ACADEMIC REGULATIONS (BH25)
COURSE STRUCTURE
AND
DETAILED SYLLABUS

DATA SCIENCES

for

M.Tech. Two Year Degree Course

(Applicable for the batches admitted from A.Y. 2025-26 onwards)

BVRIT HYDERABAD College of Engineering for Women
(UGC Autonomous Institution | Approved by AICTE | Affiliated to JNTUH)
(NAAC Accredited – A Grade | NBA Accredited B.Tech. (EEE, ECE, CSE))
Bachupally, Hyderabad -500 090
www.bvrithyderabad.edu.in

BVRIT HYDERABAD College of Engineering for Women

VISION

To emerge as the best among the institutes of technology and research in the country dedicated to the cause of promoting quality technical education.

MISSION

At BVRITH, we strive to

- Achieve academic excellence through innovative learning practices.
- Enhance intellectual ability and technical competency for a successful career.
- Encourage research and innovation.
- Nurture students towards holistic development with emphasis on leadership skills, life skills and human values.

CORE VALUES

1. Holistic Development
2. Excellence in Education
3. Women Empowerment
4. Integrity
5. Social Responsibility
6. Accountability and Transparency
7. Freedom of Expression

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO-1: Exhibit innovation in the multidisciplinary realms using analysis, design and/or critical thinking, planning and implementation.

PEO-2: Apply the expertise and proficiency in Data Science to build a propitious and enduring career as Data Scientist and Analyst.

PEO-3: Build entrepreneurial competences to obtain feasible solutions using multifaceted data dealing techniques leading to start-ups and self-employment.

PEO-4: Instil life long learning to get accustomed with leading tools and technologies.

PEO-5: Inculcate ethics, human values and life skills for holistic development.

Program Outcomes

PO-1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO-2: An ability to write and present a substantial technical report/document.

PO-3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO-4: An ability to plan, develop, state-of-the-art applications to satisfy the customized needsof business and society.

PO-5: Assimilate domains of computer science, mathematics, and statistics to produce proficient and well-versed data scientists.

PO-6: Capacity to learn through one's own efforts through dynamism and engross in life-long learning.

Academic Regulations of M. Tech (Regular/Full Time) Programmes, (BH25) (CBCS)

(Effective for the students admitted into I Year from the AY 2025-26 and onwards)

1.0 Jawaharlal Nehru Technological University Hyderabad (JNTUH) offers **Two** Years (**Four** Semesters) full-time Master of Technology (M.Tech.) Degree programmes, under Choice Based Credit System (CBCS) at its non-autonomous affiliated colleges in different branches of Engineering and Technology with different specializations.

2.0 Eligibility for Admissions

2.1 Admission to the M.Tech. programme shall be made subject to eligibility, qualification and specializations prescribed by the University from time to time, for each specialization under each M.Tech. programme.

2.2 Admission to the post graduate programme shall be made on the basis of either the merit rank or Percentile obtained by the qualified student in the GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by Telangana Government (PGECET) for M.Tech. programmes/ an entrance test conducted by JNTUH/ on the basis of any other exams approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.3 The medium of instructions for all PG Programmes will be **ENGLISH** only.

3.0 M.Tech. Programme Structure

3.1 The M.Tech. Programs of JNTUH are of Semester pattern, consisting of **Two** academic years, each academic year having **Two** Semesters (Odd and Even Semesters).

3.2 The two-year M. Tech. program consists of **68** credits and the student has to register for all **68** credits and earn all **68** credits for the award of M. Tech. degree.

3.3 The student shall not take more than four academic years to fulfill all the academic requirements for the award of M. Tech. degree from the date of commencement of first year first semester, failing which the student shall forfeit the seat in M. Tech. programme.

3.4 **UGC/AICTE** specified definitions/descriptions are adopted appropriately for various terms and abbreviations used in these PG academic regulations, as listed below:

3.4.1 Semester Scheme

There shall be a minimum of 15 weeks of instruction, excluding the mid-term and semester-end exams. Around 15 instruction hours, 30 instruction hours and 45 hours of learning need to be followed per one credit of theory course, practical course and project/field-based learning respectively. In each semester, there shall be 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)' under Choice Based Credit System (CBCS). The curriculum/course structure suggested by AICTE is followed as a reference document.

3.4.2 Credit Courses

All courses are to be registered by the student in a semester to earn credits which shall be assigned to each course in an L: T: P: C (Lecture Periods: Tutorial Periods: Practical

Periods: Credits) structure based on the following general pattern:

- One credit for one hour/week/semester for theory/lecture (L) courses or tutorials (T)
- One credit for two hours/ week/semester for laboratory/ practical (P) courses
- One credit is allocated for three hours per week in a semester for Project/Mini-Project session.

3.4.3 Course Classification

All courses offered for the Post-Graduate M.Tech. Degree program are broadly classified as follows. The University has followed in general the guidelines issued by AICTE/UGC.

