles – Semantic Role Labeling – Abstract Meaning Representation	

	Lecture	Tutorial	Practical	Total

	45	**0**	**0**	**45**

Reference Books

1. Jacob Eisenstein, “Introduction to Natural Language Processing”, MIT Press, 2019.

Web References

1. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, “Fundamentals of Speech Recognition” 1st Edition, Pearson, 2009.
2. Steven Bird, Ewan Klein, and Edward Loper, “Natural language processing with Python”, O’REILLY

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	2	3
CO3	3	2	1	1	3	3	2	1	3	3
CO4	3	3	3	1	1	3	3	1	3	3
CO5	2	3	3	1	2	3	3	1	1	2
CO6	2	3	3	1	2	3	3	1	1	2
Total	**16**	**16**	**15**	**6**	**13**	**17**	**17**	**6**	**13**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSGE6	GEC – II CLOUD AND EDGE COMPUTING	3	3 : 0 : 0	3	---	---	3	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Understand*** the design challenges in the cloud	Cognitive	K2
CO2	***Apply*** the concept of virtualization and its types	Cognitive	K3
CO3	***Experimen***t with virtualization of hardware resources and Docker.	Cognitive	K3
CO4	***Develop*** and deploy services on the cloud and set up a cloud environment.	Cognitive	K4
CO5	***Explain*** security challenges in the cloud environment.	Cognitive	K2
CO6	***Analyze*** IAM Challenges	Cognitive	K4

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Cloud Architecture Models and Infrastructure	**9**
Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges	
Module - II : Virtualization Basics	**9**
Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts – Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices.	
Module - III: Virtualization Infrastructure and Docker	**9**
Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management – Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.	
Module - Iv: Cloud Deployment Environment	**9**
Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack.	
Module - V: Cloud Security	**9**
Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyperjacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice	

	Lecture	Tutorial	Practical	Total
	45	0	0	45

Reference Books

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. James Turnbull, "The Docker Book", O'Reilly Publishers, 2014.

Web References

1. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	2	3
CO3	3	2	1	1	3	3	2	1	3	3
CO4	3	3	3	1	1	3	3	1	3	3
CO5	2	3	3	1	2	3	3	1	1	2
CO5	2	3	3	1	2	3	3	1	1	2
Total	**16**	**16**	**15**	**6**	**13**	**17**	**17**	**6**	**13**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS305	BUSINESS INTELLIGENCE LABORATORY USING ADVANCED EXCEL and POWER BI	2	2 : 0 : 0	---	---	4	4	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Explain*** the real-world business problems and model with analytical solutions.	Cognitive	K3
CO2	***Identify*** the business processes for extracting Business Intelligence	Cognitive	K3
CO3	***Apply*** predictive analytics for business fore-casting	Cognitive	K3
CO4	***Apply*** analytics for supply chain and logistics management	Cognitive	K3
CO5	***Apply*** analytics for supply chain and logistics management	Cognitive	K3
CO5	***Apply*** various plotting functions on the data set	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Explore the features of Ms-Excel.	7
2	(i) Get the input from user and perform numerical operations (MAX, MIN, AVG, SUM, SQRT, ROUND) ii) Perform data import/export operations for different file formats.	7
3	Perform statistical operations - Mean, Median, Mode and Standard deviation, Variance, Skewness, Kurtosis	7
4	Perform Z-test, T-test & ANOVA	7
5	Perform data pre-processing operations i) Handling Missing data ii) Normalization	7
6	Perform dimensionality reduction operation using PCA, KPCA & SVD	7
7	Perform bivariate and multivariate analysis on the dataset.	7
8	Apply and explore various plotting functions on the data set	7
	Dr.S.Nickolas Academic Expert suggested to include Ex.No. 7 & 8.	11

Lecture	Tutorial	Practical	Total
---	---	**60**	**60**

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation

Course Code	Course Name	Credits	Domain	Hours / Week				Max. Marks		
			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDS306	DEEP LEARNING LABORATORY	2	2 : 0 : 0	---	---	4	4	50	50	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will be able to :*		Domain	Level
CO1	***Apply*** deep neural network for simple problems.	Cognitive	K3
CO2	***Apply*** Convolution Neural Network for image processing.	Cognitive	K3
CO3	***Apply*** Recurrent Neural Network and its variants for text analysis	Cognitive	K3
CO4	***Apply*** generative models for data augmentation.	Cognitive	K3
CO5	***Develop*** a real world application using suitable deep neural networks	Cognitive	K3
CO6	***Apply*** real world application using suitable deep neural networks	Cognitive	K3

