B.S. Abdur Rahman
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2022
Curriculum and Syllabi
(As approved by the 19th Academic Council)
September - 2022

M.Tech.
(Artificial Intelligence and Data Science)

B.S. Abdur Rahman Crescent Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2022
CURRICULUM AND SYLLABI
(As approved by the 19th Academic Council)

SEPTEMBER – 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 AND TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS 2022

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

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)

ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.

iii) **"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.

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare and discipline in the campus.

viii)**"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **"Dean of the School"** means the Dean of the School of the department concerned.

x) **"Head of the Department"** means the Head of the Department concerned.

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.	
M.A.	

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 as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2.2 The other 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	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	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	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	Aeronautical Engineering	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	Civil Engineering	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.
		M. Tech. (Construction Engineering and Project Management)	B.E. / B.Tech. in Civil Engineering / Structural Engineering / B.Arch. or Equivalent degree in relevant field.
3.	Mechanical Engineering	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
		M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
7.	Information Technology	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	Computer Applications	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2level or equivalent degree in relevant field.
9.	Mathematics	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	Physics	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	Chemistry	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
		M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
			relevant field.
13.	Commerce	M.Com	B.Com. / BBA
14.	Arabic and Islamic Studies	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with AalimSanad / Diploma / Certificate in Arabic or Islamic Studies.

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 integrated theory courses
iv. Project work
v. Laboratory courses
vi. Open elective courses
vii. Seminar
viii. Mini Project
ix. Industry Internship
x. MOOC courses (NPTEL- Swayam, Coursera etc.)
xi. Value added courses

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.	76 - 80
MCA	86
M.Sc.	77 - 85
M.Com.	88
M.A.	72

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 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

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 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

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, aliter to open electives, during the entire period of study, with approval of 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 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) 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 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 project supervisor.

3.5 PROJECT WORK

3.5.1 Project work 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 / Competent authority 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 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 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 class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 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 guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

5.0 COURSE COMMITTEE

5.1 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.

6.0 CLASS COMMITTEE

6.1 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:

6.2 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

6.3 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.

6.4 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 syllabi of courses.

6.5 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.

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. 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.

7.2 Change of a Course

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.

7.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous 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 enroll for a maximum of 32 credits during a semester including Redo / Predo courses.

8.0 BREAK OF STUDY FROM PROGRAMME

8.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

8.1.1 Medical or other valid grounds

8.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

8.1.3 Debarred due to any act of indiscipline

8.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

8.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

8.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT WORK

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	22
M.Sc.	18
M.Com	NA
M.A.	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 REQUIREMENT AND SEMESTER / COURSE REPETITION

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% 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.

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 the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

10.3 If a student secures attendance between 65% and less than 75% in any course in a semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation

in the institution approved events, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examination of that course. In all such cases, the students shall submit the required documents immediately after joining the classes to the class advisor, which shall be approved by the Head of the Department / Dean of the School. The Vice Chancellor, based on the recommendation of the Dean (Academic Affairs) may approve the condonation of attendance.

10.4 A student who has obtained an “I” grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall repeat 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.

10.5 The student awarded “I” grade, shall enroll and repeat the course when it is offered next. In case of “I” grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

10.6 A student who is awarded “U” grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to redo the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains “U” grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

10.7 If a student with “U” grade, who prefers to redo any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier “U” grade and continuous assessment marks shall continue.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the department concerned, based on the availability of faculty members, and subject to a specified minimum number of students registering for each of such courses.

11.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is no provision for any substitute examination and withdrawal from a redo course.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

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 Theory Course

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

12.3 Laboratory Course

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

12.4 Laboratory Integrated Theory Courses

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 components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

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

12.6 Industry Internship

In the case of industry internship, 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 / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

In the case of project work, a committee of faculty members constituted by the Head of the Department / Dean of the School will carry out three periodic reviews. Based on the project report submitted by the students, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by the 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.

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

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 examination for theory component. There shall be no arrear or improvement examination for lab components.

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 semesters.

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 preferably 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
I	0

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

"U" denotes unsuccessful performance in the course.

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 fees tothe 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” grade is excluded for calculating GPA.

"U" and**“I”** 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

15.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the PG programme within the minimum prescribed period of study (except clause 8.1.1)

15.6.2 Eligibility for First Class

A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 8.1.1)

15.6.3 The students who do not satisfy clause 15.6.1 and clause 15.6.2 shall be classified as second class.

15.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

16.0 DISCIPLINE

16.1 Every student is expected to observe discipline and decorum 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 MASTER'S DEGREE

17.1 A student shall be declared to be eligible for the award of the Master's 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

Notwithstanding 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 2022

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MAE 6189	Statistical Methods for Data Science	3	1	0	4
2.	EC	CSE 6121	Advanced Data Structures	3	0	0	3
3.	EC	CSE 6122	Artificial Intelligence in Data Mining	3	0	0	3
4.	EC	CSE 6123	Essentials of Artificial Intelligence and Machine Learning	3	0	0	3
5.	EC	CSE 6144	Data Science Foundations using R	3	0	2	4
6.	PE		Professional Elective I	3	0	0	3
7.	SEC	ENE 6181	English for Career Development	1	0	2	2
			Credits				**22**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	GEE 6201	Research Methodology and IPR	2	0	0	2
2.	EC	CSE 6221	Natural Language Processing	3	0	0	3
3.	EC	CSE 6222	Deep Learning	3	0	2	4
4.	EC	CSE 6223	Scalable Algorithms for Data Science	3	0	0	3
5.	PE		Professional Electives II				9
6.			Value Added Course				--
			Credits				**21**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	EC	CSE 7121	Internship *	0	0	2	1
2.	PE		Professional Electives- III				6
3.	GE		Open Elective	3	0	0	3
4.	EC	CSE 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	CSE 7122	Project Work (Phase II)	0	0	36	18
			Credits				**6 + 18 = 24**

Overall Total Credits – 77

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

\# Credits for Project Work Phase I to be accounted along with ProjectWork 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	MAEY 01	Linear Algebra	3	0	0	3
2.	PE	CSEY 301	SQL for Data Science	3	0	0	3
3.	PE	CSEY 302	Cloud Computing and Technology	3	0	0	3
4.	PE	CSEY 303	Exploratory Data Analytics	3	0	0	3
5.	PE	CSEY 351	Business Intelligence	3	0	0	3

Electives - Semester II

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

Electives – Semester III

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

SEMESTER I

MAE 6189	STATISTICAL METHODS FOR DATA SCIENCE	L	T	P	C
SDG: 4		3	1	0	4

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 CORRELATION AND REGRESSION 9+3

Bi-variate data – Correlation and Regression coefficients and their relation, properties - Effect of change of origin and scale on correlation coefficient, Linear regression, Association and Independence of attributes.

