B.S. Abdur Rahman Crescent Institute of Science & Technology

Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2019 Curriculum and Syllabi (I & II semesters)

(Amendments updated upto February 2022)

M.Tech.
(Artificial Intelligence & Data Science)

REGULATIONS 2019

CURRICULUM AND SYLLABI (I & II Semesters)

(Amendments updated upto February 2022)

M.TECH.

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

VISION AND MISSION OF THE INSTITUTION

VISION

B.S.Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION AND MISSION

VISION

The vision of the Department of Computer Science and engineering is to impart quality education, inculcate professionalism and enhance the problem solving skills of the students in the domain of Computer Science and Engineering with a focus to make them industry ready, involve in possible areas of research, to pursue and have continual professional growth.

MISSION

- To equip the students with strong fundamental concepts, analytical capability, programming and problem solving skills.
- To create an academic environment conducive for higher learning through faculty training, self learning, sound academic practices and research endeavors.
- To provide opportunities in order to promote organizational and leadership.
- Skills in students through various co-curricular and extra – curricular activities.
- To make the students industry ready and to enhance their employability through training and internships.
- To improve department industry collaboration through interaction including participation in professional society activities, guest lecturers and industrial visit.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M. Tech. (Artificial Intelligence and Data Science)

Programme Educational Objectives:

- Applying the knowledge acquired in the Computational models, Knowledge Engineering to develop intelligent and Smart systems for the industrial problems.

- Design solutions for real world problems that involve acquiring variety of data from multiple sources using Data Science.

- Imbibing a scientific perspective to pursue research in Artificial Intelligence and Data Science using Mathematical, Engineering, and Computational tools.

Programme Outcomes:

On successful completion of the programme, the graduates will be able to

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- Use research –based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES

- To assess, design, and implement ethical, long-term solutions in the discipline of Artificial Intelligence and Data Science

- To apply problem-solving skills and programming concepts to build a variety of solutions in an interdisciplinary domains

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE & TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS - 2019 FOR

M.Tech. / MCA / M.Sc. / M.Com. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

"Programme" means Post Graduate Degree Programme (M.Tech. / MCA / M.Sc. / M.Com.)

"Course" means a theory / practical / laboratory integrated theory / mini project / seminar / internship / Project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.,

"Institution" means B.S. Abdur Rahman Crescent Institute of Science & Technology.

"Academic Council" means the Academic Council, which is the apex body on all academic matters of B.S. Abdur Rahman Crescent Institute of Science & Technology.

"Dean (Academic Affairs)" means Dean (Academic Affairs) of B.S. Abdur Rahman Crescent Institute of Science & Technology who administers the academic matters.

"Dean (Student Affairs)" means Dean (Student Affairs) of B.S. Abdur Rahman Crescent Institute of Science & Technology, who looks after the welfare and discipline of the students.

"Controller of Examinations" means the Controller of Examinations of B.S. Abdur Rahman Crescent Institute of Science & Technology who is responsible for the conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED AND ADMISSION REQUIREMENTS

2.1 Programmes Offered

The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	

2.2 ADMISSION REQUIREMENTS

2.2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination of this Institution as specified in the clause 3.2 [Eligible entry qualifications for admission to P.G. programmes] or any other degree examination of any University or authority accepted by this Institution as equivalent thereto.

2.2.2 Eligibility conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 DURATION, ELIGIBILITY AND STRUCTURE OF THE PROGRAMME

3.1. The minimum and maximum period for completion of the Programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA (3 years)	6	12
MCA (Lateral Entry)	4	8
MCA (2 years)	4	8
M.Sc.	4	8
M.Com.	4	8

3.1.1 Each academic semester shall normally comprise of 90 working days. Semester End Examinations shall follow within 10 days of the last Instructional day.

3.1.2 Medium of instruction, examinations and project report shall be in English.

3.2 ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO PROGRAMMES

Sl. No.	Name of the Department	Programmes offered	Qualifications for admission
1.	Aeronautical Engineering	M. Tech. (Avionics)	B.E. / B. Tech. (Aeronautical Engineering)
2.	Civil Engineering	M. Tech. (Structural Engineering)	B.E. / B. Tech. (Civil Engineering) / (Structural Engineering)
		M. Tech. (Construction Engineering and Project Management)	B.E. / B. Tech. (Civil Engineering) / (Structural Engineering) / B. Arch.
3.	Mechanical Engineering	M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace /Aeronautical / Material Science / Marine Engineering)
		M.Tech. (CAD/CAM)	
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engg.)	B.E. / B. Tech. (EEE/ECE/E&I/I&C / Electronics / Instrumentation)
		M.Tech. (Power Electronics and Drives)	
5.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	B.E. / B. Tech. (EEE/ ECE / E&I / CSE IT / I&C / Electronics / Instrumentation)
		M.Tech. (VLSI and Embedded Systems)	B.E. / B. Tech. (ECE / E&I / I&C / EEE / CSE / IT)
6.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation	B.E. / B. Tech. (EIE/ICE/Electronics/ECE/EEE)

		Engineering)	
7.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B. Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics / MCA)
		M.Tech. (Artificial Intelligence and Data Science)	B.E. / B. Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics / MCA)
		M.Tech. (Data Science)	B.E. / B. Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics / MCA)
8.	Information Technology	M.Tech. (Information Technology)	B.E. / B. Tech. (IT/CSE/ECE/EEE/EIE/ICE/ Electronics / MCA)
9.	Computer Applications	MCA (3 years)	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		MCA – (Lateral Entry)	B.Sc. Computer Science / B.Sc. Information Technology / BCA
		MCA (2 years)	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level or B.Sc. Computer Science / B.Sc. Information Technology / BCA
10.	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the subjects of study
11.	Physics	M.Sc.(Physics)	B.Sc. (Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)

12.	Chemistry	M.Sc.(Chemistry)	B.Sc. (Chemistry / Applied Science)
13.	Life Sciences	M.Sc. Molecular Biology & Biochemistry	B.Sc. in any branch of Life Sciences
		M.Sc. Biotechnology	B.Sc. in any branch of Life Sciences
		M.Sc. Microbiology	B.Sc. in any branch of Life Sciences
		M.Tech. Biotechnology	B.Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences
		M.Tech. Food Biotechnology	B.Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences
14.	Commerce	M.Com	Candidates who have passed B.Com/BBA degree (General or any Specialization) of this Institution or authority accepted by this Institution as equivalent thereto.

3.3. STRUCTURE OF THE PROGRAMME

3.3.1 The PG programmes consist of the following components as prescribed in the respective curriculum

i. Core courses
ii. Elective courses
iii. Laboratory oriented core courses
iv. Project work / thesis / dissertation
v. Laboratory Courses
vi. Seminars
vii. Mini Project
viii. Industrial Internship
ix. Value Added Courses
x. MOOC Courses (NPTEL, SWAYAM, etc.,)

3.3.2 The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

3.3.3 For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

3.3.4 The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Range of credits
M.Tech.	74 - 80
MCA (3 years)	118 - 126
MCA (Lateral Entry)	80 - 85
MCA (2 years)	85 - 90
M.Sc.	77- 82
M.Com.	88

3.3.5 Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester
- ❖ One credit for one tutorial period per week or 15 periods per semester
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester
- ❖ One credit for four weeks of industrial internship or 160 hours per semester.

3.3.6 The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 28	18 to 26
MCA	12 to 33	12 to 26
M.Sc.	9 to 32	10 to 26

3.3.7 The student may choose a course prescribed in the curriculum

from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

3.3.8 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

3.3.9 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, during the entire period of study, with the approval of the Head of the department offering the course and parent department.

3.4. ONLINE COURSES

3.4.1 Students are permitted to undergo department approved online courses under SWAYAM up to 20% of credits of courses in a semester excluding project semester with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses ratified by the respective Board of Studies shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

3.4.2 Students shall undergo project related online course on their own with the mentoring of the faculty member.

3.5 PROJECT WORK / DISSERTATION

3.5.1 Project work / Dissertation shall be carried out by the student under the supervision of a Faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research Organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization and the student shall be instructed to meet the

faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last Instructional day of the semester in which Project / Dissertation is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work / dissertation and shall re-register in the subsequent semester.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD / Dean of School as Class Advisor for the whole class. He/she is responsible for maintaining the academic, curricular and co-curricular records of all students throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling on the academic programme, the Head of the Department / Dean of School of the students shall attach a certain number of students to a faculty member of the department who shall function as Faculty Advisor for the students throughout their period of study. Such Faculty Advisor shall offer advice to the students on academic and personal matters, and guide the students in taking up courses for registration and enrolment in every semester.

5.0 CLASS COMMITTEE

5.1 A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted in every semester:

5.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the

Head of the Department

ii) Faculty members of all courses of the semester

iii) All the students of the class

iv) Faculty advisor and class advisor

v) Head of the Department – Ex officio member

5.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

5.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabus.

5.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

6.0 COURSE COMMITTEE

6.1 Each common theory / laboratory course offered to more than one group of students shall have a “Course Committee” comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single

department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

7.0 REGISTRATION AND ENROLLMENT

7.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees.

7.2 For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

7.3 A student can withdraw from an enrolled course at any time before the first assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.4 A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

8.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

8.1 A student may be permitted by the Dean (Academic Affairs) to avail temporary break of study from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. A student can avail the break of study before the start of first assessment test of the ongoing semester. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1). If any student is debarred for want of attendance or suspended due to any act of indiscipline, it will not be considered as break of study. A student who has availed break of study has to rejoin in the same semester only in the subsequent year. The student availing break of study is permitted to write arrear examinations by paying the prescribed fees.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / DISSERTATION

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA (3 years)	45
MCA (Lateral Entry)	22
MCA (2 years)	22
M.Sc.	18
M.Com	NA

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 ATTENDANCE

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% (for genuine reasons such as medical grounds, representing for the institution in approved events, etc.) to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded “I” grade in that course. The courses in which the student is awarded “I” grade, shall register and redo the course when it is offered next.

10.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in that course to the Class Advisor. The Class Advisor will consolidate and furnish the list of students who have earned less that 75% attendance, in various courses, to the Dean (Academic Affairs)

through the Head of the Department / Dean of School. Thereupon, the Dean (Academic Affairs) shall announce the names of such students prevented from writing the semester end examination in each course.

10.3 A student who has obtained 'I' grade in all the courses in a semester is not permitted to move to next higher semester. Such student shall redo all the courses of the semester in the subsequent academic year. However he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

10.4 A student shall register to redo a core course wherein "I" or "W" grade is awarded. If the student is awarded, "I" or "W" grade in an elective course either the same elective course may be repeated or a new elective course may be chosen with the approval of Head of the Department / Dean of School.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester in the evening after regular working hours, if such courses are offered by the concerned department. Students may also opt to redo the courses offered during regular semesters, without affecting the regular academic schedule and not exceeding prescribed maximum credits.

11.2 The Head of the Department with the approval of Dean (Academic Affairs) may arrange for the conduct of a few courses in the evening after regular working hours, depending on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

11.3 The number of contact hours and the assessment procedure for any redo course will be the same as those during regular semesters except that there is no provision for any substitute examination and withdrawal from an evening redo course.

12.0 ASSESSMENTS AND EXAMINATIONS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightage of Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Appearing for semester end theory examination for each course is mandatory and a student should secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However a student should have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.3 For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of theory component shall have a total of three assessments with two continuous assessments having 25% weightage each and semester end examination having 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination for the award of pass grade. The evaluation of practical component shall be through continuous assessment.

12.4 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.5 In the case of Industrial training, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship

completion certificate issued by the industry / research organisation. The weightage for Industry internship report shall be 60% and 40% for viva voce examination.

12.6 In the case of project work, a committee of faculty members constituted by the Head of the Department will carry out three periodic reviews. Based on the project report submitted by the student, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the Viva Voce examination.

12.7 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be considered for grading along with the marks scored in the semester end arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination to award grades and the internal assessment marks secured during the course of study shall not be considered.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end arrear examination for theory component. There shall be no arrear or improvement examination for lab component.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the

Department / Dean of School for that purpose. However there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 SUPPLEMENTARY EXAMINATION

14.1 Final Year students can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise students with less credit can also apply for supplementary examination for a maximum of three courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semester.

15. PASSING, DECLARATION OF RESULTS AND GRADE SHEET

15.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	0
I	0

AB	0

"W" denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevented from appearing for semester end examination

"U" denotes unsuccessful performance in the course.

"AB" denotes absence for the semester end examination.