S. No.	Broad Course Classification	Course Group/ Category	Course Description
1	Core Courses (CoC)	PC- Professional Core	Includes courses related to the parent discipline/department/ branch of Engineering
		Dissertation	M. Tech. Project or PG Project or Major Project
		Mini Project with Seminar	Seminar based on core contents related to Parent Discipline/ Department/ Branch of Engineering
2	Elective Courses (EıE)	PE - Professional Electives	Includes elective courses related to the parent discipline/department/branch of Engineering
		OE - Open Electives	Elective courses which include inter-disciplinary courses or courses in an area outside the parent discipline/department/ branch of Engineering
3	Audit Courses	--	Non-Credit Audit Courses

4.0 Course Registration

4.1 A Faculty Advisor or Counselor shall be assigned to each specialization, who will advise on the Post Graduate Programme, its Course Structure and Curriculum, Choices/Options for Courses, based on his competence, progress, pre-requisites and interest.

4.2 The on-line Registration Requests for any current semester shall be completed before the commencement of SEEs (Semester End Examinations) of the preceding semester.

4.3 A Student can apply for on-line Registration, only after obtaining the written approval from his Faculty Advisor, which should be submitted to the College Academic Section through the Head of Department (a copy of it being retained with Head of Department, Faculty Advisor and the Student).

4.4 If the Student submits ambiguous choices or multiple options or erroneous entries during on-line Registration for the Course(s) under a given/ specified Course Group/ Category

as listed in the Course Structure, only the first mentioned Course in that Category will be taken into consideration.

4.5 Course Options exercised through on-line Registration are final and cannot be changed. further, alternate choices will not be considered. However, if the Course that has already been listed for Registration by the University in a Semester could not be offered due to unforeseen or unexpected reasons, then the Student will be allowed to have alternate choice either for a new Course, if it is offered, or for another existing Course (subject to availability of seats). Such alternate arrangements will be made by the Head of Department, with due notification and time-framed schedule, within the first week from the commencement of Class-work for that Semester.

5.0 Attendance Requirements

Attendance is calculated separately for each course.

5.1 Attendance in all classes (Lectures/Laboratories) is compulsory. The minimum required attendance in each theory course (***also Audit Courses***) including the attendance of mid-term examination / Laboratory etc. is 75%. Two periods of attendance for each theory course shall be considered, if the student appears for the mid-term examination of that course. ***This attendance should also be included in the attendance uploaded every fortnight in the University Website. The attendance of Audit Courses should be uploaded separately to the University.*** A student shall not be permitted to appear for the Semester End Examinations (SEE), if his attendance is less than 75%.

5.2 A student's Seminar report and presentation on Mini Project shall be eligible for evaluation, only if he ensures a minimum of 75% of his attendance in Seminar presentation classes on Mini Project during that Semester.

5.3 **Condoning of shortage of attendance** up to a maximum of 10% (considering the days of attendance in sports, games, NCC, NSS activities and Medical grounds) in each course (Theory/Lab/Mini Project with Seminar) of a semester shall be granted by the College Academic Committee on genuine reasons.

5.4 A prescribed fee per course shall be payable for condoning shortage of attendance after getting the approval of College Academic Committee for the same. The College Academic Committee shall maintain relevant documents along with the request from the student.

5.5 Shortage of Attendance below 65% in any course shall in **no case be condoned.**

5.6 A Student, whose shortage of attendance is not condoned in any course(s) (Theory/Lab/Mini Project with Seminar) in any Semester, is considered as 'Detained in that course(s), and is not eligible to write Semester End Examination(s) of such course(s), in that Semester; and he/she has to seek re-registration for those course(s) in subsequent Semesters, and attend the same as and when offered.

5.7 A student fulfills the attendance requirement in the present semester, shall not be eligible for readmission into the same class.

5.8 **a)** A student shall put in a minimum required attendance in at least three theory courses (excluding Audit course) in first Year I semester for promotion to first Year II Semester.

b) A student shall put in a minimum required attendance in at least three theory courses (excluding *Audit* course**)** in first Year II semester for promotion to second Year I Semester.

6.0 Academic Requirements

The following academic requirements must be satisfied, in addition to the attendance requirements mentioned in clause no. 5. The performance of the candidate in each semester shall be evaluated course-wise, with a maximum of 100 marks per course (theory / practical), based on Continuous Internal Evaluation and Semester End Examination.

6.1 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course, if he secures not less than:

- 40% of Marks (24 out of 60 marks) in the Semester End Examination;
- 40% of Marks in the internal examinations (16 out of 40 marks allotted for CIE); and
- A minimum of 50% of marks in the sum total of CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades this implies securing **'B'** Grade or above in a course.

6.2 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to Mini Project with seminar, if student secures not less than 50% marks (i.e. 50 out of 100 allotted marks). The student would be treated as failed, if student (i) does not submit a seminar report on Mini Project or does not make a presentation of the same before the evaluation committee as per schedule or (ii) secures less than 50% marks in Mini Project with seminar evaluation. The failed student shall reappear for the above evaluation when the notification for supplementary examination is issued.