MODULE II PARAMETRIC TEST 9+3

Parametric tests - one sample and two sample tests for means and proportions of large samples (z-test) - one sample and two sample tests for means of small samples (t-test) - F-test for two sample standard deviations - ANOVA one and two way- Application in business decisions.

MODULE III NON PARAMETRIC TEST 9+3

Chi-square test for single sample standard deviation, Chi-square tests for independence of attributes and goodness of fit. Sign test for paired data. Rank sum test. Kolmogorov-Smirnov – test for goodness of fit, comparing two populations. Mann – Whitney U test and Kruskal Wallis test. One sample run test.

MODULE IV STATISTICAL QUALITY CONTROL - I 9+3

Quality improvement and statistics – Statistical quality control - statistical process control – control charts – design of control charts – analysis of patterns on control charts - X bar chart, R chart and S chart.

MODULE V STATISTICAL QUALITY CONTROL- II 9+3

Process and product control – attribute charts – P, np and C charts – control charts performance.

L – 45 ; T - 15; TOTAL HOURS – 60

TEXT BOOKS:

1. T.Veerarajan, “Probability and Statistics”, Tata McGraw-Hill New Delhi, 2008.
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. Arora and Arora, “Compressive Statistical Methods”, S. Chand, New Delhi 2007.

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

CO1: Correlate the data and compute Regression lines.

CO2: Develop and test hypothesis for different statistical tests.

CO3: Design an experiment and case study the experiment with different data.

CO4: Analyze the industrial data using quality control design tools statistically.

CO5: Analyze the industrial data using process and product control tools statistically.

Board of Studies (BoS):
14th BOS of Mathematics & AS held on 30.06.2022

Academic Council:
19th Academic Council meeting held on 29.09.2022

	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
CO1	H	M		M		L							M		H
CO2	H	M		M		L							M		H
CO3	H	M		M		L							M		H
CO4	H	M		M		L							M		H
CO5	H	M		M		L							M		H

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

Learning of Statistical Methods for Data Analyze will lead to knowledge of Artificial Intelligence and Data Science.

CSE 6121	ADVANCED DATA STRUCTURES	L	T	P	C
SDG: 4		3	0	0	3

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 worldproblems.

Board of Studies (BoS):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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	M			H										
CO2		L		H										
CO3	H			M										
CO4			H											
CO5	H													

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

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

COURSE OBJECTIVES:

COB1: To explore the different types of data and the preprocessing techniques for processing the data..

COB2: To learn the need of rule based approach using Association rules and Pattern mining.

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 ARTIFICIAL INTELLIGENCE IN PERSPECTIVE OF DATA MINING 9

Artificial Intelligence – AI vs Data Mining –AI in cyber security - Biomedical

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

L – 45; Total Hours– 45

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: Apply the appropriate preprocessing technique in extracting the data for the applications.

CO2: Explore the rule-based machine learning methods for discovering interesting relation between the items in the database.

CO3: Analyze the clustering and classification techniques in data mining.

CO4: Identify the use of decision trees in Artificial Intelligence.

CO5: Review the different applications of data mining with respect to Artificial Intelligence**.**

Board of Studies (BoS):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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	M	H	H										H	
CO2		H		M									H	
CO3						M						M	L	
CO4				H							M			M
CO5	L						H	H	M	L				H

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

Statement : The learner is able to work with decision-makers to improve the uptake of sustainable infrastructure (including internet access).

CSE 6123	**ESSENTIALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**	**L**	**T**	**P**	**C**
SDG:3,4		**3**	**0**	**0**	**3**

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 9

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.

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:

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

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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

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

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

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.

CSE 6144	DATA SCIENCE FOUNDATIONS USING R	L	T	P	C
SDG: 8		3	0	2	4

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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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	M	L												
CO2	M		H	M										
CO3	M	L	H	M										
CO4	M		H	M										
CO5	M	L	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 “Data Science Foundations using R”, the students are able to develop and evaluate ideas for sustainability-driven innovation and entrepreneurship.

ENE 6181	ENGLISH FOR CAREER DEVELOPMENT	L	T	P	C
SDG: 4 and 8		1	0	2	2

COURSE OBJECTIVES:

COB1: To enable students to learn about the job search, application, and interview process

COB2: To give them an opportunity to explore their global career path, build vocabulary and improve language skills to achieve professional goals

COB3: To produce a professional-looking resume

COB4: To understand networking and interview skills

COB5: To understand the key skills and behaviours required to facilitate a group discussion

MODULE I ENTERING THE JOB MARKET 3+6

(This module focuses more on the practical aspects of communication for career development.)

Introduction to the Career Development - Job Search Overview - Identifying Your Interests and Skills

Language Focus: Vocabulary and Word Forms Related to Jobs - Choosing the Job that's the Best Fit

Language Focus: Verb Tenses (Present vs. Present Progressive)

Understanding Job Descriptions: Reading a Job Advertisement

Language Focus: Phrases to Compare Similarities

Online Learning Opportunities to Extend Your Skills

MODULE II RESUMES 3+2

What is a resume? Why do you need one?

Parts of a Resume-Writing a Resume, Part 1: Name and Contact Information

Listening: Connecting Employers with Job Seekers in Today's Economy

Language Focus: Key Words

Writing a Resume, Part 2: Headline and Summary

Writing a Resume, Part 3: Work Experience

Writing a Resume, Part 4: Education

Language Focus: Action Verbs

Writing a Resume, Part 5: Complete your Resume

MODULE III WRITING A COVER LETTER 3+2

What is a Cover Letter?

Professional Writing: Letter Format

Cover Letter: Paragraph 1- Introducing Yourself
Cover Letter: Paragraph 2- Highlighting Your Skills in the Cover letter
Cover Letter: Paragraph 3- Closing
Language Focus – Present Perfect vs. Past Tense
Professional Writing: Level of Formality
Language Focus: Using Modal Verbs to Write politely
Writing a Cover Letter for a Specific Job

MODULE IV INTERVIEWING FOR A JOB 3+10

(This module focuses more on the practical aspects of communication for career development.)
Overview of the Job Interview: Answering Typical Interview Questions
Language Focus: Asking for Clarification in an Interview-
Sample Interview: Do's and Don'ts Part 1
Sample Interview: Do's and Don'ts Part 2
Sample Video: Responding to an Interview Question

MODULE V GROUP DISCUSSION 3+10

(This module focuses more on the practical aspects of communication for career development.)
Introduction to Group Discussion - Participating in group discussions – understanding group dynamics - brainstorming the topic - questioning and clarifying - GD strategies - activities to improve GD skills

L-15, P-30; TOTAL HOURS - 45

REFERENCES:

1. R. Byrne, D. *Teaching Oral Skill.* London: Longman. 1975.
2. Byrne, D. *Teaching Writing*, London: Longman. 1975.
3. Rani Asoka, Devi Vimala. *English for Career development: A Course in Functional English.* Orient Longman Pvt. Ltd., India, 2004.
4. Anderson, K., Maclean, J. & Lynch, T. *Study speaking: A Course in Spoken English for Academic Purposes*. Cambridge University Press, UK, 2004.
5. Withrow, J., Brookes, G. & Cummings, M.C. *Inspired to write. Reading and Tasks to Develop Writing Skills*. Cambridge University Press, U.K., 2004.