15.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

15.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department / Dean of School and it shall be declared by the Controller of Examinations.

15.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee to the Controller of Examinations. Subsequently the Head of the Department/ Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as convener, the faculty member of the course and a senior faculty member knowledgeable in that course as members. The committee shall meet within a week to re-evaluate the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

15.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I” and "W" grades are excluded for calculating GPA.

"U", “I”, "AB" and **"W"** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks is as follows:

Percentage Equivalent of Marks = CGPA X 10

15.6 After successful completion of the programme, the Degree shall be awarded upon fulfillment of curriculum requirements and classification based on CGPA as follows:

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the minimum prescribed period.
First Class	6.50 and above and completing the programme within a minimum prescribed period plus two semesters.
Second Class	Others

However, to be eligible for First Class with Distinction, a student

should not have obtained 'U' or 'I' grade in any course during his/her period of study and should have completed the P.G. programme within a minimum period (except break of study). To be eligible for First Class, a student should have passed the examination in all the courses within the specified minimum number of semesters reckoned from his/her commencement of study plus two semesters. For this purpose, the authorized break of study is not considered. The students who do not satisfy the above two conditions shall be classified as second class. For the purpose of classification, the CGPA shall be rounded to two decimal places. For the purpose of comparison of performance of students and ranking, CGPA will be considered up to three decimal places.

16.0 DISCIPLINE

16.1 Every student is expected to observe disciplined and decorous behaviour both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

16.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

17.0 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

17.1 A student shall be declared to be eligible for the award of the Masters Degree, if he/she has:

i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the stipulated time.
ii. No disciplinary action is pending against him/her.
iii. Enrolled and completed at least one value added course.
iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

17.2 The award of the degree must have been approved by the Institute.

18.0 POWER TO MODIFY

Not withstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

M.TECH. ARTIFICIAL INTELLIGENCE AND DATA SCIENCE CURRICULUM & SYLLABUS, REGULATIONS 2019

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MAD 6189	Statistical Methods for Data Science	3	1	0	4
2.	EC	CSD 6121	Advanced Data Structures	3	0	0	3
3.	EC	CSD 6122	Artificial Intelligence in Data Mining	3	0	2	4
4.	EC	CSD 6123	Essentials of Artificial Intelligence and Machine Learning	3	0	0	3
5.	EC	CSD 6144	Data Science Foundations using R	3	0	2	4
6.	PE		Professional Elective I	3	0	0	3
			Credits				**21**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	GED 6201	Research Methodology for Engineers	3	1	0	4
2.	EC	CSD 6221	Natural Language Processing	3	0	0	3
3.	EC	CSD 6222	Deep Learning	3	0	2	4
4.	PE		Professional Electives II				9
5.			Value Added Course				--
			Credits				**20**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	EC	CSD 7121	Internship *	0	0	2	1
2.	PE		Professional Electives- III				6
3.	GE		General Elective	3	0	0	3
4.	EC	CSD 7122	Project Work (Phase I) #	0	0	12	6
5.			MOOC Course				--
			Credits				**16**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	EC	CSD 7122	Project Work (Phase II)	0	0	36	18
2.						6 +1 8=	24
			Credits				**24**

Overall Total Credits – 75

* Industrial training will be undertaken during first year summer vacation for 30 days. The credit will be awarded in the 3rd Semester.

\# Credits for Project Work Phase I to be accounted along with Project Work Phase II in IV Semester

LIST OF PROFESSIONAL ELECTIVE COURSES

Electives –Semester I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MADY 01	Linear Algebra	3	0	0	3
2.	PE	CSDY 301	SQL for Data Science	3	0	0	3
3.	PE	CSDY 302	Cloud Computing and Technology	3	0	0	3
4.	PE	CSDY 303	Exploratory Data Analytics	3	0	0	3
5.	PE	CSDY 351	Business Intelligence	3	0	0	3

Electives - Semester II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	CSDY 304	Intelligent Information Retrieval	3	0	0	3
2.	PE	CSDY 305	Data Science and Data Analytics	3	0	0	3
3.	PE	CSDY 306	Soft Computing Techniques	3	0	0	3
4.	PE	CSDY 307	Artificial Neural Networks	3	0	0	3
5.	PE	CSDY 308	Knowledge Engineering and Expert Systems	3	0	0	3
6.	PE	CSDY 309	Scripting languages	3	0	0	3
7.	PE	CSDY 310	Distributed, Parallel and Spatial Databases	3	0	0	3
8.	PE	CSDY 311	Data Visualization	3	0	0	3
9.	BS	CSDY 353	Optimization methods for Analytics	3	0	0	3
10.	PE	CSDY 354	Knowledge Representation and Reasoning	3	0	0	3
11.	PE	CSDY 355	Data Science with Bio Informatics	3	0	0	3
12.	PE	CSDY 359	Web Analytics	3	0	0	3

Electives – Semester III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	CSDY 312	Pattern Recognition for Machine Learning	3	0	0	3
2.	PE	CSDY 313	Advanced Machine Learning	3	0	0	3
3.	PE	CSDY 314	Risks and Decision Making for Data Science and Artificial Intelligence	3	0	0	3
4.	PE	CSDY 315	Robotics and Intelligent Systems	3	0	0	3
5.	PE	CSDY 316	Computer Vision using Machine Learning	3	0	0	3
6.	PE	CSDY 317	Artificial Intelligence for Medicine	3	0	0	3
7.	PE	CSDY 362	Ethics for Data Science	3	0	0	3
8.	PE	CSDY 363	Social Network Analysis and Mining	3	0	0	3

GENERAL ELECTIVE

Sl. No.	Course Code	Course Title	L	T	P	C
1.	GEDY 101	Project Management	3	0	0	3
2.	GEDY 102	Society, Technology and Sustainability	3	0	0	3
3.	GEDY 103	Artificial Intelligence	3	0	0	3
4.	GEDY 104	Green Computing	3	0	0	3
5.	GEDY 105	Gaming Design	3	0	0	3
6.	GEDY 106	Social Computing	3	0	0	3
7.	GEDY 107	Soft Computing	3	0	0	3
8.	GEDY 108	Embedded System Programming	3	0	0	3
9.	GEDY 109	Principles of Sustainable Development	3	0	0	3
10.	GEDY 110	Quantitative Techniques in Management	3	0	0	3
11.	GEDY 111	Programming using MATLAB and SIMULINK	1	0	2	2
12.	GEDY 112	JAVA Programming	3	0	0	3
13.	GEDY 113	PYTHON Programming	3	0	0	3
14.	GEDY 114	Intellectual Property Rights	1	0	0	1
15.	GEDY 115	Research and Publication Ethics	2	0	0	2
16.	GEDY 116	IPR and Entrepreneurship	3	0	0	3
17.	GEDY 117	Nanotechnology in Food Applications	3	0	0	3

SEMESTER I

MAD 6189	STATISTICAL METHODS FOR DATA SCIENCE	L	T	P	C
		3	1	0	4

SDG: 9

COURSE OBJECTIVES:

COB1: To introduce regression techniques to evaluate the relationship between dependent and independent variables

COB2: To learn how to draw repeated samples from the original data samples

COB3: To evaluate the estimation of coefficients by linear combinations

COB4: To model data as a function which is a nonlinear combination of the model parameters

COB5: To apply tree based methods that can be used for both regression and classification of data

MODULE I **REGRESSION** **9+3**

Simple linear Regression-Multiple linear regression- Logistic regression-Discriminant Analysis.

MODULE II **RESAMPLING METHODS** **9+3**

Bootstrapping- Cross validation - Subset selection – Forward, Backward, Stepwise and Best.

MODULE III **DIMENSION REDUCTION** **9+3**

Ridge Regression, Principal Components Regression – Partial Least squares.

MODULE IV **NONLINEAR METHODS** **9+3**

Step function – Piecewise function – Splines – Generalized Additive Model.

MODULE V **TREE BASED METHODS** **9+3**

Bagging – Boosting - Random Forests - Support Vector Machines – Unsupervised learning – Principal component Analysis- k- means clustering – Hierarcical clustering.

L – 45; T-15; Total Hours – 60

TEXT BOOKS:

1. James D. Miller, “Statistics for data science” , Packt Publ. Ltd. Mumbaie . 2017
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2012.

REFERENCES:

1. Walpole R.E, K.E.Ye and R.H. Myers, “Probability and Statistics for Engineers and Scientists”, 9th Edition ,Pearson 2016
2. Peter Bruce, “ Practical Statistics for Data Scientists”, 2017
3. Vincent Granville, “Statistics- Toolbox, New Foundations

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: Classify a recorded phenome based on a log - periodogram

CO2: Customize an email spam detection system

CO3: Identify the numbers in a handwritten zipcode

CO4: Classify a tissue sample into one of several cancer classes

CO5: Establish the relationship between salary and demographic variables in population survey area

Board of Studies (BoS):	**Academic Council:**
12th BOS of Mathematics & AS held on 23.06.2021	17th AC held on 15.07.2021

SDG 9 : Sustainable Industry, innovation and Infrastructure

Learning of various techniques in Graph theory and Combinatorics will lead to knowledge required for applying in Computer Science projects.

CSD 6121 **ADVANCED DATA STRUCTURES** **L T P C**

3 0 0 3

SDG: 4

COURSE OBJECTIVES:

COB1: To understand the different mathematical abstractions and recurrences to solve problems

COB2: To become acquainted with different types of sorting and their complexity.

COB3: To familiarize with advanced data structures such as hash tables, BTrees, disjoint set union

COB4: To acquire knowledge on the various hierarchical data structures.

COB5: To understand graph algorithms such as shortest path, minimum spanning tree.

MODULE I ASYMPTOTIC NOTATIONS AND RECURRENCES 9

Growth of functions – Asymptotic notations - Mathematical Induction - Solving Recurrences – Substitution Method – Recursion Tree Method – Master Method - Probabilistic Analysis and Randomized algorithms.

MODULE II SORTING 9

Heaps – Heap sort Algorithm – Quick Sort –Randomized version of Quick sort – Sorting in linear time – Radix Sort – Bucket Sort – Topological Sorting – Medians.

MODULE III HIERARCHICAL DATA STRUCTURES 9

Hash tables – Hash functions- B-trees-Fibonacci Heaps- Red Black Trees – AVL trees – Splay Trees-Data Structures for Disjoint sets.

MODULE IV GRAPH ALGORITHMS 9

Representation of Graphs-Breadth First Search – Depth First Search – Minimum Spanning Trees – Single Source Shortest Paths – Maximum Flow – Ford-Fulkerson, Edmonds-Karp algorithm - Maximum Bipartite Matching-Pattern Matching Algorithms.

MODULE V ALGORITHMIC TECHNIQUES 9

Divide and Conquer -Dynamic Programming – Optimal Binary Search Trees – Greedy Algorithms – Huffman Codes – Amortized Analysis – NP completeness - Approximation Algorithms.

L – 45; Total Hours – 45

TEXT BOOKS :

1. Thomas H Cormen, Charles.E.Leiserson, Ronald L.Rivest, and Clifford.Stein, Introduction to Algorithms", Third Edition MIT Press, ISBN: 978-0262033848, 2009.
2. Robert Sedgewick, Kevin Wayne, "Algorithms", Fourth Edition, Addison Wesley, ISBN-13: 978-0321573513, 2011.

REFERENCES :

1. Alfred V Aho, John E Hopcrof," The Design and Analysis of Computer Algorithms", Pearson Education, Fourth Edition ISBN: 978813170205, 2009.
2. Mark Allen Weiss," Data Structures and Algorithm Analysis in C++", Addison-Wesley, Third edition, ISBN: 978-0132847377, 2013.

COURSE OUTCOMES:

CO1: Analyze the time complexity and performance of different algorithms.

CO2: Compare and contrast the different sorting algorithms based on time complexity

CO3: Select suitable data structures and algorithms, and use it to design algorithms for a specific problem.

CO4: Comprehend and analyze the different graph algorithms and apply graphs to model engineering problems.

CO5: Apply suitable algorithm design techniques to solve real world problems.

Board of Studies (BoS) :
18th BoS of CSE held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	M			H
CO2		L		H
CO3	H			M
CO4			H	
CO5	H			

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement:

A lot of real-world complex problems persist and Data Structures help in understanding the nature of the problems at a deeper level. By observing the problems in depth it helps to come up with a feasible solution thereby providing way for life long learning opportunities for everyone.

CSD 6122	ARTIFICIAL INTELLIGENCE IN DATA MINING	L	T	P	C
SDG: 1,3		3	0	2	4

COURSE OBJECTIVES:

COB1: To explore the use of Association rules and Pattern mining.