6.3 A student shall register for all courses for total of **68** credits as specified and listed in the course structure for the chosen specialization, put in the required attendance and fulfill the academic requirements for securing **68** credits obtaining a minimum of **'B'** Grade or above in each course, and shall ***pass all the Audit Courses*** to complete the M.Tech. Programme successfully.

Note: (1) The SGPA will be computed and printed on the marks memo only if the candidate passes in all the courses offered and gets minimum B grade in all the courses.

(2) CGPA is calculated only when the candidate passes in all the courses offered in all the semesters

6.4 Letter Grades obtained in all those courses covering the above specified **68** credits alone shall be considered for the calculation of final CGPA, which will be indicated in the consolidated grade memo.

6.5 When a student is detained due to shortage of attendance in any course(s) in any semester, shall not be permitted to write the Semester End Examinations. However, he is eligible for re-registration of such course(s) in the subsequent semester(s), as and
when next offered, with the academic regulations of the batch into which he is re-registered, by paying the prescribed fees per course. In all these re-registration cases, the student shall have to

secure a fresh set of internal marks and Semester End Examination marks for performance evaluation in such course(s), and SGPA/CGPA calculations.

6.6 A student eligible to appear for the Semester End Examination in any course, but absent from it or failed (failing to secure 'B' Grade or above), may reappear for that course at the supplementary examination as and when conducted. In such cases, his Internal Marks assessed earlier for that course will be carried over, and added to the marks secured in the supplementary semester end examination, for the purpose of evaluating his performance in that course.

6.7 A Student who fails to earn **68** credits as per the specified course structure, and as indicated above, within **four** academic years from the date of commencement of his first year first semester, shall forfeit his seat in M. Tech. programme and his admission **shall stand cancelled.**

7.0 Evaluation - Distribution and Weightage of Marks

The performance of a student in each semester shall be evaluated course- wise (irrespective of credits assigned) for a maximum of 100 marks.

7.1 The performance of a student in every course (including practicals and Project) will be evaluated for 100 marks each, with 40 marks allotted for CIE (Continuous Internal Evaluation) and 60 marks for SEE (Semester End-Examination). The Continuous Internal Evaluation for theory courses shall be made based on the average of the marks secured in the two Mid-Term Examinations conducted, first Mid-Term examinations in the middle of the Semester and second Mid-Term examinations during the last week of instruction.

7.2 In CIE, for theory courses, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of two hours as follows:

1. Mid-Term Examination for 30 marks:
   a. Part - A: Objective/quiz paper for 10 marks.
   b. Part – B: Descriptive paper for 20 marks.

The objective/quiz paper is set with multiple choice, fill-in the blanks and match the following type of questions for a total of 10 marks. The descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks.

The average of the two Mid Term Examinations shall be taken as the final marks for Mid Term Examination for 30 marks.

The remaining 10 marks of Continuous Internal Assessment (out of 40) are distributed as:

2. 5 marks for Assignment. (Average of 2 Assignments each for 5 marks)
3. Course Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned course for 5 marks.

While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

Five (5) marks are allocated for assignments (as specified by the course teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the

second assignment should be submitted before the conduct of the second mid-term examination. The average of the two assignments shall be taken as the final marks for assignment.

Course Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned course for five marks before II Mid-Term Examination.

- The Student, in each course, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.

The student is eligible to write Semester End Examination of the concerned course, if the student scores ≥ 40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned course but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that course in SEE shall stand cancelled inspite of appearing the SEE.

The details of the end semester question paper pattern are explained in the next clause:

7.3 The Semester End Examinations (SEE), for theory courses, will be conducted for 60 marks consisting of two parts viz. i) **Part- A** for 10 marks, ii) **Part - B** for 50 marks.

- Part-A is a compulsory question which consists of ten sub-questions with uniform coverage from all units carrying equal marks.
- Part-B consists of five questions (numbered from 2 to 6) carrying 10 marks each. Each of these questions is from each unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.
- The duration of Semester End Examination is three hours.

7.4 For practical courses there shall be a Continuous Internal Evaluation (CIE) during the semester for 40 marks and 60 marks for semester end examination. Out of the 40 marks for internal evaluation:

1. A write-up on day-to-day experiment in the laboratory (in terms of aim, components/procedure, expected outcome) which shall be evaluated for 10 marks
2. 10 marks for viva-voce (or) tutorial (or) case study (or) application (or) poster presentation of the course concerned.
3. Internal practical examination conducted by the laboratory teacher concerned shall be evaluated for 10 marks.
4. The remaining 10 marks are for Laboratory Project, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

In the Semester End Examination, held for three hours, total 60 marks are divided and allocated as

shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

- The Student, in each course, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.