COURSE OUTCOMES:

CO1: Identify the steps in the job search process

CO2: Describe themselves and their experiences in a résumé

CO3: Build their job-related vocabulary

CO4: Write a clear cover letter that tells employers why they are the right person for the job

CO5: Take part in Group discussion confidently.

Board of Studies (BoS):	**Academic Council:**
15th BoS of the Department of English held on 14.6.2022	19th Meeting of the Academic Council held on 29.09.2022

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

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

Statement: This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

SEMESTER II

GEE 6201	RESEARCH METHODOLOGY AND IPR	L	T	P	C
SDG: 4, 8, 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To apply a perspective on research

COB2: To analyze the research design, information retrieval and problem formulation techniques.

COB3: To select the appropriate statistical techniques for hypothesis construction and methods of data analysis and interpretation

COB4: To execute the effective communications of research findings and apply the ethics in research.

COB5: To describe the research findings as research reports, publications, copyrights Patenting and Intellectual Property Rights.

PREREQUISITES:

- Basics of core engineering, probability and statistics.
- Basics of flowchart and algorithm techniques.

MODULE I RESEARCH PROBLEM FORMULATION AND RESEARCH DESIGN **6**

Research - objectives – types - Research process, solving engineering problems - Identification of research topic - Formulation of research problem, literature survey and review. Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle, Design of experimental setup, Mathematical modeling - Simulation, validation and experimentation.

MODULE II DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA **8**

Sources of Data, Use of Internet in Research, Types of Data - Research Data Processing and analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision –limitations, Application of Computer in Research- Spreadsheet tool - Basic principles of Statistical Computation. Importance of statistics in research - Concept of probability - Popular distributions - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays.

MODULE III OPTIMIZATION TECHNIQUES 8

Use of optimization techniques - Traditional methods – Evolutionary Optimization Techniques. Multivariate analysis Techniques, Classifications, Characteristics, Applications - correlation and regression, Curve fitting.

MODULE IV INTELLECTUAL PROPERTY RIGHTS 8

The Research Report - Purpose of written report - Synopsis writing - preparing papers for International Journals, Software for paper formatting like LaTeX/MS Office, Reference Management Software, Software for detection of Plagiarism – Thesis writing, - Organization of contents - style of writing- graphs, charts and Presentation tool - Referencing, Oral presentation and defense - Ethics in research - Patenting, Intellectual Property Rights - Patents, Industrial Designs, Copyrights, Trade Marks, Geographical Indications-Validity of IPR, Method of Patenting, procedures, Patent Search.

L –30 ; TOTAL HOURS – 30

TEXT BOOKS:

1. Ganesan R., “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
2. George E. Dieter., “Engineering Design”, McGraw Hill – International edition, 2020.
3. Kothari C.R., “Research Methodology” – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2020.
4. Kalyanmoy Deb., “Genetic Algorithms for optimization”, Kangal report, No.2001002.
5. Rajkumar S. Adukia, “Handbook on Intellectual Property Rights in India”, TMH Publishers, 2020.
6. Prabhuddha Ganguli. ”Intellectual Property Rights”. 1st Edition, TMH Publishers, 2012.

REFERENCES:

1. Holeman, J.P., ”Experimental methods for Engineers, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2. Govt. of India, ”Intellectual Property Laws; Acts, Rules & Regulations”, Universal Law Publishing Co. Pvt. Ltd., New Delhi 2020.
3. R Radha Krishnan & S Balasubramanian, ”Intellectual Property Rights”. 1st Edition, Excel Books, 2012.
4. Derek Bosworth and Elizabeth Webster. ”The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2013.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

CO1: Formulate the research problem

CO2: Design and Analyze the research methodology

CO3: Apply statistical techniques for hypothesis construction

CO4: Analyze and interpret the data to construct and optimize the research hypothesis

CO5: Report the research findings as publications, copyright, trademarks and IPR

Board of Studies (BoS) :
23rd BOS of ECE held on 13.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H	H	M	L	L	L	L	L	L	L	H	H	H
CO2	H	H	H	H	M	-	-	-	-	-	-	-	H	H	H
CO3	H	H	H	H	M	L	L	L	L	L	L	-	H	H	H
CO4	H	H	H	H	M	-	M	M	M	M	M	-	H	H	H
CO5	H	H	H	H	M	-	M	M	M	M	M	-	H	H	H

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

SDG 4: Analysis and design of core field design promotes engineering skills and quality education.

Statement: This course enables the student to analyze the existing technology for further solution and its qualitative measures in terms of societal requirements.

SDG 8: Development of new technologies with core field design provides sustainable economic growth and productive employment.

Statement: To apply the hybrid techniques and concepts for different applications provides sustainable economic growth and productive employment.

SDG 9: Creative and curiosity of core field design fosters innovation and sustainable industrialization.

Statement: This course plays major roles through innovative ideas in industry towards modern infrastructures and sustainability.

CSE 6221	NATURAL LANGUAGE	L	T	P	C
SDG: 8	PROCESSING	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 – Tree Bank 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- 45

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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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.

CSE 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 over fittingness of the Ex3 network and make improvementsusing 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 Tensor flow/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, Yoshua Bengio, 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 NeuralNetwork

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

Board of Studies (BoS):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	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

CSE 6223	SCALABLE ALGORITHMS FOR DATA SCIENCE	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the students to scalability and its' applications.

COB2: To comprehend network and data as graphs.

COB3: To explore modern applications of graph theory.

COB4: To introduce various algorithms to formulate data structures

COB5: To study the applications of scalability in solving engineering problems.

MODULE I INTRODUCTION **9**

Challenges of Massive Data- Scalability of Algorithms-Complexity Class-Scalable Reduction and Algorithmic Primitives.

MODULE II NETWORKS AND DATA **9**

Weighted Graphs and Affinity Networks -Sources of Affinities- Basic Problems in Data and Network Analysis- Sparse Networks and Sparse Matrices.