COB2: To lay the foundation of data mining in Artificial Intelligence and study the impact of it.

COB3: To study about the concepts and methods of clustering and classification techniques.

COB4: To explore the use of decision tree in the perspective of Artificial Intelligence.

COB5: To provide a comprehensive introduction to data mining theories, relevant Artificial Intelligence techniques, and their many real-world applications.

MODULE I DATA MINING - INTRODUCTION 9

Mining different Data and Pattern types - Data Objects and Attribute types - Intelligence Methods for Data Mining tasks – Data Preprocessing – Data Visualization.

MODULE II ASSOCIATION RULES AND PATTERN MINING 9

Rule based Mining – Apriori Algorithm- Frequent Item set – Pattern Evaluation – Pattern Mining in multidimensional and Multi level databases – Constraint based Mining- Compressed Patterns.

MODULE III CLUSTERING AND CLASSIFICATION 9

Introduction to Clustering – Clustering Techniques – K Means – Unsupervised Learning Methods- Heuristic Methods - Rule based Classifiers -Deep Learning Methods and Neural Networks for Data Classification.

MODULE IV DECISION TREES 9

Introduction – Entropy and Decision Trees – Regression tree- Evaluation-Splitting Criteria- Pruning Trees-Decision Forests – Incremental Learning.

MODULE V APPLICATION OF ARTIFICIAL INTELLIGENCE IN PERSPECTIVE OF DATA MINING 9

Biomedical Data Mining – Satellite Data – Agriculture - Defense – Security – Health care – Industry Sector.

PRACTICALS

List of Experiments

1. Perform the basic pre-processing operations on data relation such as removing an attribute and filter attribute bank data.
2. Generate association rule for the credit card promotion dataset using a priory algorithm with the support range 40% to 100% confidence as 10% incremental decrease as 5% and generate 6 rules
3. To predict, calculate and interpret the output using K Nearest Neighbor in classification and regression
4. To Demonstrate Clustering features in Large Databases with noise
5. Demonstrate performing classification on data sets
6. Learn to perform data mining tasks using a data mining toolkit (such as open source WEKA).
7. Learn to work using real time data sets
8. Explore visualization features of the tool for analysis like identifying trends etc.
9. Navigate the options available in the WEKA(ex. select attributes panel, preprocess panel, classify panel, cluster panel, associate panel and visualize)
10. Train a Decision tree using the complete data set as the training data. Report the model obtained after training.

L 45; P 30; Total Hours – 75

TEXT BOOKS:

1. D. Binu B.R. Rajakumar, “Artificial Intelligence in Data Mining”, 1st Edition, Elsevier Publication, 2021. ISBN**:** 9780128206010
2. Lior Rokach, Oded Maimon, “Data Mining with Decision Trees- Theory and Applications”, 2nd Edition, World Scientific Publications, 2014. ISBN:9789814590075

REFERENCES:

1. Jiawei Han, Micheline Kamber and Jian Pei, “Data Mining – Concepts and Techniques”, 3rd Edition, Elsevier Publications, 2012. ISBN: 9780123814791.

COURSE OUTCOMES:

CO1: Examine the various methods of association rules and pattern mining.

CO2: Analyze the clustering and classification techniques in data mining.

CO3: Identify the use of decision trees in Artificial Intelligence

CO4: Review the different applications of data mining with respect to Artificial Intelligence

CO5: Explore the use of different data mining methods in predictive techniques.

Board of Studies (BoS) :
18th BoS of CSE held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1		M		
CO2	L		M	
CO3				H
CO4			H	
CO5				H

SDG 1: Agriculture
SDG 3 : Health
Statement:
Artificial intelligence along with data mining can help in detecting diseases in plants and also target weeds. Farmers are now using AI forecasting models to predict upcoming weather patterns, thus enabling them to make better decisions.
Artificial Intelligence has the ability to collect and process this data for faster treatment in health sector. Coming up with technologies to check whether the person is cancerous or not, to estimate the probability of a person to develop cancer, to name a few are taking shape because of AI. India is marching towards an AI driven economy with every passing day.

CSD 6123	ESSENTIALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

SDG: 3,4

COURSE OBJECTIVES:

COB1: To provide a strong foundation of fundamental concepts in Artificial Intelligence

COB2: To provide a basic exposition to the goals and methods of Artificial Intelligence

COB3: To enable the student to apply these techniques in applications which involve perception, reasoning and learning

COB4: To provide knowledge on supervised and unsupervised learning.

COB5: To familiarize the students with basic learning algorithms and techniques and their applications.

MODULE I FOUNDATIONS OF ARTIFICIAL INTELLIGENCE 7

The Foundations of Artificial Intelligence - History of Artificial Intelligence - Risks and Benefits of Artificial Intelligence – Intelligent Agents - Problem-Solving Agents - Informed Search Strategies - Heuristic Functions.

MODULE II PROBLEM SOLVING 10

Game Theory - Two-player zero-sum games - Optimal Decisions in Games - Heuristic Alpha--Beta Tree Search - Monte Carlo Tree Search - Stochastic Games - Partially Observable Games - Limitations of Game Search Algorithms - Constraint Satisfaction Problems - Defining Constraint Satisfaction Problems - Constraint Propagation: Inference in CSPs - Backtracking Search for CSPs -Local Search for CSPs - The Structure of Problems.

MODULE III KNOWLEDGE AND REASONING 10

Knowledge Representation – Uncertain Knowledge and Reasoning - Acting under Uncertainity - Bayes' Rule and Its Use - Naive Bayes Models - Probabilistic Reasoning - Representing Knowledge in an Uncertain Domain - The Semantics of Bayesian Networks.

MODULE IV LEARNING FROM EXAMPLES 10

Forms of Learning - Supervised Learning - Learning Decision Trees - Model Selection and Optimization - The Theory of Learning - Linear Regression and Classification – Nonparametric - Ensemble Learning - Developing Machine

Learning Systems.

MODULE V LEARNING PROBABILISTIC MODELS 8

Statistical Learning - Learning with Complete Data - Learning with Hidden Variables: The EM Algorithm – Introduction to Deep and Reinforcement Learning.

L – 45 ; Total Hours – 45

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson, Fourth Edition, ISBN 978-0134610993, 2020.
2. Yaser S. Abu-Mostafa, Malik Magdon-Ismail l, Hsuan-Tien Lin, “Learning From Data”, AMLBook, ISBN-13: 978-1600490064, 2012.

REFERENCES:

1. Andriy Burkov, “Machine Learning Engineering”, True Positive Inc, ISBN 978-1777005467, 2020.

COURSE OUTCOMES

CO1: Describe the concept of knowledge representation and predicate logic and transform the real-life information.

CO2: Illustrate state space and its searching strategies.

CO3: Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.

CO4: Recognise machine learning concepts and range of problems that can be handled by machine learning

CO5: Analyze a real-world problem and understand the dynamic behavior of a system.

Board of Studies (BoS) : 18th BoS of CSE held on 26.06.2021

Academic Council: 17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	H			M
CO2	M	L		
CO3		M	H	H
CO4	M		H	H
CO5	H		H	H

SDG 3 : Good Health

The knowledge gained will help in good contribution towards healthcare, and can be applied in the analysis of historical data to prevent premature mortality, epidemics, Accidents, Maternal mortality rate and many more.

SDG 4: Quality Education

The students will play a key role in driving technological and societal progress through research, discovery, knowledge creation and dissemination. They educate and equip young people with the knowledge, acquired by building various models.

CSD 6144	DATA SCIENCE FOUNDATIONS USING R	L	T	P	C
		3	0	2	4

SDG: 8

COURSE OBJECTIVES:

COB1: To learn the basics of Data science.

COB2: To understand various the classification techniques

COB3: To provide knowledge on different Regression methods

COB4: To understand the clustering techniques used in data science

COB5: To learn the various data science functionalities in R language

MODULE I INTRODUCTION 9

Introduction - Artificial Intelligence , Machine Learning And Data Science, Case For Data Science, Data Science Classification, Data Science Algorithms – Data Science Process- Data Preparation, Modeling, Application, Knowledge - Data Exploration- Objectives Of Data Exploration, Datasets, Descriptive Statistics, Data Visualization.

MODULE II CLASSIFICATION 9

Classification - Decision Trees, Rule Induction, K-Nearest Neighbors, Naïve Bayesian, Artificial Neural Networks, Support Vector Machines, Ensemble Learners.

MODULE III REGRESSION METHODS & ASSOCIATION ANALYSIS 9

Regression Methods - Linear Regression, Logistic Regression, Association Analysis - Mining Association Rules, Apriori Algorithm, Frequent Pattern-Growth Algorithm.

MODULE IV CLUSTERING 9

Clustering - Types Of Clustering Techniques - K-Means Clustering, Dbscan Clustering, Self-Organizing Maps, Model Evaluation - Confusion Matrix, Roc And Auc, Lift Curves.

MODULE V DATA SCIENCE USING R 9

Data Visualization with ggplot2 - Introduction, Aesthetic mappings, Common Problems, Facets, Geometric Objects, Statistical Transformation, Position Adjustments, Coordinate Systems. Data Transformation with dplyr – Filter rows with filter(), arrange(), select(), mutate(), summarize(), Grouped mutates. Exploratory Data Analysis – Questions, Variation, Missing Values, Covariation,

patterns and models, ggplot2 calls.

PRACTICALS

List of Experiments

1. Write an R script to find basic statistics using summary, str, quartile function on cars datasets.
2. Write an R script to find subset of dataset by using subset (), aggregate () functions on iris dataset
3. a. Write a program for Reading Excel data sheet in R.
   b. Write a program for Reading XML dataset in R.
   c. Write a program for Reading SQL Data in R.
   d. Write a program for Reading NoSQL data in R.
4. Write a R script to find the data distributions using box and scatter plot.
5. Write a R script to find the outliers using plot.
6. Write a R script to plot the histogram, bar chart and pie chart on sample data.
7. Write a R script to find Correlation and Covariance
   a. Find the correlation matrix.
   b. Plot the correlation plot on dataset and visualize giving an overview of relationships among data on iris data.
   c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.
8. Write a Classification process in R.
   a. Install relevant package for classification.
   b. Choose classifier for classification problem.
   c. Evaluate the performance of classifier.
9. Write a Clustering process in R.
   a. Clustering algorithms for unsupervised classification.
   b. Plot the cluster data using R visualizations.

L - 45; P - 30; Total Hours - 75

TEXT BOOKS:

1. Avrim Blum, John Hopcroft, and Ravindran Kannan, “Foundations of Data Science”, Cambridge University Press, 2020, ISBN:9781108485067, 1108485065
2. Hadley Wickham, Garrett Grolemund , “R for Data Science Import, Tidy, Transform, Visualize, and Model Data”, O'Reilly Media, 2017, ISBN:9781491910368, 1491910364

REFERENCES:

1. Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publications, 2019, ISBN:9781617295874, 1617295876.

COURSE OUTCOMES:

CO1: Explain the basics of data science.

CO2: Examine the various classification techniques.

CO3: Identify various regression models

CO4: Use appropriate clustering techniques on data

CO5: Implement data science concepts in R.

Board of Studies (BoS) :
18thBoS of CSE held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	M	L		
CO2	M		H	M
CO3	M	L	H	M
CO4	M		H	M
CO5	M	L	H	H

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: By learning “Data Science Foundations using R”, the students are able to develop and evaluate ideas for sustanability-driven innovation and entrepreneurship.

SEMESTER II

GED 6201	RESEARCH METHODOLOGY FOR ENGINEERS	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To provide a perspective on research to the scholars
- To educate on the research conceptions for designing the research
- To impart knowledge on statistical techniques for hypothesis construction
- To gain knowledge on methods of data analysis and interpretation
- To learn about the effective communication of research finding

MODULE I RESEARCH PROBLEM FORMULATION 12

The research problem – Sources of research problem – Information, how to deal with it – Criteria / characteristics of a good research problem – Errors in selecting a good research problem – Types of research – Nature and use of arguments.

MODULE II HYPOTHESIS FORMULATION 12

Research design – meaning and need – basic concepts, Different research designs, experimental design – principle – important experimental designs, Design of experimental setup, mathematical modeling, simulation – validation and experimentation, dimensional analysis andsimilitude.