The student is eligible to write Semester End Examination of the concerned course, if the student scores ≥ 40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned course but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that course in SEE shall stand cancelled inspite of appearing the SEE.

7.5 For conducting laboratory end examinations of all PG Programmes, one internal examiner and one external examiner are to be appointed by the Principal of the College and this is to be informed to the Director of University Examinations within two weeks, before commencement of the lab end examinations. The external examiner should be selected from outside the College concerned but within the cluster. No external examiner should be appointed from any other College in the same cluster/any other cluster which is run by the same Management.

7.6 There shall be Mini Project with Seminar during I year II semester for internal evaluation of 100 marks. The Departmental Academic Committee (DAC) will review the progress of the mini project during the seminar presentations and evaluate the same for 50 marks. Mini Project Viva Voce will be evaluated by the DAC for another 50 marks before the semester end examinations. Student shall carryout the mini project in consultation with the mini project supervisor which may include critically reviewing the literature, project implementation and submit it to the department in the form of a report

and shall make an oral presentation before the DAC consisting of Head of the Department, Mini Project supervisor and two other senior faculty members of the department. The student has to secure a minimum of 50% of marks in i) seminar presentation and ii) mini project viva voce, to be declared successful. If he fails to obtain the minimum marks, he has to reappear for the same as and when scheduled.

7.7 Every candidate shall be required to submit a dissertation on a topic approved by the Dissertation Review Committee.

7.8 The M.Tech. Dissertation shall be prepared in the structure prescribed by the University, adhering to the style files and formatting guidelines. To facilitate this process, each institution will organize a brief orientation session for the entire class/section at the beginning of the final semester, guiding the students on the required structure and formatting of the dissertation.

7.9 A Dissertation Review Committee (DRC) shall be constituted with the Head of the Department as Chairperson, Dissertation Supervisor and one senior faculty member of the Department offering the M.Tech. programme.

7.10 Registration of Dissertation Work: A candidate is permitted to register for the Dissertation Work after satisfying the attendance requirement in all the courses, both theory and laboratory.

7.11 After satisfying the previous clause, a candidate must present in ***Dissertation Work Review - I***, in consultation with his Dissertation Supervisor, the title, objective and plan of action of his Dissertation work to the Dissertation Review Committee (DRC) for approval ***within four weeks*** from the commencement of **Second year First Semester**. Only after obtaining the approval of the DRC can the student initiate the Dissertation work.

7.12 If a candidate wishes to change his supervisor or topic of the Dissertation, he can do so with the approval of the DRC. However, the DRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of Dissertation proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

7.13 A candidate shall submit his Dissertation progress report in two stages at least with a gap of **three** months between them.

7.14 The work on the Dissertation shall be initiated at the beginning of the II year and the duration of the Dissertation is two semesters. A candidate is permitted to submit Dissertation Thesis only after successful completion of all theory and practical courses with the approval of DRC ***not earlier than 40 weeks*** from the date of approval of the Dissertation work. For the approval of DRC, the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the DRC.

7.15 ***The Dissertation Work Review - II*** in II Year I Semester carries 100 internal marks. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate

the work for the other 50 marks. The Supervisor and DRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Dissertation Work. A candidate has to secure a minimum of 50% of marks to be declared successful in Dissertation Work Review - II. If he fails to obtain the minimum required marks, he has to reappear for Dissertation Work Review - II as and when conducted.

7.16 ***The Dissertation Work Review - III*** in II Year II Sem. carries 100 internal marks. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate it for the other 50 marks. The DRC will examine the overall progress of the Dissertation Work and decide whether or not the Dissertation is eligible for final submission. A candidate has to secure a minimum of 50% of marks to be declared successful in Dissertation Work Review - III. If he fails to obtain the required minimum marks, he has to reappear for Dissertation Work Review - III as and when conducted. For Dissertation Evaluation (Viva Voce) in II Year II Semester there are external marks of 100 and it is evaluated by the external examiner. The candidate has to secure a minimum of 50% marks

in Dissertation Evaluation (Viva-Voce) examination.

7.17 Dissertation Work Reviews - II and III shall be conducted in phase I (Regular) and Phase II (Supplementary). Phase II will be conducted only for unsuccessful students in Phase I. The unsuccessful students in Dissertation Work Review - II (Phase II) shall reappear for it at the time of Dissertation Work Review - III (Phase I). These students shall reappear for Dissertation Work Review- III in the next academic year at the time of Dissertation Work Review - II only after completion of Dissertation Work Review - II, and then Dissertation Work Review - III follows. The unsuccessful students in Dissertation Work Review - III (Phase II) shall reappear for Dissertation Work Review - III in the next academic year only at the time of Dissertation Work Review - II (Phase I).