MODULE III CLUSTERING **9**

Local Algorithms for Network Analysis -Local Clustering and Random Walks-Performance Analysis of Local Clustering -Scalable Local Computation of Personalized Page Rank - Interplay Between Dynamic Processes and Networks - Cheeger's Inequality and its Parameterization.

MODULE IV PARTITIONING: GEOMETRIC TECHNIQUES FOR DATAANALYSIS **9**

Center points and Regression Depth – Scalable Algorithms for Center points - Geometric Separators-Dimension Reduction -Scalable Geometric Divide-and-Conquer -Graph Partitioning - Multiway Partition of Network and Geometric Data-Spectral Graph Partitioning.

MODULE V SPARSIFICATION : MAKING NETWORKS SIMPLER **9**

Spectral Similarity of Graphs -Spectral Graph Sparsification -Graph Inequalities and Low-Stretch Spanning Trees Edge Centrality, Sampling and Spectral Approximation- Scalable Dense-Matrix Computation via Sparsification-PageRank Completion of Networks.

L – 45 ; Total Hours– 45

TEXT BOOKS:

1. Ping Zhang, Jay Yellen, Jonathan L. Gross," Handbook of Graph Theoryǁ, ", Chapman and Hall/CRC, 2nd Edition, ISBN: 9781439880197, 2015.

REFERENCES:

1. Michel Rigo," Advanced Graph Theory and Combinatorics", Wiley & Sons, ISBN: 9781848216167, 2016.
2. Martin Charles, "Algorithmic Graph Theory and Perfect Graphs", North Holland, 2nd Edition, ISBN: 9780444515308, 2004.

COURSE OUTCOMES:

CO1: Formulate problems statements in terms of scalable algorithm.

CO2: Apply concepts of geometric techniques in real time problems.

CO3: Integrate core theoretical knowledge of graph theory to solve problems.

CO4: Analyze new networks using the main concepts of scalability.

CO5: Apply theories and concepts to test and validate independent mathematical thinking in problem solving.

Board of Studies (BoS):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

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

Statement :

By learning the scalable algorithmic design techniques, the students are able to implement better software by applying the algorithms that leads to sustainable economic growth, full and productive employment and decent work for all.

VALUE ADDED COURSE	L	T	P	C
	0	0	0	0

COURSE 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 of40 hours.
- Selection and completion of value added course by the students shall be endorsed by Head of the Department.

COURSE 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

COURSE OBJECTIVES:

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

GENERAL GUIDELINES:

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

COURSE OUTCOMES:

Students will be able to

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

PROFESSIONAL ELECTIVES (SEMESTER – I)

MAEY 01	LINEAR ALGEBRA	L	T	P	C
SDG: 4		3	0	0	3

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, WellesleyCambridge Press, Wellesley, 2016
3. K. Hoffman and R. Kunze,"Linear Algebra", Prentice Hall Ltd, NewJersey,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):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

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

CSEY 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 - Relational 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 – SubQueries – Unions – Transforming data.

MODULE III AGGREGATE FUNCTIONS AND DATA ANALYSIS 9

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

MODULE IV ANALYTICS USING COMLEX DATA TYPES 9

Date and time data types for analysis– Performing geospatial analysis 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 –Case study.

L – 45; Total Hours– 45

TEXT BOOKS:

1. Upom Malik, Matt Goldwasse and Benjamin 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 Data science: Data Analysis andprediction 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 solveopen data analytics problems

Board of Studies (BoS):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

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

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

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)

CSEY 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 – Distributedcomputing 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 ofVMs 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, Apache Cloud Stack, 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 computingmodels.
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):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
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 societycritically and to communicate them in public spheres.

CSEY 303	EXPLORATORY DATA ANALYTICS	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 data frames - 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 group by() – Group by 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

Understanding regression - Model development and evaluation – Model Hypothesis Testing and Regression - Hypothesis testing - p-hacking - 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 Python Perform 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):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
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.

CSEY 351	BUSINESS INTELLIGENCE	L	T	P	C
SDG: 9		3	0	0	3

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 visualization tools.

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, Dursun Delen, Efrainm Turban, “Business Intelligence a Managerial Perspective on Analytics”, Pearson Publications, 3rdEdition, 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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
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 (SEMESTER – II)

CSEY 304	INTELLIGENT INFORMATION	L	T	P	C
SDG: 4	RETRIEVAL	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) inIR – 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):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	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.

CSEY 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 ofMa

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 VersusPresentation. 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):	**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	PO 11	PO 12	PSO 1	PSO 2
CO1				M										L
CO2					H									H
CO3														
CO4								M			L		M	
CO5											H			

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

SDG 9: Promoting sustainable industries, and investing in scientific researchand 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.

CSEY 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. Saroj Kaushik, Sunita Tiwari ,“Soft Computing “,McGraw-Hill Education, ISBN:9789353160678, 9353160677, 2018.
2. Millie Pant, Kanad Ray, Anirban Bandyo padhyay, ”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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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.

CSEY 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 DYNAMICSMODELS AND HOPFIELD 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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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
CO1		L											L		
CO2	M												M		
CO3					M								M		
CO4							M							M	
CO5								H						H	

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

SDG 4: Quality Education

Ensure inclusive and equitable quality education and promote lifelonglearning 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.

CSEY 308	KNOWLEDGE ENGINEERING AND	L	T	P	C
SDG: 4	EXPERT SYSTEMS	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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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.

CSEY 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 java scripts – 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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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.

CSEY 310	DISTRIBUTED PARALLEL AND SPATIAL	L	T	P	C
SDG: 9	DATABASES	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):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	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													H
CO2					M									
CO3		L												
CO4			M											
CO5				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.

CSEY 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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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
CO1	H													M	
CO2			M												
CO3				M											
CO4					L										
CO5		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.

CSEY 353	OPTIMIZATION METHODS FOR	L	T	P	C
SDG: 9	ANALYTICS	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 multi objective 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 MULTIOBJECTIVE OPTIMIZATION METHODS 9

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):
20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO 1	PSO 2
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.

CSEY 354	KNOWLEDGE REPRESENTATION AND	L	T	P	C
SDG: 9	REASONING	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

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20th BoS of Department of CSE held on 16.08.2022

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19th Academic Council held on 29.09.2022

	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.

CSEY 355	DATA SCIENCE WITH BIO	L	T	P	C
SDG: 9	INFORMATICS	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 algorithmsapplied in knowledge based systems.

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

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20th BoS of Department of CSE held on 16.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	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.