MODULE III STATISTICAL TECHNIQUES 12

Statistics in research – concept of probability – popular distributions –hypothesis testing- sample design- design of experiments – factorial designs -– orthogonal arrays- ANOM - ANOVA - Multivariate analysis - use of optimization techniques – traditional methods – evolutionary optimization techniques –transportation model

MODULE IV STATISTICAL ANALYSIS OF DATA 12

Research Data analysis – interpretation of results – correlation with scientific facts- Accuracy and precision – error analysis, limitations - Curve fitting, Correlation and regression.

MODULE V RESEARCH REPORT 12

Purpose of written report – audience, synopsis writing, preparing papers for International journals, thesis writing – organization of contents – style of writing – graphs and charts – referencing, oral presentation and defense, ethics in research, Patenting, Intellectual Property Rights.

L - 60; Total Hours - 60

REFERENCES:

1. Ganesan R., Research Methodology for Engineers, MJP Publishers, Chennai, 2011.
2. George E. Dieter., Engineering Design, McGraw Hill – International edition, 2000.
3. Kothari C.R., Research Methodology – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2003.
4. Holeman, J.P., Experimental methods for Engineers, Tata McGraw Hill PublishingCo., Ltd., New Delhi, 2007.
5. Govt. of India, Intellectual Property Laws; Acts, Rules & Regulations, UniversalLaw Publishing Co. Pvt. Ltd., New Delhi, 2010.

OUTCOMES:

At the end of the course, the student will be able to

- Identify the research problem.
- Analyze the data using mathematical techniques.
- Apply the statistical concepts inresearch.
- Demonstrate the different research methods applicable to a specificproblem.
- Prepare the papers for theJournals

CSD 6221	NATURAL LANGUAGE PROCESSING	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on syntax and semantics in Natural Language Processing (NLP)

COB2: To learn about existing linguistic resources.

COB3: To explore various statistical approaches and language models for NLP.

COB4: To learn the semantics to understand the meanings.

COB5: To recognize the significance of pragmatics for natural language processing.

MODULE I INTRODUCTION 9

NLP Phases–Ambiguity and Uncertainty in Natural Language – Environments - Knowledge based agent-Real-World Knowledge Representation - Knowledge representation Techniques.

MODULE II LINGUISTIC RESOURCES 9

Introduction to Corpus–Corpus Representativeness – TreeBank Corpus – PropBank Corpus–VerbNet(VN) -WordNet-Managing linguistic data with NLP tools.

MODULE III LANGUAGE MODELING 9

Statistical language Model– N-Gram Model-Hidden Markov Models (HMM)-Neural language model-Evaluating Language Models-evolution of language models.

MODULE IV SEMANTIC ANALYSIS 9

Representation of Meaning –Lexical Semantic – Word Sense Disambiguation – Supervised and Unsupervised analysis – Semantic Role Labeling – Discourse Analysis.

MODULE V APPLICATION OF NLP 9

Named Entity Recognition – Relation Extraction – Information retrieval–Text categorization –Clustering – Speech Recognition – Machine Translation-Case Study.

L - 45; Total Hours - 75

TEXT BOOKS:

1. Imed Zitouni, “Natural language processing of semantic language“, Springer, ISBN :97836424535588, 2014.
2. Nitin Indurkhya, Fred J. Damerau, “Handbook of Natural Language Processing”, 2nd Edition”, CRC Press, ISBN: 9781420085921,2010.

REFERENCES:

1. Dipanjan Sarkar, "Text Analytics with Python: A Practitioner's Guide to Natural Language Processing“, Apress, ISBN-9781484243541,2019.
2. Daniel Jurafsky and James H.Martin, “Speech and Language Processing”,2nd Edition, Prentice Hall, ISBN: 100131873210, 2009.

COURSE OUTCOMES:

CO1: Identify the different linguistics components in a given sentence.

CO2: Design a tagger application specific to semantics.

CO3: Implement a parser by providing suitable grammar and words.

CO4: Employ the statistical machine translation techniques.

CO5: Analyze the various applications of language processing.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1				H			M					H		H
CO2	H			H			M					H		
CO3			H				L						H	H
CO4	H		H				M							H
CO5				H			M					H	H	H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement:

By learning “Natural Language Processing”, the students will be able to design and develop various applications using methods for language translation into machine language and hence develop the economics sustainable and enormous employment opportunities.

CSD 6222	DEEP LEARNING	L	T	P	C
SDG: 9		3	0	2	4

COURSE OBJECTIVES:

COB1: To gain knowledge on perceptron, multi-layer perceptron

COB2: To learn how to construct a neural network

COB3: To implement, optimize and tune state of the art deep neural network architectures.

COB4: To study the architecture and mathematical details of CNN

COB5: To understand the RNN and the variants of LSTM, BPTT and NTM

MODULE I INTRODUCTION 9

Deep Learning – Perceptron and Multi-layer Perceptron – Hebbian Learning – Neural net as an Approximator – Training a Neural Network – Perceptron learning rule – Gradient-based Learning – Sigmoid output units – Back Propagation – Calculus of Back Propagation.

MODULE II REGULARIZATION FOR DEEP LEARNING 9

Regularization – Regularization strategies – Noise injection – Ensemble methods – Dropout.

MODULE III OPTIMIZATION FOR TRAINING DEEP MODELS 9

Optimization by gradient descent – optimization algorithms:Hessian-Free, Newton – momentum – Batch Normalization.

MODULE IV CONVOLUTIONAL NEURAL NETWORKS 9

Weights as Templates – Translation Invariance – Training with shared parameters – Arriving at the convolutional model – Mathematical details of CNN – Alexnet – Inception – VGG – Transfer Learning.

MODULE V RECURRENT NEURAL NETWORKS 9

Recurrence relationship & recurrent networks - Long short-term memory (LSTM) -Back propagation through time (BPTT)- Gated and simple recurrent units - Neural Turing machine (NTM) - Deep Learning Models for Healthcare Applications, Enterprise-Scale Applications.

PRACTICALS

List of Experiments:

1. For a binary classification task, use Python to implement a shallow network.

2. Make the network of Ex1 and compare the two networks' performance in various ways.
3. To classify the Cifar10 dataset, create a fully connected deep network.
4. Analyze the convergence of Ex3 network and come up with ways to speed it up using the various strategies you've learned about.
5. Analyze the overfittingness of the Ex3 network and make improvements using the regularisation methods you learned about.
6. To classify Cifar10 data, create a CNN using basic python and numpy.7. 7.
7. Go through internet tutorials to learn how to use Pytorch / Tensorflow.
8. Implement the Ex 7 network in Tensorflow/Pytorch.9.9
9. Train an RNN language model to predict words and characters at the word and character levels.
10. Use of deep learning techniques for solving image related problems.
11. Compare and evaluate the different deep learning models.

L – 45; P – 30; TOTAL HOURS –75

TEXT BOOKS:

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press, ISBN No. 0262035618,2017.

REFERENCES:

1. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2016
2. Seth Weidman, Deep Learning From Scratch: Building with Python from First Principles,O`Reilley, ISBN-10 935213902X, 2019.

COURSE OUTCOMES

CO1: Identify the deep learning algorithms for various types of learning tasks in various domains.

CO2: Implement various optimization algorithms for training deep models

CO3: Analyze the various regularization strategies and ensemble methods

CO4: Design and implement simple projects using Convolutional Neural Network

CO5: Provide solutions for solving simple real time problems using Recurrent Neural Network

Board of Studies (BoS): 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	H				H			L						
CO2		H	M						M			H	H	M
CO3											L			

CO4	M			M		M			M		M	M	M	H
CO5	M			M		H	M		M		H	M	M	H

Note: L - Low Correlation M - Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Design and develop the various industrial projects using Convolutional Neural Network and Recurrent Neural Network

VALUE ADDED COURSE	L	T	P	C
	0	0	0	0

OBJECTIVES:

- To expose the latest technology / tools used in the industry and enable the students acquire knowledge and skill set in the same.

GENERAL GUIDELINES:

- Students should undergo any relevant certification course offered by the institution or other institutions / universities / IIT / IISc etc. for a minimum of 40 hours.
- Selection and completion of value added course by the students shall be endorsed by Head of the Department.

OUTCOMES:

- Students should be exposed and gained knowledge in any one latest technology used in the industry

MOOC COURSE	L	T	P	C
	0	0	0	0

OBJECTIVES:

- To learn the basics principles and concepts of the topic in which a project work is undertaken by the student.

GENERAL GUIDELINES:

- Students shall identify a MOOC course related to his/her project topic in consultation with the project supervisor.
- Student shall register for a MOOC course with minimum two credit offered by any recognized organization during the project phase I.
- Selection and completion of MOOC course by the students shall be endorsed by Head of the Department.

OUTCOMES:

Students will be able to

- Familiarize the basic principles and concepts related to the topic of his/her project work.
- Utilize the knowledge gained in the field of study to perform literature review with ease.
- Formulate the experimental / analytical methodology required for the project work

PROFESSIONAL ELECTIVE I

MADY 01	LINEAR ALGEBRA	L	T	P	C
		3	0	0	3

SDG: 4

COURSE OBJECTIVES:

COB1: Introduce the methods for analysis and implementation of algorithms to solve linear algebra problems in practice

COB2: Understand properties of matrices

COB3: Use matrices for solving linear system of equations

COB4: Find the matrix limits and Markov chains

COB5: Learn linear transformation between vector spaces

MODULE I VECTOR SPACES 9

Vector spaces – Subspaces – Linear combinations and system of linear equations – Linear dependence and independence – Bases and dimension - Maximal linear independent subsets.

MODULE II LINEAR TRANSFORMATIONS AND MATRICES 9

Linear Transformations, Null spaces and Ranges – The Matrix representation of a linear transformation - Composition of Linear transformations and Matrix multiplication - Invertibility and Isomorphisms – the change of coordinate matrix – Dual spaces – Homogeneous linear differential equations.

MODULE III MATRIX OPERATIONS 9

Elementary matrix operations – Rank of a matrix and matrix inverses - System of linear equations: theoretical and computational aspects – Determinants

MODULE IV DIAGONALIZATION 9

Eigenvalues and eigenvectors – Diagonalizability - Matrix limits and Markov chains - Invariant subspaces and Cayley Hamilton theorem.

MODULE V INNER PRODUCT SPACES 9

Inner products and Norms – The Gram – Schmidt orthogonalization process and orthogonal complements – The Adjoint of a linear operator – Normal and Self-Adjoint operators – Unitary and Orthogonal operators and their matrices - Orthogonal projections and the Spectral theorem.

L - 45; Total Hours – 45

TEXT BOOKS:

1. S.H. Friedberg, A.J. Insel, and L.E. Spence, “Linear Algebra”,4th Edition,Pearson 2017
2. G.Strang, “Linear Algebra and its Applications”, 5th Edition, Wellesley Cambridge Press, Wellesley, 2016
3. K. Hoffman and R. Kunze,”Linear Algebra”, Prentice Hall Ltd, New Jersey,2008.

REFERENCES:

1. David C Lay, “Linear Algebra and its Applications”, 5th Edition , Pearson 2010
2. H.Anton, “ Elementary Linear Algebra with Applications”, 9th Edition, John Wiley 2004
3. S.Roman, “Advanced Linear Algebra”, Springer, 2002

COURSE OUTCOMES: At the end of the course students will be able to

CO1: investigate properties of vector spaces and subspaces using linear transformations

CO2: Analyze the solution set of a system of linear equations.

CO3: Perform elementary row operations for the matrices and systems of linear equations

CO4: Determine whether a linear transformation is diagonalizable or not.

CO5: Find the Gram- Schmidt orthogonalization of a matrix

Board of Studies (BoS):
12th BOS of Mathematics & AS held on 23.06.2021

Academic Council:
17th AC held on 15.07.2021

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all

Learning of various techniques in Linear Algebra will be useful for applications in Data Science and Computing

CSDY 301	SQL FOR DATA SCIENCE	L	T	P	C
SDG: 2		3	0	0	3

COURSE OBJECTIVES:

COB1: Learn structured query language (SQL) to an intermediate/advanced level.

COB2: Be able to write data retrieval queries and evaluate the result set.

COB3: Understand the structure and design of relational databases.

COB4: Understand the importance and major issues of database security and the maintenance of data integrity.

COB5: Provide expertise to plan, organize, direct and lead full-scale data analytics projects and business ventures.

MODULE I UNDERSTANDING AND DESCRIBING DATA 9

Introduction – Methods of descriptive statics - Reletional database and SQL– Basic types of SQL – Creating table- Updating table–Deleting data and tables–SQL and analytics.

MODULE II SQL FOR DATA PREPARATION 9

Assembling Data – Connecting tables using join – Types of join – Sub Queries – Unions – Transforming data.