∗ **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF EXPERIMENTS

Ex. No.	Name of the Experiment	Hours
1	Solving XOR problem using Multilayer perceptron	10
2	Implement character and Digit Recognition using ANN.	10
3	Implement the analysis of X-ray image using auto encoders	10
4	Develop a code to design object detection and classification for traffic analysis using CNN	10
5	Implement online fraud detection of share market data using any one of the data analytics tools.	10
6	Implement Sentiment Analysis using LSTM.	10
	Dr.V.Adithya Pothan Raj Industry Expert suggested that to include Ex.No. 5 & 6	

Lecture	Tutorial	Practical	Total
---	---	**60**	**60**

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relatio

Course	Course Name	Credits	Domain	Hours / Week	Max. Marks

Code			C : P : A	L	T	P	Tot.	CIA	ESE	Tot.
YDSSE3	SEC – 3 RESEARCH ETHICS AND SKILLS	3	3 : 0 : 0	2	1	---	3	60	40	100
Pre-requisite										

Course Outcomes *On successful completion of this course, the students will able to :*		Domain	Level
CO1	***Understanding*** about the Cyberwarfare and necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.	Cognitive	K2
CO2	***Analyze*** how report these crimes through the prescribed legal and Government channels.	Cognitive	K3
CO3	***Understand*** other countries and legal and ethical aspects related to new technologies.	Cognitive	K2
CO4	***Understand*** data privacy and security issues related to Social media platform	Cognitive	K3
CO5	***Understand*** cyber security audit and compliance	Cognitive	K2
CO6	***Apply*** cyber security audit and compliance	Cognitive	K3

* **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Module - I : Philosophy And Ethics & Scientific Conduct	**9**
Introduction to Philosophy : definition, nature and Scope, Concept, Branches - Ethics: definition, moral philosophy, nature of moral judgements and reaction. Ethics with respect to science and research Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication, and Plagiarism(FFP) - Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data.	
Module - II : Publication Ethics	**9**
Publication ethics: definition, introduction and importance - Best practices /Standards setting initiatives and guidelines: COPE. WAME, etc., - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, authorship and contributorship - Identification of publication misconduct, complaints and appeals - Predatory publishers and journals	
Module - III: Open Access Publishing	**9**
Open access publications and initiatives - SHEERPA/RoMEO online resource to check publisher copyright & Self – archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finder /Journal suggestion tools viz.JANE., Elsevier journal Finder, Springer Journal Suggester, etc.	
Module - IV: Publication Misconduct	**9**
Group Discussions: Subject specific ethical issues, FFP, authorship - Conflicts of interest - Complaints and appeals: examples and fraud from India and abroad. Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.	
Module - V: Databases and Research Metrics	**9**
Databases: Indexing databases - Citation databases: Web of Science, Scopus, etc Research Metrics: Impact Factor of Journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 index, altmetric	

	Lecture	Tutorial	Practical	Total
	30	15	0	45

Reference Books

1. Bird, A.(2006). Philosophy of Science.Routledge
2. Maclntyre, Alasdair (1967) A Short History of Ethics. London
3. P.Chaddah, (2018) Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN :978-9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to responsible conduct in Research: Third Edition, National Academies Press
5. Resnik, D.B.(2011) What is ethics in research & why is it important. National institute of Environmental Health Science, 1-10 Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

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1. Beall, J: (2012) Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
2. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. htt://www.insaindia.res.in/pdf/Ethics_Book.pdf

COs - POs / PSOs Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	3	3	1	2	2	3	1	3	2
CO2	3	2	2	1	3	3	3	1	3	3
CO3	3	2	2	1	3	3	2	1	3	3
CO4	3	3	3	1	2	3	3	1	3	3
CO5	3	3	3	1	2	3	3	1	3	2
CO6	3	3	3	1	2	3	3	1	3	2
Total	**18**	**16**	**16**	**6**	**14**	**17**	**17**	**6**	**18**	**15**

Relativity : 0 → No relation 3 → Highly relation 2 → Medium relation 1→ Low relation