CSEY 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:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	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
CO1			H		L	H	H						L	L
CO2	L		M			M	M					M	M	M
CO3	L	H	M		H	M	M	M				H	H	M
CO4	M		H			H	H					M	M	M
CO5	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.

PROFESSIONAL ELECTIVES (SEMESTER - III)

		L	T	P	C
CSDY 312	**PATTERN RECOGNITION FOR MACHINE LEARNING**				
SDG 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To understand the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms.

COB2: To design and implement certain important pattern recognition techniques

COB3: To apply both supervised and unsupervised classification methods to detect and characterize patterns in real-world data.

COB4: To implement the entropy minimization, clustering transformation and feature ordering

COB5: To apply the knowledge of feature extraction methods, feature evaluation, and data mining on real life

MODULE I PATTERN CLASSIFIER **9**

Overview of pattern recognition - Discriminant functions - Supervised learning - Parametric estimation - Maximum likelihood estimation - Bayesian parameter estimation - Perceptron algorithm - LMSE algorithm - Problems with Bayes approach - Pattern classification by distance functions - Minimum distance pattern classifier.

MODULE II UNSUPERVISED CLASSIFICATION **9**

Clustering for unsupervised learning and classification - Clustering concept - C-means algorithm – Hierarchical clustering procedures - Graph theoretic approach to pattern clustering - Validity of clustering solutions.

MODULE III STRUCTURAL PATTERN RECOGNITION **9**

Elements of formal grammars - String generation as pattern description - Recognition of syntactic description - Parsing - Stochastic grammars and applications - Graph based structural representation.

MODULE IV FEATURE EXTRACTION AND SELECTION **9**

Entropy minimization - Karhunen - Loeve transformation - Feature selection through functions approximation -Binary feature selection.

MODULE V NEURO FUZZY AND GENETIC ALGORITHM CLASSIFICATION **9**

Neural network structures for Pattern Recognition - Neural network based Pattern

associators – Unsupervised learning in neural Pattern Recognition - Self organizing networks - Fuzzy logic – Fuzzy pattern classifiers - Pattern classification using Genetic Algorithms.

L – 45; Total Hours – 45

TEXT BOOKS:

1. Ulisses Braga-Neto ,Fundamentals of Pattern Recognition and Machine Learning,Springer,2020. ISBN 978-3-030-27655-3
2. Duda R.O., and Hart.P.E.,Pattern Classification and Scene Analysis, second edition, Wiley, 2001.
3. Robert J.Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, JohnWiley& Sons Inc., New York, 2007.
4. Trevor H, Robert T,Jerome Friedman, The Elements of Statistical Learning, Springer Series,2017
5. Christopher M Bishop, Pattern Recognition and Machine Learning. Springer. 2011.

REFERENCES:

1. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.
2. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.

COURSE OUTCOMES:

CO1: Design systems and algorithms for pattern recognition (signal classification), with focus on sequences of patterns that are analyzed using, e.g., hidden Markov models (HMM)

CO2: Analyze classification problems probabilistically and estimate classifier performance

CO3: Understand the impact of dimensionality reduction on the design of intelligent models and to apply the dimensionality reduction techniques on data

CO4: Apply Maximum-likelihood parameter estimation in relatively complex probabilistic models, such as mixture density models and hidden Markov models

CO5: Understand the principles of Bayesian parameter estimation and apply them in relatively simple probabilistic models

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	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	m	H		L	L			M		H			M		L
CO2		L													
CO3	h	H		H		H		M		L		M		H	
CO4		M											L		
CO5	l			M						H					M

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

SDG 9 : Develop dynamic classification and clustering algorithm for real time applications.

Statement : The holistic understanding of pattern recognition and artificial intelligence leads to construction of robust algorithms and sustainable industrialization.

CSEX 313	ADVANCED MACHINE LEARNING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To explore the deep belief networks.

COB2: To explore the unsupervised machine learning techniques.

COB3: To educate the various semi-supervised learning techniques.

COB4: To evaluate the convolution neural networks.

COB5: To Expose the students to ensemble methods

MODULE I UNSUPERVISED MACHINE LEARNING AND DEEP BELIEF NETWORKS 9

Unsupervised machine learning - Working of unsupervised learning - Types of Unsupervised learning algorithm - Clustering – clustering analysis - Association Rule learning - Self-organizing maps - Employing SOMSOM - Deep Belief Networks - Neural networks – Composition of neural network - Network topologies - Restricted Boltzmann Machine.

MODULE II STACKED DENOISING AUTOENCODERS AND CONVOLUTION NEUTAL NETWORKS 9

Convolution layers – Stacked Denoising Autoencoders - Autoencoder Topology – Training Adaptive Stacked Denoising Autoencoder - Stacked convolution sparse Denoising Autoencoders - Convolutional Neural Networks – convNet Convolutional Neural Networks – convNet topology layers – CNN algorithms - Use case implementation using CNN.

MODULE III SEMI-SUPERVISED LEARNING 9

Semi-Supervised Learning – Consistency, Cluster and Manifold Assumptions – Working of Semi-supervised learning - Applications - Types of Semi-supervised algorithms - Self-training – Building and Finessing self-training classifier – Contrastive Pessimistic Likelihood Estimation - Mixture models - Heuristicapproaches.

MODULE IV FEATURE ENGINEERING 9

Feature Engineering - Life cycle and Techniques - Creating a feature set – Engineering features for ML applications - Rescaling techniques to improve the learnability of features - Creating effective derived variables - Reinterpreting non-numeric features – Correlation – LASSO - Recursive Feature Elimination.

MODULE V ENSEMBLE METHODS 9

Ensembles - Averaging ensembles - Bagging algorithms - Random forests – Applying boosting methods - XGBoost - Stacking ensembles - Applying ensembles in practice - Models in dynamic applications - Understanding model robustness - Modeling risk factors - Strategies to managing model robustness.

L – 45; Total Hours – 45

TEXT BOOKS:

1. By John D. Kelleher, Brian Mac Namee and Aoife D'Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics”, MIT Press, 1st Edition, ISBN: 9780262029445. 2015.
2. Amouzegar, Mahyar (Ed.), “Advances in Machine Learning and Data Analysis”, Springer, 1st Edition, ISBN 978-90-481-3176-1, 2010.

REFERENCES:

1. Koronacki, Jacek, Ras, Zbigniew W, Wierzchon, Slawomir T. ,“Advances in Machine Learning II” , Springer, 1st Edition, ISBN 978-3-642-05178-4, 2010
2. John Hearty, “Advanced Machine Learning with Python”, PACKT publishing limited, Kindle Edition, ISBN-13: 978-1784398637, 2016.
3. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2nd Edition, ISBN-10: 0-387-31073-8, 2006.