MODULE III AGGREGATE FUNCTIONS AND DATA ANALYSIS 9

Aggregate function – Aggregate functions with group by – The HAVING Clause – Windows Functon – Statistics with window function – Importing and Exporting data.

MODULE IV ANALYTICS USING COMLEX DATA TYPES 9

Date and time data types for analysis– Performing geospatialanalysis in postgres- Using array data Types in postgres – Using JSON data Types in postgres – Test analytics in post.

MODULE V DATA WRANGLING 9

Reshaping Data – Joining Tables – Web scarping- String processing – string package –Testing and improving –Casestudy.

L – 45; Total Hours – 45

TEXT BOOKS:

1. Upom Malik, Matt GoldwasseandBenjamin Johnston, ”SQL for Data

Analytics :Perform Fast and Efficient Data Analysis with the Power of SQL", Packet Publishing,1st Edition Mumbai,2019.(ISBN: 9781789803846)

2. Cathy tanimura,"SQL for Data Analysis: overview of SQL",O Really Media publisher, 5th Edition,US,2021.(ISBN: 9781492088783)

REFERENCES:

1. Rafael. Airizarry., "Introduction to Datascience: Data Analysis and prediction algorithm with R", CRCP press Publisher, US , 2019 .(ISBN :9780429341830)

COURSE OUTCOMES:

CO1: Identify the knowledge and understanding of Database analysis and design.

CO2: Develop programming and software Engineering Skills and techniques using SQL and PL/SQl.

CO3: Design and develop a SQL Data Environment according to the benchmarks

CO4: Analyze the data using various statistical methods.

CO5: Develop applications using large scale analytics tools to solve open data analytics problems

Board of Studies (BoS) :
18thBoS of CSE held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	L			
CO2				
CO3			L	
CO4	M			
CO5				H

SDG 2: Zero Hunger.

Statement: This SDG with data science is MEANS which uses a system of emails, text and cloud-based data crunching to match right food to the right needy people.

(Ex.: The problem that MEANS is attempting to solve is the mismatch of food between what food kitchens and charities need and what is being given to them)

CSDY 302	CLOUD COMPUTING AND TECHNOLOGY	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the concepts of Cloud Computing and its Evolution

COB2: To provide the knowledge on various virtualization concepts

COB3: To explore the different types of Cloud computing models

COB4: To understand the concepts of capacity planning and Resource management.

COB5: To provide the cloud security concepts&development tools in cloud computing

MODULE I INTRODUCTION **9**

Introduction – Cloud Computing, Service delivery models, Deployment Models- Characteristics and Benefits of Cloud computing, Cloud computing platforms and technologies – Distributed and Parallel Computing – Distributed computing and its properties, Performance consideration in distributed Computing, Parallel Computing, performance consideration in parallel computing, Amdahl's law, Flynn's classical taxonomy, Classes of parallel computers – Multi core Architecture - Multi cores in cloud computing, Classes of parallelism, Limitations.

MODULE II VIRTUALIZATION **9**

Virtualization – Defining virtualization, Virtualization models, Server virtualization models, Desktop virtualization, Application virtualization- Hardware Maximization – Move to 64 bit, Rely on shared storage, Architectures, Manage virtualization.

MODULE III CLOUD COMPUTING MODELS **9**

Infra structure-as-a-Service(IaaS)-IaaS in cloud, Benefits, Management of VMs in IaaS, IaaS Providers, Key to successfully moving to IaaS, Challenges of Iaas – SaaS and PaaS in cloud – Characteristics, implementation, advantages and disadvantages of SaaS, Characteristics, implementation, advantages and disadvantages of PaaS.

MODULE IV CAPACITY PLANNING, SLA MANAGEMENT AND RESOURCE MANAGEMENT **9**

Cloud capacity models, probabilistic auto-scaling for capacity planning – SLA

Management – Components of SLA, Life Cycle of SLA, SLA Management system in Cloud – Resource Management in Cloud – Significant resources, Issues and Solutions.

MODULE V CLOUD COMPUTING SECURITY & DEVELOPMENT TOOLS **9**

Cloud security – Data Security, Encryption techniques in Cloud, Infra Structure security, PaaS Application security, SaaS Application security, Securing virtual servers, Cloud Security controls - Cloud computing Development - Kernel Virtual Machine, Delta Cloud, Eucalyptus, OpenStack, SaltStack, ApacheCloudStack, AWS Cloud Development Kit(AWS CDK), Windows Azure SDK.

L- 45; Total Hours - 45

TEXT BOOKS:

1. SunilkumarManvi, Gopal Shyam, “Cloud Computing Concepts and Technologies”, First Edition, CRC Press, SBN: 9781000337952, 1000337952, 2021.
2. Dac-Nhuong Le, Raghvendra Kumar, Gia Nhu Nguyen, Jyotir Moy Chatterjee, “Cloud Computing and Virtualization”, Wiley, 2018, SBN:9781119488125, 1119488125

REFERENCES:

1. Dinesh G. Harkut, KashmiraKasat, Saurabh Shah, “Cloud Computing Technology and Practices”, Intechopne, 2019, ISBN:9781789849158, 1789849152.

COURSE OUTCOMES:

CO1: Articulate the main concepts of cloud computing.

CO2: Illustrate the concepts of virtualization.

CO3: Develop the ability to understand and use the Cloud computing models.

CO4: Develop the ability to understand Capacity planning, SLA management and Resource Management.

CO5: Explain the use various cloud computing development tools.

Board of Studies (BoS) :
18thBoS of CSE held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	M	L	L	
CO2	M		M	M
CO3	M	L	H	M
CO4	M	L	M	M
CO5	M	L	H	H

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement:

By learning “Cloud Computing and Technology”, the students will be able to discuss economic models and future visions of economy and society critically and to communicate them in public spheres.

CSDY 303 **EXPLORATORY DATA ANALYSIS** **L T P C**

SDG: 8 **3 0 0 3**

COURSE OBJECTIVES:

COB1: To understand the fundamentals of Exploratory Data Analysis

COB2: To know the Data Transformation techniques

COB3: To provide the knowledge on Descriptive Statistics

COB4: To learn the correlation analysis and Time series analysis

COB5: To understand the model development and evaluation

MODULE I EXPLORATORY DATA ANALYSIS FUNDAMENTALS **9**

Understanding data science- The significance of EDA- Making sense of data - Comparing EDA with classical and Bayesian analysis - Software tools available for EDA - Getting started with EDA - Visual Aids for EDA - Line chart - Bar charts - Scatter plot - Area plot and stacked plot - Pie chart - Table chart - Polar chart – Histogram - Lollipop chart - Choosing the best chart - Other libraries to explore.

MODULE II DATA TRANSFORMATION **9**

Technical requirements – Background - Merging database-style dataframes - Transformation techniques - Renaming axis indexes - Discretization and binning - Outlier detection and filtering - Permutation and random sampling - Computing indicators/dummy variables - Benefits of data transformation.

MODULE III DESCRIPTIVE STATISTICS & GROUPING DATASETS **9**

Descriptive Statistics - Understanding statistics - Measures of central tendency - Measures of dispersion - Grouping Datasets - Understanding groupby() - Groupby mechanics - Data aggregation - Pivot tables and cross-tabulations.

MODULE IV CORRELATION& TIME SERIES ANALYSIS **9**

Introducing correlation - Types of analysis - Discussing multivariate analysis using the Titanic dataset - Outlining Simpson's paradox - Correlation does not imply causation - Understanding the time series dataset - TSA with Open Power System Data.

MODULE V MODEL DEVELOPMENT AND EVALUATION **9**

Hypothesis Testing and Regression - Hypothesis testing - p-hacking - Understanding regression - Model development and evaluation - Model

Development and Evaluation - Types of machine learning - Understanding supervised learning - Understanding unsupervised learning - Understanding reinforcement learning - Unified machine learning workflow - EDA on Wine Quality Data Analysis - Disclosing the wine quality dataset - Analyzing red wine - Analyzing white wine - Model development and evaluation

L 45 ; Total Hours – 45

TEXT BOOKS:

1. Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with PythonPerform EDA Techniques to Understand, Summarize, and Investigate Your Data”, Packt Publishing – 2020, ISBN:9781789535624, 178953562X

REFERENCES:

1. Peter Bruce, Andrew Bruce, “Practical Statistics for Data Scientists”, O'Reilly Media – 2017, ISBN:9781491952917, 1491952911

COURSE OUTCOMES:

CO1: Examine the fundamentals of Exploratory Data Analysis
CO2: Comprehend the Data Transformation techniques
CO3: Apply Descriptive Statistics
CO4: Apply correlation analysis and Time series analysis
CO5: Develop the Model and evaluate it

Board of Studies (BoS):
18th BoS of CSE held on 26.06.2021

Academic Council:
17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	H	L	M	M
CO2	H	L	H	M
CO3	H	L	L	H
CO4	H	L	M	H
CO5	H	L	H	H

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: By learning “**Exploratory Data Analysis**”, the students are able to develop and evaluate ideas for sustainability-driven innovation and entrepreneurship.

CSDY 351 BUSINESS INTELLIGENCE L T P C

3 0 0 3

SDG: 9

COURSE OBJECTIVES:

COB1: Understand the basics of analytics and summarize Data, Categorize Models, and techniques

COB2: Illustrate different models suitable for different type of data

COB3: Make familiar with different analytics for business platform.

COB4: Analyse and visualize results using data visualizationtools.

COB5: Emphasize various applications where BI can be used.

MODULE I INTRODUCTION 9

Ubiquity of Data Opportunities – Decision Making – Big Data – Data Analytic Thinking – Data Mining Process – Techniques and Technologies.

MODULE II MODELS AND METHODS 9

Supervised Segmentation – Visualizing Segmentation – Classification, Regression via Mathematical Functions – Time Series – Association Rules – Clustering - Generalization – Fitting and Overfitting.

MODULE III TEXT AND WEB ANALYTICS 9

NLP – Sentiment Analysis – Search Engines – Web Usage Mining – Social Analytics.

MODULE IV DATA VISUALIZATION 9

Tables – Charts –Heat Maps – GIS – Data Dashboards –Business Performance Management - Balance Score Cards.

MODULE V BI APPLICATIONS 9

Relational marketing- Salesforce Management –Supply Chain Optimization – Data Envelopment Analysis – Case Studies.

L – 45; Total Hours – 45

TEXT BOOKS:

1. Foster Provost and Tom Fawcett, “Data Science for Business”, O’Reilly Media, Inc., 1st Edition, 2013. (ISBN 978-1-449-36132-7)
2. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, Dennis J. Sweeney, Thomas A.

Williams “Business Analytics”, Cengage Learning, Inc., 3rd Edition, 2018. (ISBN 978-1-337-40642-0)

REFERENCES:

1. Drew Bentley, “Business Intelligence and Analytics”, Library Press, Inc., 1st Edition, 2017. (ISBN 978-1-9789-2136-8)
2. Ramesh Sharda, DursunDelen, Efrainm Turban, “Business Intelligence a Managerial Perspective on Analytics”, Pearson Publications, 3rd Edition, 2017. (ISBN 978-9352862719)
3. Carlo-Vercellis, “Business Intelligence Data Mining and Optimization for Decision-Making”, Wiley Publications, 1st Edition, 2013. (ISBN 978-8126541881)

COURSE OUTCOMES:

CO1: Comprehend the fundamentals of BI and data analytics and the corresponding terminologies

CO2: Develop predictive models for various Real-Time Applications

CO3: Illustrate competently on the topic of analytics

CO4 Implement different visualization techniques for various datasets.

CO5: Demonstrate the real time scenario by using BI and Analytics techniques

Board of Studies (BoS) : 18th BoS of CSE held on 26.06.2021

Academic Council: 17th AC held on 15.07.2021

	PO1	PO2	PO3	PO4
CO1	L		H	
CO2		M		H
CO3		M		
CO4			H	H
CO5			H	H

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: Implementing data analytics in small and medium-sized enterprises can improve production, create new goods and services, and improve processes and marketing strategies. Data analytics, if well harnessed, can also help SMEs overcome disadvantages related to scale.

PROFESSIONAL ELECTIVES II

CSDY 304	INTELLIGENT INFORMATION RETRIEVAL	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn basics of information retrieval and role of Artificial Intelligence.

COB2: To provide knowledge on TF-IDF weighting, indexing and querying

COB3: To familiarize with Web Search Engine and crawling.

COB4: To expose to Link Analysis, Hadoop, Map Reduce and XML.

COB5: To understand document text mining techniques and clustering algorithms.