7.18 After approval from the DRC, a soft copy of the thesis should be submitted for Anti-Plagiarism check and the plagiarism report should be submitted to the University and be included in the final thesis. The Thesis will be accepted for submission, if the similarity index is less than **30%**. If the similarity index is more than the required percentage, the student is advised to revise the thesis and re-submit the soft copy of the thesis after one month. The maximum number of re-submissions of thesis after plagiarism check is limited to ***TWO***. The candidate has to register for the Dissertation work and work for two semesters. After three attempts, the admission is liable to be cancelled.

7.19 Three copies of the Dissertation Thesis certified by the supervisor shall be submitted to the College/School/Institute.

7.20 The thesis shall be adjudicated by an external examiner selected by the University. For this, the Principal of the College/School/Institute shall submit a panel of **three** examiners from among the list of experts in the relevant specialization as submitted by the supervisor concerned and Head of the Department.

7.21 If the report of the external examiner is unsatisfactory, the candidate shall revise and

resubmit the Thesis. If the report of the examiner is unsatisfactory again, the thesis shall be summarily rejected. Subsequent actions for such dissertations may be considered, only on the specific recommendations of the external examiner and /or Dissertation Review Committee. No further correspondence in this matter will be entertained, if there is no specific recommendation for resubmission.

7.22 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and decide for the conduct of Dissertation Viva-Voce examination. The Dissertation Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The candidate has to secure a minimum of 50% of marks in Dissertation Evaluation (Viva-Voce) examination.

7.23 If he fails to fulfill the requirements as specified in the above clause, he will reappear for the Dissertation Viva-Voce examination ***only after three months***. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for award of the degree, unless he is asked to revise and resubmit his Dissertation Work by the board within a specified time period.

7.24 The Dissertation Viva-Voce External examination marks must be submitted to the University on the same day of the examination.

7.25 For Audit courses, a student has to secure 40 marks out of 100 marks (i.e. 40% of the marks allotted) in the continuous internal evaluation for passing the course. These marks should also be uploaded along with the internal marks of other courses.

7.26 No marks or letter grades shall be allotted for Audit Courses. Only Pass/Fail shall be indicated in Grade Card.

8.0 Re-Admission/Re-Registration

8.1 Re-Admission for Discontinued Student

A student, who has discontinued the M. Tech. degree programme due to any reason whatsoever, may be considered for '**readmission'** into the same degree programme (with the same specialization) with the academic regulations of the batch into which he gets readmitted, with prior permission from the authorities concerned.

8.2 If a student is detained in a course (s) due to shortage of attendance in any semester, he may be permitted to **re-register** for the same course(s) or the student may register in an equivalent course, If the same course is not available, as suggested by the Board of Studies of that department, in the subsequent semester(s), with the academic regulations of the batch into which he seeks re-registration, with prior permission from the authorities concerned.

8.3 A candidate shall be given chance to re-register any number of courses, if the candidate failed in these courses due to securing less than 40% marks in CIE. A candidate must re-register for failed courses within four weeks of commencement of the class work, in the next academic year and secure the required minimum attendance. In the event of the student taking this chance, his Continuous Internal Evaluation (internal) marks and

Semester End Examination marks obtained in the current semester only will be accepted, if he secures pass grade.

9.0 Examinations and Assessment - The Grading System

9.1 Grades will be awarded to indicate the performance of each student in each Theory Course, or Lab/Practicals, or Mini Project with Seminar, Dissertation, etc., based on the percentage of marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together), and a corresponding Letter Grade shall be given.

9.2 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured in a Course (Class Intervals)	Letter Grade (UGC Guidelines)	Grade Points
90% and above (≥ 90%, ≤ 100%)	O (Outstanding)	10
Below 90% but not less than 80% (≥ 80%, <90%)	A^+ (Excellent)	9
Below 80% but not less than 70% (≥70%, <80%)	A (Very Good)	8
Below 70% but not less than 60% (≥60%, <70%)	B^+ (Good)	7

Below 60% but not less than 50% (≥50%, <60%)	B (above Average)	6
Below 50% (< 50%)	F (FAIL)	0
Absent	**Ab**	**0**

9.3 A student obtaining **'F'** Grade in any Course is deemed to have 'failed' and is required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted. In such cases, his Internal Marks (CIE Marks) in those courses will remain as obtained earlier.

9.4 If a student has not appeared for the examinations, '**Ab**' Grade will be allocated to him for any course and shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted.

9.5 A Letter Grade does not imply any specific marks percentage; it is only the range of percentage of marks.

9.6 In general, a student shall not be permitted to repeat any Course (s) only for the sake of 'Grade Improvement' or 'SGPA/ CGPA Improvement'.

9.7 A student earns Grade Point (GP) in each Course, on the basis of the Letter Grade obtained by him in that Course. The corresponding 'Credit Points' (CP) are computed by multiplying the Grade Point with Credits for that particular Course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

9.8 The student passes the Course only when he **gets GP □ 6 (B Grade or above).**

9.9 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points secured from all Courses registered in a Semester, by the total number of credits offered in that Semester. SGPA is rounded off to two decimal places. SGPA is thus computed as

$$\textbf{SGPA} = \{ \sum_{i=1}^{N} C_i G_i \} / \{ \sum_{i=1}^{N} C_i \} \textbf{ …. For each Semester}$$

where 'i' is the Course indicator index (taking into account all Courses in a Semester), 'N' is the no. of Courses offered in the Semester (as specifically required and listed under the Course Structure of the parent Department), C_i is the no. of Credits allotted to the i^{th} Course, and G_i represents the Grade Points corresponding to the Letter Grade awarded for that i^{th} Course.