COURSE OUTCOMES:

Students who complete this course will be able to

CO1: Design the semi-supervised learning techniques.

CO2: Develop- the unsupervised learning techniques.

CO3: Improve the effectiveness of your deep learning models further by using powerful ensembling techniques.

CO4: Develop the accuracy of models and existing input data using powerful features engineering techniques**.**

CO5: Use multiple learning techniques to improve the consistency of results.

Board of Studies (BoS):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO2	PSO3
CO1	M	M	M	L	L	L			L	L	L		L		
CO2	M	M	M	L	L	L			L	L	L		L	L	
CO3	M	M	M	L	L				L	L	L		L	L	
CO4	M	M	M	M	H	L			M	L	L		L		
CO5	M	L	L	M	L				M	L	L		L		

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

SDG 9: Automate large sets of complex data and overcome time-consuming practical challenges.

The holistic understanding of Advanced Machine Learning by developing the principles components analysis, Deep Belief Network, Understanding Stacked Denoising Autoencoders, Semi-Supervised, Averaging ensembles.

CSEY 314	**RISKS AND DECISION MAKING FOR DATA**	**L**	**T**	**P**	**C**
SDG: 9	**SCIENCE AND ARTIFICIAL INTELLIGENCE**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To introduce decision support frameworks and enabling technologies.

COB2: To understand the predictive analytics including statistical concepts and inferences.

COB3: To emphasize the prescriptive analytics including optimization and simulation.

COB4: To discover personal assistants, chatbots and recommender systems.

COB5: To learn the security, privacy, risks and societal dimensions of Analytics and AI.

MODULE I DECISION SUPPORT SYSTEMS 9

Decision Making process – Data and its analysis in Decision Making – Technologies for Data Analysis and Decision Support –Computerized Decision Support to Business Intelligence – Analytics overview – Artificial Intelligence overview – Convergence of Analytics and AI

MODULE II PREDICTIVE ANALYTICS 9

Nature of Data – Data preprocessing – Statistical Modeling for Business Analytics – Business Reporting – Data Visualization – Predictive Analytics and Data Mining – Machine Learning Techniques for Predictive Analytics.

MODULE III PRESCRIPTIVE ANALYTICS 9

Model Based Decision Making – Structure of Mathematical Models for Decision Support – Certainty, Uncertainty and Risk – Decision Modeling with Spreadsheets – Mathematical Programming Optimization - Multiple goals – Sensitivity Analysis – Decision Analysis with Decision Tables and Decision Trees.

MODULE IV KNOWLEDGE SYSTEMS 9

Expert Systems and Recommenders – Concepts, Drivers and Benefits of Chatbots – Enterprise Chatbots – Virtual Personal Assistants – Robo Advisors – Implementation issues.

MODULE V CAVEATS OF ANALYTICS AND AI 9

Implementation issues – Legal, Privacy and Ethical issues – Impacts of intelligent systems on organizations – Impact on decision making – Industrial restructuring – Impacts on Jobs and Works – Potential dangers of Robots, AI and Analytical modeling – Risk Modeling - Risk Categorization/Classification Model - Predicting risk - Relevant Technology Trends – Future of Intelligent Systems.

L – 45 ; Total Hours – 45

TEXT BOOKS:

1. Ramesh Sharda, Dursun Delen and Efraim Turban, "Systems for Analytics, Data Science, & Artificial Intelligence: Systems for Decision Support", Pearson, 11th edition, March 2020, (ISBN 13: 978-1-292-34155-2).
2. Archie Addo, Srini Centhala and Muthu Shanmugam, "Artificial Intelligence for Risk Management", Business Expert Press, March 2020, (ISBN 13: 978-1949443516).

REFERENCES:

1. Luiz Paulo Favero and Patricia Belfiore, "Data Science for Business and Decision Making", Elsevier, 2019, (ISBN-13: 9780128112168).
2. Banasiewicz Andrew D, "Evidence-Based Decision-Making", Taylor & Francis, 1st edition, March 2019, (ISBN-13: 978-1138485198)

COURSE OUTCOMES:

CO1: Design classical knowledge driven decision support systems to solve real time problems.

CO2: Use predictive models to forecast inventory and manage resources.

CO3: Determine an optimal course of action to achieve organizational goals.

CO4: Implement different types of new generation expert knowledge systems.

CO5: Analyze the risks and implementation issues of intelligent systems.

Board of Studies (BoS):	**Academic Council:**
20th BoS of Department of CSE held on 16.08.2022	19th Academic Council held on 29.09.2022

	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	M	M	M	L	L	L			L	L	L		L	
CO2	M	M	M	L	L	L			L	L	L		L	L
CO3	M	M	M	L	L				L	L	L		L	L
CO4	M	M	M	M	H	L			M	L	L		L	
CO5	M	L	L	M	L				M	L	L		L	

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

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

Statement:

The holistic understanding of the decision making processes for business analytics, data science and artificial intelligence can build intelligent decision support systems in customer relationship management, banking and finance, health care and medicine, sports and entertainment and virtually every industry imaginable.

CSEY315	ROBOTICS AND INTELLIGENT SYSTEMS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: Introduce the components of robots, basic working concepts and types of robots.

COB2: Understand the various robot programming languages.

COB3: Enlighten the students with robot design process.

COB4: Illustrate the intelligent algorithm used in robotics.

COB5: Expose the students to the fundamentals of AI and Intelligent systems and its application in Robotics.

MODULE I INRTODUCTION TO ROBOTICS 9

Introduction- brief history- components of robotics – classification – workspace - work-envelop - motion of robotic arm - end-effectors and its types - service robot and its application - Artificial Intelligence in Robotics.

MODULE II ROBOT PROGRAMMING 9

Introduction to robot languages –VAL – RAPID – language - basic commands - motion instructions - pick and place operation using industrial robot - manual mode - automatic mode - subroutine command based programming - move master command language – introduction - syntax-simple problems.

MODULE III ROBOT DESIGN PROCESS 9

Image recognition process – Neural network – Picking up the toys - Task Analysis - Teaching the robot arm - Other robot arm machine learning approaches – Teaching a Robot to listen - Robot Speech recognition.

MODULE IV ALGORITHM 9

A* algorithm - D* Algorithm - probabilistic roadmap algorithm - Zero Moment Point (ZMP) Algorithm - Proportional Integral Differential (PID) Control Algorithm - GPS path finding.

MODULE V INTELLIGENT SYSTEMS 10

basic activities of Intelligent system – Interpretation – Prediction – Diagnosis – Design – Planning – Monitoring – Debugging – Repair – Instruction – Control - Basic aspects of Intelligent system – Acquisition module - Knowledge base –

Production rules - semantic net – frames - Inference engine – Backward chaining and forward chaining - Explanatory interface. Applications of Expert System - Design Domain - Medical Domain - Monitoring Systems - Process Control Systems - Knowledge Domain - Finance/Commerce.