MODULE I INTRODUCTION **9**

Introduction -History of IR- Components of IR - Issues –Open source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR Versus Web Search - Components of a Search engine- Characterizing the web.

MODULE II INFORMATION RETRIEVAL **9**

Boolean and vector-space retrieval models- Term weighting - TF-IDF weighting- cosine similarity – Preprocessing - Inverted indices - efficient processing with sparse vectors – Language Model based IR - Probabilistic IR –Latent Semantic Indexing - Relevance feedback and query expansion.

MODULE III WEB SEARCH ENGINE – INTRODUCTION AND CRAWLING **9**

Web search overview, web structure, the user, paid placement, search engine optimization/ spam. Web size measurement - search engine optimization/spam – Web Search Architectures - crawling - meta-crawlers- Focused Crawling - web indexes –- Near-duplicate detection - Index Compression - XML retrieval.

MODULE IV SEARCH – LINK ANALYSIS AND SPECIALIZED SEARCH **9**

Link Analysis –hubs and authorities – Page Rank and HITS algorithms -Searching and Ranking – Relevance Scoring and ranking for Web – Similarity - Hadoop& Map Reduce - Evaluation -Personalized search - Collaborative filtering and content-based recommendation of documents and products – handling “invisible” Web - Snippet generation, Summarization, Question Answering, Cross- Lingual Retrieval.

MODULE V DOCUMENT TEXT MINING 9

Information filtering; organization and relevance feedback – Text Mining -Text classification and clustering - Categorization algorithms: naive Bayes -Decision trees; and nearest neighbor - Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM).

L –45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. C. Manning, P. Raghavan, and H. Schütze, Introduction to Information Retrieval , Cambridge University Press, 2008.
2. Ricardo Baeza -Yates and BerthierRibeiro - Neto, Modern Information Retrieval: The Concepts and Technology behind Search
   2nd Edition, ACM Press Books 2011.
3. Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, 1st Edition Addison Wesley, 2009.
4. Mark Levene, An Introduction to Search Engines and Web Navigation, 2nd Edition Wiley, 2010.

REFERENCES:

1. Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2010.
2. OphirFrieder “Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series “, 2nd Edition, Springer, 2004.
3. Manu Konchady, “Building Search Applications: Lucene, Ling Pipe”, and First Edition, Gate Mustru Publishing, 2008.

COURSE OUTCOMES:

CO1: Apply information retrieval in artificial intelligence.

CO2: Exert TF-IDF weighting, indexing and querying in Information retrieval.

CO3: Design Web Search Engine and work on Link Analysis.

CO4: Use Hadoop, Map Reduce and XML.

CO5: Relate document text mining techniques and clustering algorithms.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PS O2
CO1		M												
CO2				L							M			
CO3							M							
CO4													H	
CO5					M					H				

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all**.**

Statement: Beyond work-specific skills, emphasis must be placed on developing high-level cognitive and non-cognitive/transferable skills, such as problem solving, critical thinking, creativity, teamwork, communication skills and conflict resolution, which can be used across a range of occupational fields.

CSDY 305	DATA SCIENCE AND DATA ANALYTICS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand about the basics of data Science and to understand the various supervised and unsupervised learning techniques

COB2: To analyze several key technologies used for manipulating, storing, and analyzing big data from advanced analytics perspectives

COB3: To realize the different types of data used in different domains.

COB4: To extract useful knowledge (patterns) from the data collected.

COB5: To learn the Hadoop architecture and implementation of MapReduce Application.

MODULE I INTRODUCTION TO DATA SCIENCE 9

Introduction of Data Science, Basic Data Analytics using R, R Graphical User Interfaces. Data Import and Export, Attribute and Data Types, Descriptive Statistics, Exploratory Data Analysis, Visualization Before Analysis, Dirty Data, Visualizing a Single Variable, Examining Multiple Variables, Data Exploration Versus Presentation. Statistical Methods for Evaluation, Hypothesis Testing.

MODULE II ANALYTICAL THEORY AND METHODS 9

Overview of Clustering, K-means, Use Cases, Overview of the Method, Perform a K-means Analysis using R, Classification, Decision Trees, Decision Tree Algorithms, Decision Tree in R, Bayes' Theorem, Naïve Bayes Classifier, Smoothing, Naïve Bayes in R

MODULE III ADVANCED ANALYTICS TECHNOLOGY AND TOOLS 9

Analytics for Unstructured Data, Use Cases, MapReduce, , The Hadoop Ecosystem, Pig, Hive, Hbase, Mahouth, NoSQL, SQL Essentials, Joins, Set Operations, Grouping Extensions, In-Database Text Analysis, Advanced SQL, Window Functions, Userdefined Functions and Aggregates, MADlib.

MODULE IV HADOOP DISTRIBUTED FILE SYSTEM 9

HDFS- Architecture, Blocks, NameNode, Secondary NameNode, DataNode, HDFS Federation, HDFS High Availability, Basic File System Operations, Data Flow, Anatomy of File Read and File Write, Anatomy of a MapReduce Job Run.

MODULE V PROCESSING YOUR DATA WITH MAPREDUCE 9

Getting to know MapReduce, MapReduce Execution Pipeline, Runtime Coordination

and Task Management, MapReduce Application, Hadoop Word Count Implementation, Installing and Running Pig, Hbase Versus RDBMS, Installing and Running ZooKeeper, Case study.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Joao Moreira, Andre Carvalho, André Carlos Ponce de Leon Ferreira Carvalho, Tomás Horvath, “A General Introduction to Data Analytics”, Wiley Publications, 1st Edition, 2019, ISBN: 9781119296256.
2. David Dietrich, Barry Heller and Beibei Yang, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, EMC Education Services, Wiley, ISBN: 9788126556533, 2015
3. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly, ISBN: ISBN 9789352130672, 2015

REFERENCES:

1. Nathan Marz, James Warren, “Big Data-Principles and best practices of scalable real-time data systems”, Edition 2015, DreamTech Press, ISBN: 9789351198062.
2. Al-Sakib Khan Pathan, Mohiuddin Ahmed, “Data Analytics Concepts, Techniques, and Applications”, CRC Press, 2018, ISBN: 9780429820915

COURSE OUTCOMES:

CO1: Apply the basics of data science for the various supervised and unsupervised learning models.

CO2: Implement several key technologies used for manipulating, storing, and analyzing big data from advanced analytics perspectives.

CO3: Realize the Hadoop architecture and implementation of MapReduce Application.

CO4: Choose the appropriate data analysis technique for extracting the pattern.

CO5: Integrate machine learning libraries and mathematical and statistical tools with modern technologies like Hadoop and MapReduce.

Board of Studies (BoS) :
19th BoS of CSE held on 28.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1				M										L
CO					H									H

2														
CO 3														
CO 4								M			L		M	
CO 5											H			

Note: L - Low Correlation M -Medium Correlation H - High Correlation

SDG 9: Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development

.

Statement: Small and medium-sized enterprises can use data analytics to improve production; create new goods and services, improve processes and marketing strategies.

CSDY 306 **SOFT COMPUTING TECHNIQUES** **L T P C**

SDG: 8 **3 0 0 3**

COURSE OBJECTIVES:

COB1: To provide an overview of constituents of soft computing.

COB2: To gain knowledge about the concepts of fuzzy logic system.

COB3: To illustrate various architectures of artificial neural network.

COB4: To study evolutionary computing and machine learning techniques.

COB5: To discuss the applications of soft computing and implementation using Mat lab.

MODULE I INTRODUCTION TO SOFT COMPUTING 9

Introduction – Hard Computing and Soft Computing – Constituents of Soft Computing – Fuzzy logic – Crisp and Fuzzy sets – Fuzzy logic and inference rules – Fuzzy inference System.

MODULE II ARTIFICIAL NEURAL NETWORK 9

Biological Neurons – Artificial Neural Network – Perceptron – Multi layer Feed Forward Neural Network – Radial Basis Function Neural Network – Recurrent Neural System – Neuro Fuzzy System.

MODULE III EVOLUTIONARY COMPUTING 9

Evolutionary algorithm – Swarm Intelligence – Genetic algorithm process – Ant Colony Optimization.

MODULE IV MACHINE LEARNING 9

Machine Learning System – Supervised and Unsupervised Learning – Inductive and Deductive Learning –Clustering Method – Decision tree – Classification tree - Regression tree – Advanced machine learning techniques.

MODULE V PROGRAMMING AND APPLICATIONS 9

Implementation of Soft computing techniques using Matlab– Soft computing applications in engineering and health.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. SarojKaushik, Sunita Tiwari ,“Soft Computing “,McGraw-Hill Education, ISBN: 9789353160678, 9353160677, 2018.
2. Millie Pant, Kanad Ray, AnirbanBandyopadhyay, ”Soft Computing Applications”,Springer Singapore,ISBN: 9789811080494, 9811080496, 2018.

REFERENCES:

1. S.A.Mohiuddine, PradipDebnath, Soft Computing Techniques in Engineering, Health, Mathematical and Social Sciences, CRC Press, ISBN: 9781000409819, 1000409813, 2021.
2. Snehashish Chakraverty, Concepts of Soft Computing, Springer Singapore, ISBN: 9789811374302, 9811374309, 2019.

COURSE OUTCOMES:

CO1: Comprehend the various concepts of soft computing.

CO2: Design neuro fuzzy system through the knowledge of fuzzy logic and neural networks.

CO3: Apply evolutionary computing algorithms.

CO4: Analyze various machine learning techniques to solve the problem.

CO5: Implement the soft computing techniques using matlab programming.

Board of Studies (BoS) :
19th BoS of CSE held on 28.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2
CO1	M		L	M	L	M						L	H	
CO2	H	H	M		M					L				H
CO3			M		M							M		
CO4			M	H		M						H	H	
CO5	H	H		M	H								H	H

Note: L - Low Correlation M -Medium Correlation H - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement:
By learning the course, the students are able to design soft computing system applications thereby promote sustainable economic growth and productive employment.

CSDY 307 **ARTIFICIAL NEURAL NETWORKS** **L T P C**

SDG: 4 **3 0 0 3**

COURSE OBJECTIVES:

COB1: To learn the neural network terminologies & Process.

COB2: To realize the biological neural network and to model equivalent neuron models.

COB3: To solve the back propagation methods.

COB4: To discuss the self-organization maps.

COB5: To learn the neuro dynamics in artificial neural networks.

MODULE I INTRODUCTION & LEARNING PROCESS 9

A Neural Network - Human Brain, Models of a Neuron - Neural Networks viewed as Directed Graphs - Network Architectures - Knowledge Representation - Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning - Memory Based Learning - Hebbian Learning – Competitive - Boltzmann Learning - Credit Assignment Problem – Memory – Adaption - Statistical Nature of the Learning Process.

MODULE II SINGLE AND MULTI LAYER PERCEPTRONS 9

Adaptive Filtering Problem - Unconstrained Organization Techniques - Linear Least Square Filters - Least Mean Square Algorithm - Learning Curves - Learning Rate Annealing Techniques - Perceptron - Convergence Theorem - Relation Between Perceptron and Bayes Classifier for a Gaussian Environment. Multilayer Perceptron: Back Propagation Algorithm XOR Problem – Heuristics - Output Representation and Decision Rule - Computer Experiment - Feature Detection.

MODULE III BACK PROPAGATION 9

Back Propagation and Differentiation - Hessian Matrix – Generalization - Cross Validation - Network Pruning Techniques - Virtues and Limitations of Back Propagation Learning - Accelerated Convergence - Supervised Learning.

MODULE IV SELF-ORGANIZATION MAPS (SOM) 9

Two Basic Feature Mapping Models - Self-Organization Map - SOM Algorithm - Properties of Feature Map - Computer Simulations - Learning Vector Quantization - Adaptive Patter Classification.

MODULE V NEURO DYNAMICS AND HOPFIELD MODELS 9

Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical

Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, Computer Experiment.

L –45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Michael Zgurovsky, Victor Sineglazov, Elena Chumachenko, Artificial Intelligence Systems Based on Hybrid Neural Networks: Theory and Applications, Springer International Publishing, 2021.
2. Hugh Cartwright, Artificial Neural Networks, Springer US, 2021.

REFERENCES:

1. Simon Haykin, “Neural Networks a Comprehensive Foundations”, PHI edition, 2008.
2. B. Yegnanarayana, Artificial Neural Networks, Prentice Hall of India, 2005.

COURSE OUTCOMES:

CO1: Identify the knowledge of artificial neural networks and its applications.

CO2: Perform the training of neural networks using various learning rules.

CO3: Knowledge gathered from different types of layer perceptrons.