9.10 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in all registered Courses in all Semesters, and the Total Number of Credits registered in all the Semesters. CGPA is rounded off to two decimal places. CGPA is thus computed from the I Year Second Semester onwards, at the end of each Semester, as per the formula

$$\textbf{CGPA} = \{ \sum_{j=1}^{M} C_j G_j \} / \{ \sum_{j=1}^{M} C_j \}$$

(ie., up to and inclusive of S Semesters, S ≥ 2),

where 'M' is the total no. of Courses (as specifically required and listed under the Course Structure of the parent Department) the Student has 'registered'. C_j is the no. of Credits allotted to the j^{th} Course, and G_j represents the Grade Points (GP) corresponding to the Letter Grade awarded for that j^{th} Course. After registration and completion of I Year I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

Illustration of calculation of SGPA

Course	Credits	Letter Grade	Grade points	Credit Points
Course 1	4	A	8	4*8 = 32
Course 2	4	O	10	4*10 = 40
Course 3	4	B	6	4*6 = 24
Course 4	3	B	6	3*6 = 18
Course 5	3	A+	9	3*9 = 27
Course 6	3	B	6	3*6 = 18
	21			159

SGPA = 159/21 = 7.57

Illustration of calculation of CGPA from SGPA

Semester	Credits	SGPA	Credits * SGPA
Semester I	24	7	24*7 = 168
Semester II	24	6	24*6 = 144
Semester III	24	6.5	24*6.5 = 156
Semester IV	24	6	24*6 = 144
	96		612

CGPA = 612/96 = 6.37

10.0 Award of Degree and Class

10.1 If a student who registers for all the specified Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Programme, and secures the required number of **68** Credits (with CGPA ≥6.0), shall be declared to have 'qualified' for the award of the M.Tech. Degree in the chosen Branch of Engineering/Technology with the specialization that he was admitted into.

10.2 Award of Class

Class Awarded	CGPA
First Class with Distinction	≥ 7.50
First Class	6.50≤ CGPA < 7.50

Second Class	6.00≤ CGPA < 6.50

After a student has earned the requirements prescribed for the completion of the programme and is eligible for the award of M.Tech. Degree, he shall be placed in one of the following three classes based on the CGPA:

student with final CGPA (at the end of the **PGP) < 6.00** shall not be eligible for the Award of Degree.

11.0 Withholding of Results

If the student has not paid the dues, if any, to the University or if any case of indiscipline is pending against him, the result and degree of the student will be withheld and he will not be allowed into the next semester.

12.0 Conversion of CGPA into equivalent Percentage of Marks

The following formula shall be used for the conversion of CGPA into equivalent marks, whenever it is necessary

Percentage (%) of Marks = (Final CGPA – 0.5) x 10

13.0 Mapping with the Sustainable Development Goals

All the courses specified in the course structure of every programme are mapped with the one or more sustainable development goals.

14.0 General

14.1 **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

14.2 **Credit Point:** It is the product of grade point and number of credits for a course.

14.3 Wherever the words “he”, “him”, “his”, occur in the regulations, they shall include “she”, “her”.

14.4 The academic regulation should be read as a whole for the purpose of any interpretation.

14.5 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the University is final.

14.6 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

BVRIT HYDERABAD College of Engineering for Women
(UGC Autonomous Institution | Approved by AICTE | Affiliated to JNTUH) (NAAC Accredited – A Grade | NBA Accredited (EEE, ECE, CSE))
Bachupally, Hyderabad - 500090

M.Tech. in DATA SCIENCES

COURSE STRUCTURE (BH25 Regulations)

Applicable from AY 2025-26 Batch

I Year I – Semester

S.No.	Code	Title	L	T	P	Credits
1	B0101PC	Advanced Data Structures using Python	3	0	0	3
2	B0102PC	Statistical Foundations for Data Science	3	0	0	3
3		Professional Elective - I 1. Image and Video Processing (B0111PE) 2. Advanced Databases (B0112PE) 3. Data Wrangling and Visualization (B0113PE)	3	0	0	3
4		Professional Elective - II 1. . Data Stream Processing (B0121PE) 2. Social Media Analytics (B0122PE) 3. Web and Database Security (B0123PE)	3	0	0	3
5	B0103PC	Advanced Data Structures Lab (using Python)	0	0	4	2
6		Professional Elective- I Lab 1. Image and Video Processing Lab (B0131PE) 2. Advanced Databases Lab (B0132PE) 3. Data Wrangling and Visualization Lab (B0133PE)	0	0	4	2
7	B0104PC	Research Methodology & IPR	2	0	0	2
8		Audit Course – I	2	0	0	0
		Total	16	0	8	18

*Professional Elective- I and Professional Elective- I Lab must be of same course.