L – 45 ; Total Hours – 45

TEXT BOOKS:

1. John J. Craig, “Introduction to Robotics: Mechanics and Control, 4th Edition”, Addison Wesley publication, 2018.
2. D.W. Patterson, “Introduction to AI and Expert Systems”, PHI, 1992.

REFERENCES:

3. Tsuneo Yoshikawa, “Foundations of Robotics: Analysis and Control”, MIT Press, 2nd edition, ISBN: 0262240289, 2013.
4. Francis X. Govers, “Artificial Intelligence for robotics”, 1st Edition, Packt publishing Ltd, UK, ISBN :978-1-78883-544-2, 2018.
5. Peter Sincak, Pitoyo Hartono, Maria Vircikova, Jan Vascak, Rudolf Jaksa, “Emerging Trends in Robotics and Intelligent Systems”, 1st Edition, Springer Cham Heidelberg New York Dordrecht London, 2015, ISBN : 978-3-319-10783-7.

COURSE OUTCOMES:

CO1: Understand the basic concepts of working of robot.

CO2: Ability to program the robot for the real time application.

CO3: Conduct and design the experiments for various robot operations.

CO4: Comprehend and analyze the algorithm for the given specific problem.

CO5: Familiarize the application of AI in robotics.

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	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
CO1							L							I	
CO2			L												
CO3			L		L										
CO4	L				H										M
CO5			M		M										

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

SDG 9: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.

Upgrade infrastructure and retrofit industries to make them sustainable with the knowledge and understanding of advanced technology like robotics, Intelligent systems etc.

CSEY 316	COMPUTER VISION USING MACHINE LEARNING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce major deep neural network frameworks and issues in basic neural networks.

COB2: To solve real world applications using machine learning.

COB3: To Develop the practical skills necessary to build computer vision applications.

COB4: To enable the student to apply these techniques in applications which involve perception, reasoning and learning.

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

MODULE I INTRODUCTION TO COMPUTER VISION 9

Brief history of Computer Vision – Image Processing, Machine Learning - Feature Selection, Supervised-SVM, Unsupervised – K-means Clustering, Semi-Supervised – Feature Extraction – SIFT, SURF, FAST, ORB - Information Retrieval – Neuroscience – Robotics – Speech – Cognitive Sciences – Graphics, Algorithms, Systems and Theory – Pattern Recognition – Computer Graphics.

MODULE II COMPUTER VISION FOUNDATIONS 9

Image Processing - Color - Linear Algebra Primer - Pixels and Filters - Edge Detection - Features and Fitting - Feature Descriptors - Image Resizing - Segmentation - Semantic Segmentation - Clustering - Object recognition - Dimensionality Reduction - Face Identification - Visual Bag of Words - Object Detection from Deformable Parts - Semantic Hierarchies and Fine Grained Recognition - Motion - Tracking - Deep Learning.

MODULE III IMAGE FORMATION 9

Geometric primitives and transformations – Photometric image formation – The digital camera – Point operators – Linear Filtering – More neighborhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization.

MODULE IV IMAGE PRE-PROCESSING 9

Feature detection and matching – Segmentation – Edge detection - 2D and 3D

feature based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation – Two-Frame Structure from motion – Factorization – Bundle adjustment – Constrained Structure and Motion – Dense motion estimation.

MODULE V 3D VISION **9**

Methods for 3D Vision - 3D reconstruction – Image based rendering, Image Recognition – Object Detection – Space, Instance and Category Recognition – Recognition Databases and test sets.

L – 45; Total Hours – 45

TEXT BOOKS:

1. Ranjay Krishna, "Computer Vision: Foundations and Applications", 2nd Edition, Stand ford University, ISBN-4543066381, 2017.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", 3rd Edition, O'Reilly Media, Sebastopol, ISBN-6620414801,2017.

COURSE OUTCOMES:

Students who complete this course will be able to

CO1: Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.

CO2: Design and develop custom Deep-nets for human intuitive applications.

CO3: Design of test procedures to assess the efficiency of the developed model.

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

CO5: Gaining exposure to three dimensional data acquisition.

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	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	M		L				L				L			L
CO2					L					L		H		
CO3		M					H		M					M
CO4				L	H							L		L
CO5	M		H							M				

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

SDG 9 : Industry Innovation and Infrastructure

Statement: Promote inclusive and sustainable industrialization, enhance research and upgrade the technology. Streamlines a system by removing human inputs, which decreases errors, increases speed of delivery, boosts quality, minimizes costs, and simplifies the business process.

CSEY 317	ARTIFICIAL INTELLIGENCE FOR MEDICINE	L	T	P	C
SDG: 4,9		3	0	0	3

COURSE OBJECTIVES:

COB1: To Learn basic of artificial intelligence in medicine by algorithms, models and data sources

COB2: To attain knowledge by analysis of biomedical images using deep learning.

COB3: To explore the information by model development and validation.

COB4: To analyze the machine learning algorithms for medical data and system for wellness and healthy living.

COB5: To create apps for medicine based on locations, decision support and predictions.

MODULE I ARTIFICIAL INTELLIGENCE IN MEDICINE: PAST, PRESENT AND FUTURE **9**

Introduction, applications in medicine – Algorithms and models – Health data sources and types – Challenges – Technology used in clinical artificial intelligence tools – Clinical applications

MODULE II BIOMEDICAL IMAGING AND ANALYSIS THROUGH DEEP LEARNING **9**

Introduction – Tomographic Image Reconstruction – Image Segmentation – Image Registration – Deep Learning based Radiomics – Variants of Distributed Learning – Handling data heterogeneity – Protecting patient privacy.

MODULE III ARTIFICIAL INTELLIGENCE MODEL DEVELOPMENT AND VALIDATION **9**

Introduction – Model Development – Learning a Model – Data Quality – Education – Deploying Artificial Intelligence in Clinical Settings: Introduction – Settings for Application of AI in Health Care – Applications of AI in Clinical Care Delivery – Criteria for AI Selection and Implementation in Clinical Care – AI and Interpretability.

MODULE IV ANALYTICS TOOLS FOR INTEGRATION OF BIOMEDICAL DATA IN MEDICINE & WELLNESS AND HEALTHY LIVING **9**

The rise of multimodal data in medicine, machine learning algorithms for integrating medicine and biological data, Artificial intelligence in wellness, healthy

living: introduction, Diet, Fitness and physical activity, sleep, mental health, Behavioral factors, Environments and social determinants of health.