CO4: Analyze the self-organization maps in artificial neural networks.

CO5: Apply the neuro dynamic and hope field model in artificial experiment system.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1		L											L		
CO 2	M												M		
CO 3					M								M		
CO 4							M							M	
CO 5								H						H	

Note: L - Low Correlation M -Medium Correlation H - High Correlation

SDG 4: Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement: The students will play a key role in artificial neural network algorithms and societal progress through research, discovery, knowledge creation and dissemination. They educate and equip young people with the knowledge, acquired by building various application models.

CSDY 308	KNOWLEDGE ENGINEERING AND EXPERT SYSTEMS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the knowledge of engineering.

COB2: To learn the concepts of knowledge base and information management.

COB3: To discuss the expert systems and its scope.

COB4: To explain the architecture of expert system.

COB5: To recognize the programming language with expert systems.

MODULE I INTRODUCTION OF KNOWLEDGE ENGINEERING 9

Trends in Knowledge of Engineering: Introduction to knowledge engineering, Limitations and Possibilities of knowledge engineering, Business Management Styles, Management Styles and Information Technology, Management Source of Information, Information Processing, Multidimensional Management Systems (MMS), Computer-Aided Decision-Making (CAD), Organization Marketing, Virtual Management, Computer-Aided Management and Communications.

MODULE II ISSUES IN KNOWLEDGE ENGINEERING AND EXPERT SYSTEM 9

Problem solving strategies, Knowiedgewux Information Engineering Workbench, The Systematic-Intuitive Approach, Information Engineering Workbench, Language and Perceptual Models, Standards of expert system, Inference, Reasoning, and Knowledge Acquisition.

MODULE III PROBLEM SOLVING PROCESS 9

Rule Based Systems – Heuristic Classifications – Constructive Problem Solving.

MODULE IV EXPERT SYSTEMS 9

Tools for Building Expert Systems - Case Based Reasoning – Semantic of Expert Systems – Modeling Of Uncertain Reasoning – Applications of Semiotic Theory; Designing For Explanation.

MODULE V EXPERT SYSTEM ARCHITECTURE AND PROGRAMMING 9

Expert System Architectures - High Level Programming Languages – Logic Programming for Expert Systems.

L – 45 ; TOTAL HOURS – 45

TEXTBOOKS:

1. By Thomas B. Cross, “Knowledge Engineering 2017 The Uses of Artificial Intelligence in Business”, TECHtionary Corporation, 2017.Ashok N Kamthane, “Computer Programming”, Pearson Education, 2nd Edition, India, 2012. (ISBN 13: 9788131704370)
2. Peter Jackson, “Introduction to Expert Systems”, 3rd Edition, Pearson Education 2007.
3. Jean-Louis Ermine, “Expert Systems: Theory and Practice”, 4th printing, Prentice-Hall of India, 2001.

REFERENCES:

1. Padhy N.P, “Artificial Intelligence and Intelligent Systems”, 4th impression, Oxford University Press, 2007.
2. Robert I. Levine, Diane E. Drang, Barry Edelson: “AI and Expert Systems: a comprehensive guide, C language”, 2nd edition, McGraw-Hill 1990.

COURSE OUTCOMES:

CO1:Apply knowledge in logical form and construct ontology for different domains.

CO2: Identified the knowledge engineering issues and implement the workbench process

CO3: Analyze the classification and constructive problem solution.

CO4: Tools identification of expert system.

CO5: Recognize the flow of expert system architecture and programming logic in expert system.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1						M								L	
CO 2		M											M		
CO 3								M						M	
CO 4											H			M	
CO 5												M		H	

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement : The real-world problems persist and different types of data sets help in understanding the nature of the problems at a profounder level. By observing the problems in depth it helps to come up with a feasible solution thereby providing way for lifetime learning opportunities for everyone.

CSDY 309	SCRIPTING LANGUAGES	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To acquire the knowledge about the basics of Javascript.

COB2: To understand the object model in Javascript.

COB3: To impart the validation and error handling functionalities in Javascript.

COB4: To comprehend the fundamentals of HTML and CSS for the webpages development.

COB5: To highlight the basics of PHP and MYSQL.

MODULE I INTRODUCTION TO JAVASCRIPT 9

Introduction to web development – client side and server side javascripts – Evolution of Javascript – Features of Javascript – Lexical Structure – Characters – Variables – Datatype – Operators – Control Flow statements – Objects – Classes – Functions – Arrays.

MODULE II OBJECT MODEL 9

Browser Object Model – Window object – History object – Navigator object – Location object – Screen object – Document object Model (DOM) – DOM Trees and Nodes – Elements in DOM – Standard Built in Objects – Error Objects – Number and Dates – Text and String Processing.

MODULE III VALIDATION 9

Server side validation – Client Side Validation – Built-in Form validation – Using Javascript for validation – Error Handling – Cookies – Strict Mode.

MODULE IV FUNDAMENTALS OF HTML AND CSS 9

Building webpages in HTML – Using CSS and templates – Styling with CSS - Adding dynamic elements with Javascript – Using Javascript in HTML pages – Working with window event handlers – Using Mouse and Keyboard Event Handlers – Using Javascript in forms – Validating forms.

MODULE V PHP AND MYSQL 9

Fundamentals of PHP – PHP Control and File handling – PHP Arrays and Forms – Fundamentals of MySQL and SQL – Using MySQL Database With PHP – Working With Forms and Databases – Registering and Responding To Users – Handling Online Purchases.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Ravi Tomar, Sarishma Dangi, JavaScript: Syntax and Practices, CRC Press, 9780367641429, 2021.
2. Marty Matthews, PHP and MySQL Web Development: A Beginner's GuideMcGraw-Hill, First edition, ISBN-10 0071837302, 2015

REFERENCES:

1. David Flanagan, JavaScript: The Definitive Guide, Seventh Edition, O'Reilly Media, ISBN: 9781491952023, 2020
2. Marijn Haverbeke, Eloquent JavaScript. 3rd edition, No Starch Press, ISBN 13: 9781593275846, 2018.

COURSE OUTCOMES:

CO1: Analyze the fundamentals of web development and the advantages of using Javascript.

CO2: Design a Javascript program by utilizing the object models.

CO3: Implement validation features in a Javascript program.

CO4: Design a webpage using HTML and CSS

CO5: Apply the PHP concepts and add the functionality of connecting to MYSQL.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	H													
CO2			M											
CO3		M												H
CO4				L										
CO5					H								H	

Note:L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

The comprehensive understanding of web development using Javascript, HTML, CSS and PHP intends to improve the execution of crucial tasks with robust validations. This aids in building websites that will impart resilient software and innovations.

CSDY 310	DISTRIBUTED PARALLEL AND SPATIAL DATABASES	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basics of distributed and parallel database storage

COB2: To study the various processes for handling parallel and distributed databases**.**

COB3: To describe the transactions in the parallel and distributes storages.

COB4: To introduce the basic operations in spatial databases

COB5: To explore the different kind of implementations of spatial databases.

MODULE I INTRODUCTION TO DISTRIBUTED AND PARALLEL DATABASES **9**

Centralized Database Systems - Server System Architectures - Parallel Systems - Distributed Systems – History of Distributed Database Systems - Transaction Processing in Parallel and Distributed Systems - Cloud-Based Services.

MODULE II PARALLEL AND DISTRIBUTED STORAGE AND QUERY PROCESSING **9**

Data Partitioning - Replication - Parallel Indexing - Distributed File Systems - Parallel Key-Value Stores - Parallel Sort - Parallel Join - Other Operations - Parallel Evaluation of Query Plans - Query Processing on Shared-Memory - Architectures - Query Optimization for Parallel Execution - Parallel Processing of Streaming Data - Distributed Query Processing.

MODULE III PARALLEL AND DISTRIBUTED TRANSACTION PROCESSING **9**

Distributed Transactions - Commit Protocols - Concurrency Control in Distributed - Databases - Replication - Extended Concurrency Control - Protocols - Replication with Weak Degrees of Consistency - Coordinator Selection - Consensus in Distributed Systems.

MODULE IV INTRODUCTION TO SPATIAL DATABASES **9**

Database Principles And Architecture – Spatial Data - Representation Of Spatial Objects – Spatial Database Systems – Spatial Data Standards – Metadata – Spatial Data Sharing – Spatial Data Warehousing and Database Federation.

MODULE V SPATIAL DATABASE IMPLEMENTATION **9**

DBMS Support for Geospatial Data - User Education and Legal Issues of Spatial Database Systems - User Needs Assessment and Multi-user Spatial Solutions - Project Management for Spatial Database Implementation - Web-enabled Spatial Database Systems - Spatial Data Mining and Decision Support Systems - Trends of Spatial Database Systems.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, 7th Edition, McGrawHill, ISBN 9780078022159, 2021 – (Module I - III)
2. M. Tamer Ozsu, Patrick Valduriez, Principles of Distributed Database Systems, Fourth Edition, Springer Nature, Switzerland AG, ISBN-10 1441988335, 2020 (Module IV and V)

REFERENCES:

1. Albert K.W. Yeung, G. Brent Hall, Spatial Database Systems Design, Implementation and Project Management, Springer, ISBN 1402053924, 2007 (Module I - III).
2. Philippe Rigaux, Michel Scholl, Agnes Voisard, Spatial Databases With Application to GIS, Morgan Kaufmann Publishers, ISBN 0080517463, 2002. (Module IV and V)

COURSE OUTCOMES:

CO1: Analyze the basics of parallel and distributed storage systems.

CO2: Implement the parallel and distributed database operations and query processing techniques.

CO3: Apply the various transactions and methods for parallel and distributed databases.

CO4: Interpret the basics of spatial databases and implement them.

CO5: Develop spatial database storage system and analyze them.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	H													H
CO 2					M									
CO		L												

3														
CO 4			M											
CO 5				H									M	

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

The holistic understanding to define, create, store and maintain parallel, distributed and spatial databases leads to construction of resilient infrastructure and sustainable industrialization.

CSDY 311	DATA VISUALIZATION	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To study the basic elements in data visualization

COB2: To impart the learning of visualizing distributions and proportions

COB3: To understand the visualization methods for data related to associations, time series and trends.

COB4: To learn the functionalities in python for visualizing data.

COB5: To expose the visualization techniques for images, shapes and spatial data.

MODULE I FUNDAMENTALS OF DATA VISUALIZATION 9

From Data to Visualization – Mapping data to Aesthetics – Coordinate System and Axes – Color Scales – Directory of visualizations – Visualizing amounts – Bar plots – Grouped and Stacked bars – Dot plots and Heatmaps

MODULE II DISTRIBUTIONS AND PROPORTIONS 9

Histograms and density plots – Visualizing single and multiple distributions – Empirical Cumulative Distribution Functions - Highly Skewed Distributions - Quantile-Quantile Plots - Visualizing distributions along vertical and horizontal axes – Visualizing proportions – Pie charts – Side-by-side bars – stacked bars and stacked densities.

MODULE III ASSOCIATIONS, TIME SERIES AND TRENDS 9

Visualizing associations – Scatterplots – Correlograms - Dimension Reduction - Paired Data – Visualizing Time Series - Individual Time Series

Multiple Time Series and Dose–Response Curves - Time Series of Two or More Response Variables – Visualizing Trends – Smoothing - Showing Trends with a Defined Functional Form - Detrending and Time-Series Decomposition.

MODULE IV VISUALIZATION IN PYTHON 9

Introduction to Python – Python Scripting Basics - Exploring Jupyter Notebook – Getting Started with Pandas – Scientific Python Ecosystem and Numpy – Data Visualization with Leather – Data Visualization with Numpy and Matplotlib.

MODULE V VISUALIZING IMAGES AND SHAPES 9

Visualizing Images and 3D shapes – Visualizing graphs and networks – Visualization with Seaborn– Spatial visualization and analysis in python in folium –Geospatial Visualization.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Claus O. Wilke, “Fundamentals of Data Visualization”, O'Reilly Media, Inc, ISBN: 9781492031086, 2019.

2. Samuel Burns, “Python Data Visualization: An Easy Introduction to Data Visualization in Python with Matplotlib, Pandas, and Seaborn”, Independently Published, ISBN-10 1701860252, 2019

REFERENCES:

1.Jake VanderPlas, “Python Data Science Handbook Essential Tools for Working with Data”, O'Reilly Media, ISBN 1491912146, 2016.

2.Ashwin Pajankar, “Practical Python Data Visualization: A Fast Track Approach to Learning Data Visualization with Python”, Apress, ISBN-10 1484264541 2021.