I Year II Semester

S.No.	Code	Title	L	T	P	Credits
1	B0201PC	Big Data Technologies	3	0	0	3
2	B0202PC	Deep Learning	3	0	0	3
3		Professional Elective - III 1. Edge Analytics (B0211PE) 2. Natural Language Processing (B0212PE) 3. Enterprise Cloud Concepts (B0213PE)	3	0	0	3
4		Professional Elective - IV 1. Predictive Analytics (B0221PE) 2. Mining Massive Datasets (B0222PE) 3. Nature Inspired Computing (B0223PE)	3	0	0	3
5	B0203PC	Big Data Analytics/Technologies Lab	0	0	4	2
6		*Professional Elective- III Lab 1. Edge Analytics Lab (B0231PE) 2. Natural Language Processing Lab (B0232PE) 3. Enterprise Cloud Concepts Lab (B0233PE)	0	0	4	2
7	B0204CC	Mini Project with Seminar	0	0	4	2
8		Audit Course – II	2	0	0	0
		Total	14	0	12	18

*Professional Elective- III and Professional Elective- III Lab must be of same course.

II YEAR I SEMESTER

S.No.	Code	Title	L	T	P	Credits
1		Professional Elective - V 1. Digital Forensics (B0311PE) 2. Conversational AI (B0312PE) 3. Video Analytics (B0313PE)	3	0	0	3
2		Open Elective	3	0	0	3
3	B0301DS	Dissertation Work Review – II	0	0	18	6
		Total	6	0	18	12

II YEAR II SEMESTER

S.No.	Code	Title	L	T	P	Credits
1	B0401DS	Dissertation Work Review – III	0	0	18	6
2	B0402DS	Dissertation Viva-Voce	0	0	42	14
		Total	0	0	60	20

*** For Dissertation Work Review - I, Please refer BH25 Academic Regulations.**

Audit Course-I & II

Code	Title	L	T	P	Credits
B0501AC	English for Research Paper Writing	**2**	**0**	**0**	**0**
B0502AC	Disaster Management				
B0503AC	Sanskrit for Technical Knowledge				
B0504AC	Value Education				
B0505AC	Constitution of India				
B0506AC	Pedagogy Studies				
B0507AC	Stress Management by Yoga				
B0508AC	Personality Development Through Life Enlightenment Skills				

Open Electives

Code	Title	L	T	P	Credits
B0300OE	Statistical Foundations for Data Science	**3**	**0**	**0**	**3**
B0301OE	Big Data Technologies				
B0302OE	Predictive Analytics				
B0303OE	Generative AI				

Course Code	Course Title	L	T	P	Credits
B0101PC	Advanced Data Structures Using Python	3	0	0	3

Course Description: This course helps the students to implement Object Oriented Programming concepts in Python and explore various linear and non-linear data structures. This course also enables them to write python scripts for various applications.

Course Outcomes: After completion of this course, the student will be able to

C101.1 Understand basic concepts of scripting with all Python syntax and semantics
C101.2 Understand data structures like Lists, Dictionaries and Regular expressions in Python
C101.3 Implement all searching and sorting techniques using python
C101.4 Apply different data structures to solve real world problem
C101.5 Interpret the concepts of Object-Oriented Programming as used in python
C101.6 Develop python application using objects and classes

Unit – I

Oops Concept - class, object, constructors, types of variables, types of methods.
Inheritance: single, multiple, multi-level, hierarchical, hybrid.
Polymorphism: with functions and objects, with class methods, with inheritance.
Abstraction: abstract classes.

Unit – II

Data Structures - Definition, Linear Data Structures, Non-Linear Data Structures. Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, slicing.

Unit – III

Arrays - Overview, Types of Arrays, Operations on Arrays, Arrays vs List. Searching - Linear Search and Binary Search, Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort.

Unit – IV

Linked Lists - Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists, Stacks - Overview of Stack, Implementation of Stack (List & Linked list), Applications of Stack. Queues: Overview of Queue, Implementation of Queue (List & Linked list), Applications of Queues, Priority Queues.

Unit – V

Graphs - Introduction, Directed vs Undirected Graphs, Weighted vs Unweighted Graphs, Representations, Breadth First Search, Depth First Search. Trees - Overview of Trees, Tree Terminology, Binary Trees: Introduction, Implementation, Applications. Tree Traversals, Binary Search Trees: Introduction, Implementation, AVL Trees: Introduction, Rotations, Implementation.

Text Books:

1. Michael T. Goodrich, “Data structures and algorithms in Python”.
2. Narasimha Karumanchi, “Data Structures and Algorithmic Thinking with Python”.