MODULE V EXPERT SYSTEM IN ARTIFICIAL INTELLIGENCE 9

Introduction , Architecture of KBES , Components of Expert system, Inference using Knowledge in Frames , Expert System Development Shell , Mycin Expert systems, Mycin architecture, PXDES, Computer aided Diagnosis system,

L - 45 ; Total Hours - 45

TEXT BOOKS:

1. Michael Matheny, Sonoo Thadaney Israni, Mahnoor Ahmed and Danielle Whicher, “Artificial Intelligence in Health care”, National Academy of Medicine, 2022.
2. Lei Xing, Maryellen L. Giger and James K. Min, “Artificial Intelligence in Medicine”, Academic Press, Elsevier
3. C.S. Krishnamoorthy and S. Rajeev,” Artificial Intelligence and Expert Systems for Engineers”, CRC Press, CRC Press LLC, ISBN: 0849391253.

COURSE OUTCOMES:

CO1: Learn basic of artificial intelligence in medicine by algorithms, models and data sources.

CO2: Attain knowledge by analysis of biomedical images using deep learning.

CO3: Explore the information by model development and validation.

CO4: Analyze the machine learning algorithms for medical data and system for wellness and healthy living.

CO5: Create apps for medicine, collect AI laws and regulations related to health care and attain knowledgeable on expert systems in medicine.

Board of Studies (BoS):
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Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO1	PSO2
CO1	H	H	H	M	M	H	L	L	L	L	L	M	H	M
CO2	H	H	H	M	M	H	L	L	L	L	L	M	H	H
CO3	H	H	H	H	M	H	L	L	L	L	L	M	H	H
CO4	H	H	H	H	M	H	L	L	L	L	L	M	H	M
CO5	H	H	H	H	M	H	L	L	L	L	L	M	H	M

SDG 4, 9: Quality Education. Industry, innovation and Infrastructure

Statement : The learner is able to learn quality education and work with decision-makers to improve the uptake of sustainable infrastructure (including internet access)..

CSEY 362	ETHICS FOR DATA SCIENCE	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: Provide an overview of the data science.

COB2: To understand the knowledge of data ethics.

COB3: Illustrate the various research ethics in data science.

COB4: To learn the different data processing in data science.

COB5: To gain the knowledge about data science privacy and surveillance.

MODULE I INTRODUCTION **10**

Overview of ethical issues in data - driven organizations: Overview of data science as an ethical practice, Introduction to the unique ethical challenges of 'big data', Ethical Theory - Philosophical frameworks for assessing fairness, Early theories of fairness, Moving towards contemporary theories of fairness.

MODULE II RESEARCH ETHICS **10**

Research ethics for data science: Ethical side effects of the publish or perish system: p-hacking and small sample size - The misapplication of informed consent in dataveillance practices - Techniques of data ethics: Getting from data to individuals: Internet traces and Geofingerprints - All data are human data: On the discriminatory trouble with training data.

MODULE III DATA SCIENCE & ETHICS **9**

Discrimination and algorithms: The ethics of price discrimination - Criminal justice by algorithm - The philosophical challenge of thinking in categories - Social worlds through perceptions and statistics - Social processes and the impact of categorical life - Data ethics for researchers Health Research - Educational Research.

MODULE IV DATA PROCESSING ETHICS **8**

Ethics of data scraping and storage - Mosaic data - Found data and Designed Data.

MODULE V PRIVACY AND SURVEILLANCE **8**

privacy and Surveillance - Special topics in surveillance: Adtech - Employment - Differential privacy – Case Study.

L – 45; Total Hours – 45

REFERENCES:

1. Ethics and Data Science, by DJ Patil, Hilary Mason, and Mike Loukides, 25 July 2018, ISBN- 978-1-492-04388-1.
2. Bill Franks, “Things About Ethics Everyone in Data Science Should Know Writing”, O'Reilly Medi Publications, ISBN 9781492072669, 2020.
3. Vladimir Batagelj, Hans-Hermann Bock, AnukaFerligoj, Ale iberna, “Data Science and Classification”, Springer Publications, ISBN3540344152, 2016.

COURSE OUTCOMES:

CO1: Identified the basic knowledge and data science unique challenges.

CO2: Recognize the research data ethics in data science.

CO3: Data science ethics gathered from various algorithm and health research.

CO4: Memorize the data processing ethics like found and designed data.

CO5: Analyze the data security and privacy in data science.

Board of Studies (BoS):
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19th Academic Council held on 29.09.2022

	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
CO1	L												L		
CO2		L											L		
CO3				M										L	
CO4					M								M		
CO5					M									M	

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

SDG No 4: Industry, Innovation & Infrastructure
Build the knowledge in data science innovations and industrial development.

Statement : The holistic understanding of data science terminologies and components leads to the construction of resilient infrastructure and sustainable industrialization.

CSEY 363	SOCIAL NETWORK ANALYSIS AND MINING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES :

COB1: To understand the components of the social network.

COB2: To model and visualize the social network.

COB3: To mine the users in the social network.

COB4: To understand the evolution of the social network.

COB5: To know the applications in real time systems.

MODULE I INTRODUCTION 9

Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks - Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

MODULE II MODELING AND VISUALIZATION 9

Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix- Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

MODULE III MINING COMMUNITIES 9

Aggregating and reasoning with social network data, Advanced Representations – Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.

MODULE IV EVOLUTION 9

Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert

Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

MODULE V APPLICATIONS **9**

A Learning Based Approach for Real Time Emotion Classification of Tweets - A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments - Explaining Scientific and Technical Emergence Forecasting - Social Network Analysis for Biometric Template Protection.

L – 45;Total Hours - 45

TEXT BOOKS:

1. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel, — Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 2012.

REFERENCES :

1. Giles, Mark Smith, John Yen, —Advances in Social Network Mining and Analysis‖, Springer, 2010.
2. Guandong Xu , Yanchun Zhang and Lin Li, — Web Mining and Social Networking – Techniques and applications‖, Springer, 1st edition, 2012.

COURSE OUTCOMES :

Students who complete this course will be able to

CO1: Work on the internals components of the social network.

CO2: Model and visualize the social network.

CO3: Mine the behavior of the users in the social network.

CO4: Predict the possible next outcome of the social network.

CO5: Apply social network in real time applications.

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	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	M													
CO2			M											
CO3				H									M	
CO4						L						H	M	
CO5	M													M

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

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

Statement: By learning “SOCIAL NETWORK ANALYSIS AND MINING” the students will be able to analyze methods to extract data sets from the SOCIAL NETWORK with guidelines and frameworks for various real time applications which leads to sustainable economic growth and provide productive employment.