COURSE OUTCOMES:

CO1: Investigate the basic elements regarding the data visualization.

CO2: Analyze the methods needed for visualizing distributions and proportions

CO3: Apply the visualization of associations, time series data and trends.

CO4: Perform basic visualization of data using Python.

CO5: Apply the functionalities of python to visualize images, shapes and spatial data

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H													M	
CO 2			M												
CO 3				M											
CO 4					L										
CO 5		M													H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The practice of translating information into a visual context, such as a map or graph, aids to make the data easier for the human brain to understand and draw insights, which results in construction of a resilient software and remarkable innovations.

CSDY 353	OPTIMIZATION METHODS FOR ANALYTICS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basics of optimization problem

COB2: To describe the various first order and second order methods of optimization.

COB3: To interpret the direct and stochastic methods of optimization.

COB4: To study several functions for optimizing using population methods and utilizing constrained methods.

COB5: To learn the different kinds of methods for multiobjective optimization.

MODULE I INTRODUCTION 9

Basic Optimization problem – Constraints – Critical Points – Conditions for Local Minima – Derivatives and Gradients – Bracketing Methods – Unimodality - Finding an Initial Bracket - Fibonacci Search - Golden Section Search - Quadratic Fit Search - Shubert-Piyavskii Method - Bisection Method.

MODULE II FIRST ORDER AND SECOND ORDER METHODS 9

Local Descent - Descent Direction Iteration - Line Search - Trust Region Methods - Termination Conditions - First-Order Methods - Gradient Descent - Conjugate Gradient - Momentum - Nesterov Momentum - Adagrad - RMSProp - Adadelta - Adam - Hypergradient Descent - Second-Order Methods - Newton's Method - Secant Method - Quasi-Newton Methods.

MODULE III DIRECT AND STOCHASTIC METHODS 9

Direct Methods - Cyclic Coordinate Search - Powell's Method - Hooke-Jeeves - Generalized Pattern Search - Nelder-Mead Simplex Method - Divided Rectangles - Stochastic Methods - Noisy Descent - Mesh Adaptive Direct Search - Simulated Annealing - Cross-Entropy Method - Natural Evolution Strategies - Covariance Matrix Adaptation.

MODULE IV POPULATION METHODS AND CONSTRAINTS 9

Population Methods - Initialization - Genetic Algorithms - Differential Evolution - Particle Swarm Optimization - Firefly Algorithm - Cuckoo Search - Hybrid Methods - Constraints - Constraint Types - Constrained Optimization - Transformations to Remove Constraints - Legrange Multipliers – Inequality Constraints - Duality - Penalty Methods - Augmented Lagrange Method - Interior Point Methods.

MODULE V LINEAR CONSTRAINED AND 9

MULTIOBJECTIVE OPTIMIZATION METHODS

Linear Constrained Optimization - Simplex Algorithm - Problem Formulation - Dual Certificates - Multiobjective Optimization - Pareto Optimality - Constraint Methods - Weight Methods - Multiobjective Population Methods - Preference Elicitation - Discrete Optimization - Integer Programs - Rounding - Cutting Planes - Branch and Bound - Dynamic Programming - Ant Colony Optimization.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Kochenderfer, M.J. and Wheeler, T.A., 2019. Algorithms for optimization. Mit Press. 2019
2. Singiresu S. Rao, “Engineering optimization – Theory and practice”, Fifth Edition -John Wiley & Sons, Inc. 2020.

REFERENCES:

1. Joshi MC, Moudgalya KM. Optimization: theory and practice, Alpha Science International Ltd. 2004.

COURSE OUTCOMES:

CO1: Employ the various basic elements of optimization problems including derivatives and gradients

CO2: Demonstrate the first order and second order methods for optimization.

CO3: Illustrate the different kind of function under the direct and stochastic methods.

CO4: Implement the several methods of linear constrained optimization.

CO5: Design multiobjective optimization methods and assess its importance.

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H													M
CO2		M												
CO3				L										
CO4											H			
CO5					M									

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic understanding of optimization helps in identifying the best design related to a set of constraints and criteria that leads to the resilient infrastructure and sustainable industrialization.

CSDY 354	KNOWLEDGE REPRESENTATION AND REASONING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the foundations of KRR and the tradeoff between representation and reasoning

COB2: To expose which knowledge-based techniques are appropriate for which tasks;

COB3: To highlight KRR systems to their research and challenging problems;

COB4: To learn about research papers related to knowledge representation

COB5: To create awareness on the limitations and complexity of reasoning algorithms applied in knowledge based systems.

MODULE I FIRST ORDER LOGIC 9

Introduction to Representations and Reasoning – the role of logic – the language of first order logic: syntax, semantics and pragmatics – expressing knowledge – resolution.

MODULE II REASONING WITH HORN CLAUSES AND PROCEDURAL CONTROL 9

Horn Clauses – SLD resolution – facts and rules of procedural control – rule formation and strategy – algorithm design – specifying goal order – committing to proof methods – controlling backtracking.

MODULE III RULES IN PRODUCTION SYSTEMS 9

Basic operations – working memory – production rules – examples – conflict resolution – making production system more efficient – applications.

MODULE IV OBJECT ORIENTED REPRESENTATION 9

Objects and frames – basic frame formalization – structured descriptions – Inheritance – defaults – uncertainty.

MODULE V ACTIONS AND PLANNING 9

Situation calculus – simple solution to frame problem – complex actions – planning the situation calculus – planning as a reasoning task.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Ronald J Brachman and Hector J Levesque, “Knowledge Representations and Reasoning”, ISBN-13 : 978-1558609327, Morgan Kaufmann publishers, 2004.

REFERENCES:

1. Handbook of Knowledge Representation Franl Van Harmelen, Vladimir Lifschitz and Bruce Porter, Foundations of Aritifical Intelligence 2008.

COURSE OUTCOMES:

CO1 : Realize the fundamental principles of logic based knowledge representation

CO2: Design simple application domains in logic based language

CO3: Comprehend the notion of a reasoning service.

CO4: Master the fundamentals of the reasoning algorithms underlying current systems.

CO5: Representing information about the world in a form that a computer system can use to solve complex tasks

Board of Studies (BoS) : 19th BoS of CSE held on 28.12.2021

Academic Council: 18th AC held on 24.02.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO 1	PSO 2
CO1					L									
CO2												L		
CO3		H						M						
CO4														L
CO5										H				

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: To representing information about the world in a form that a computer system can use to solve complex tasks such as diagnosing a medical condition or having a dialog in a natural language.

CSDY 355	DATA SCIENCE WITH BIO INFORMATICS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge in the basic concepts of Data Analysis

COB2: To acquire skills in data preparatory and preprocessing steps

COB3: To understand the mathematical skills in statistics

COB4: To acquire knowledge in data interpretation and visualization techniques

COB5: To learn on how to develop technological tools that help analyze biological data

MODULE I INTRODUCTION 9

Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications.

MODULE II DESCRIBING DATA I 9

Frequency distributions – Outliers – relative frequency distributions – cumulative frequency distributions – frequency distributions for nominal data – interpreting distributions – graphs – averages – mode – median – mean – averages for qualitative and ranked data – describing variability Tentative – range – variance – standard deviation – degrees of freedom – interquartile range – variability for qualitative and ranked data.

MODULE III PYTHON FOR DATA HANDLING 9

Basics of Numpy arrays – aggregations – computations on arrays – comparisons, masks, Boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – hierarchical indexing – combining datasets – aggregation and grouping – pivot tables.

MODULE IV INTRODUCTION TO BIOINFORMATICS DATA AND DATABASES 9

Types of Biological data:- Genomic DNA, Complementary DNA, Recombinant DNA, Expressed sequence tags, Sequence-Tagged Sites, Genomic survey sequences; Primary Databases:- GenBank, EMBL, DDBJ; Composite Databases:-NRDB, UniProt; Literature Databases:- Open access and open sources, PubMed, PLoS, Biomed Central, NAR databases;

Bioinformatics Resources:- NCBI, EBI, ExPASy, RCSB.

MODULE V BIOINFORMATICS DATABASE SEARCH ENGINES 9

Text-based search engines (Entrez, DBGET / LinkDB). Sequence similarity based search engines (BLAST and FASTA). Motif-based search engines (ScanProsite and eMOTIF). Structure similarity based search engines (Combinatorial Extension, VAST and DALI). Proteomics tools:- ExPASy server, EMBOSS.

L –45 ; TOTAL HOURS –45

TEXT BOOK:

1. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009.
2. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.

REFERENCES:

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.

COURSE OUTCOMES:

CO1: Apply the skills of data inspecting and cleansing.

CO2: Determine the relationship between data dependencies using statistics

CO3: Can handle data using primary tools used for data science in Python

CO4: Apprehend the limitations and complexity of reasoning algorithms applied in knowledge based systems.

CO5: Design, implement and apply a knowledge-based system

Board of Studies (BoS) :
19th BoS of CSE held on 28.12.2021

Academic Council:
18th AC held on 24.02.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO2
CO1					L									
CO2										L				
CO3		H						M						
CO4														L
CO5										H				

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: To gain overall knowledge in Applying quantitative modeling and data analysis techniques to the bioinformatics problems.

CSDY 359	WEB ANALYTICS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To provide an overview and establish the need for web analytics.

COB2: To collect data set from web.

COB3: To learn and apply metrics to analyze the web data.

COB4: To learn the different strategies of web analytics.

COB5: To provide exposure to usage of web analytic tools.

MODULE I **INTRODUCTION TO WEB ANALYTICS** **9**

Introduction - Web Analytics - History of Web Analytics - Traditional Web Analytics - Capturing Data, Tools Selection – Quality Aspects.

MODULE II **WEB DATA COLLECTION** **9**

Web Traffic Data - Web Transactional Data - Web Server Data - Page Weights - Usability Studies - Integrating Form based data - Web Data Sources -Server Log Files – Page Tags – Clickstream Data - Outcomes Data – Research Data – Competitive Data.

MODULE III **WEB ANALYTICS STRATEGY** **9**

Component of Web Analytics Strategy - Customer Centric Focus, Business Problem Solving Focus - Reporting vs Analysis – IT and Business Strength - Clickstream vs Web 2.0 – Vendor Specific Options and Issues,

MODULE IV **METRICS AND KPIs** **9**

Measuring Reach - Measuring Acquisition - Measuring Conversion, Measuring Retention – Data Analysis - Customer centricity - Web enabled user research options - Competitive Intelligence Analysis.

MODULE V **WEB ANALYTICS TOOLS** **9**

Content organization tool - Process measurement tools - Visitor Segmentation Tools- Campaign Analysis - Commerce Measurement Tools - Google Analytics – Piwik Web Analytics - Yahoo Web Analytics - Emerging Analytics: Social, Video, and Mobile. - Case study on twitter, Discovering the Trending Topics, Searching for Tweets, Collecting Time-Series Data, Extracting Tweet Entities, Tabulating Frequency Analysis.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Michael Beasley, Practical Web Analytics for User Experience, 1st Edition, Elsevier, 2013.ISBN: 978-0-12-404619-1.

REFERENCES:

1. Avinash Kaushik, “Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity”, 1st Edition, Sybex, 2009.
2. Brian Clifton, “Advanced Web Metrics with Google Analytics”, 3rd Edition, Sybex , 2012.
3. Eric Peterson, “Web Analytics Demystified:A Marketer's Guide to Understanding How Your Web Site Affects Your Business” ,1st Edition, CeliloGroup Media, 2004.
4. .Avinash Kaushik, “Web Analytics: An Hour a Day”, 6th Edition, Sybex, PAP/CDR Edition, 2007.
5. Justin Cutroni, “Google Analytics”, 2nd Edition, O'Reilly Media, 2010.

COURSE OUTCOMES:

CO1: Collect and integrate data from various sources such as web and social media data.

CO2: Explore web data and apply the learning to improve the quality of web sites.

CO3: Perform customer oriented competitive intelligence analysis.

CO4: Solve real time problems using various web analytics strategies.

CO5: Use various tools and study real-time websites for enhancing business performance.

Board of Studies (BoS) :	**Academic Council:**
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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2
CO 1			H		L	H	H						L	L
CO 2	L		M			M	M					M	M	M
CO 3	L	H	M		H	M	M	M				H	H	M
CO 4	M		H			H	H					M	M	M
CO 5	M	L		M	H	H	H			H		H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Web analytics is to analyze the behavior of website visitors. This engages tracking, reviewing and reporting data to measure web activity. Thus learning the various web analytics strategies helps in promoting inclusive and sustainable industrialization and foster innovation.