Reference Books:

1. Dr. Basant Agarwal, Benjamin Baka, “Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7”, 2nd Edition.
2. Kent D. Lee and Steve Hubbard, “Data Structures and Algorithms with Python”.
3. Bradley N Miller, “Problem Solving with Algorithms and Data Structures Using Python”.
4. R. Nageswara Rao, David L. Ranum, “Core Python Programming”, Second Edition, Dreamtech Press.

Course Code	Course Title	L	T	P	Credits
B0102PC	Statistical Foundations for Data Science	3	0	0	3

Course Description: The course statistical foundation for data science provides an insight into statistical concepts required for data science applications. The role of statistics in data science applications is vital. The concepts like regression, correlation, probability distribution, hypotheses etc. play a key role in data analysis. The comprehensive understanding on all these topics is covered in this course.

Course Outcomes: After completion of this course, the student will be able to

C102.1 Examine various theorems, algorithms in arithmetic for GCD and factorization
C102.2 Analyze the techniques of regression and correlation
C102.3 Justify the importance of discrete probability distributions in data science
C102.4 Compare various continuous probability distribution techniques
C102.5 Inspect the methods of Estimation and tests of hypotheses.
C102.6 Distinguish between Stochastic Processes and Markov Chains in data analysis

Unit – I Greatest Common Divisors and Prime Factorization

Greatest common divisors- The Euclidean algorithm, the fundamental theorem of arithmetic, Factorization of integers and the Fermat numbers Congruences: Introduction to congruences, Linear congruences, The Chinese remainder theorem, Systems of linear congruences.

Unit – II Simple Linear Regression and Correlation

Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators, Inferences Concerning the Regression Coefficients, Prediction, Simple Linear Regression Case Study Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Statistical Independence. Discrete Probability Distributions: Binomial Distribution, Poisson distribution.

Unit – III Continuous Probability Distributions

Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Fundamental Sampling Distributions: Random Sampling, Sampling Distributions, Sampling, Distribution of Means and the Central Limit Theorem, Sampling Distribution of S2, t–Distribution, F Distribution.

Unit – IV Estimation & Tests of Hypotheses

Introduction, Statistical Inference, Classical Methods of Estimation, Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples and Maximum Likelihood Estimation.

Unit – V Stochastic Processes and Markov Chains

Introduction to Stochastic processes- Markov process, Transition Probability, Transition Probability Matrix, First order and Higher order Markov process, n step transition probabilities, Markov chain, Steady state condition, Markov analysis.

Text Books:

1. Kenneth H. Rosen, “Elementary number theory & its applications”, sixth edition, Addison Wesley, ISBN 978 0-321-50031-1.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, “Probability & Statistics for Engineers & Scientists”, 9th Ed. Pearson Publishers.
3. S.D. Sharma, “Operations Research”, Kedarnath and Ramnath Publishers, Meerut, Delhi.

Reference Books:

1. S C Gupta and V K Kapoor, “Fundamentals of Mathematical statistics”, Khanna publications.
2. T.T. Soong, “Fundamentals of Probability and Statistics for Engineers”, John Wiley & Sons Ltd, 2004.
3. Sheldon M Ross, “Probability and statistics for Engineers and scientists”, Academic Press.

Course Code	Course Title	L	T	P	Credits
B0111PE	Image and Video Processing (Professional Electives- I)	3	0	0	3

Course Description: Explore the fundamentals of digital image and video processing, including techniques for image enhancement, restoration, compression, segmentation, and feature extraction.

Course Outcomes: After completion of this course, the student will be able to

C111.1 Understand theory and models in Image and Video Processing.

C111.2 Explain the need of spatial and frequency domain techniques for image compression.

C111.3 Comprehend different methods, models for video processing and motion estimation.

C111.4 Illustrate quantitative models of image and video segmentation.

C111.5 Apply image segmentation techniques to identify and extract meaningful objects or regions in images.

C111.6 Apply feature extraction methods, including boundary pre-processing, region and boundary feature descriptors for image analysis and recognition tasks.

Unit – I Digital image fundamentals

A simple image formation model, Image sampling and quantization, some basic relationships between pixels, Basic intensity transformation functions, Sampling and Fourier transform of sampled functions, The Discrete Fourier transform of one variable, Extensions to functions of two variables (2-D Discrete Fourier transform, Properties of 2-D DFT and IDFT, 2-D Discrete Convolution Theorem.

Unit – II Image Enhancement

Image Enhancement (spatial domain): Histogram processing, Fundamentals of spatial filtering, smoothing spatial filters, Sharpening spatial filters, The Laplacian-use of second order derivative for image sharpening, The Gradient-use of first order derivative for image sharpening.

Image Enhancement (frequency domain): Basics of filtering in frequency domain, Image smoothing using lowpass frequency domain filters, Image sharpening using high pass filters.

Unit – III Image Restoration and Signal Processing

Image restoration: Noise Models, Restoration in the presence of noise only – Spatial filters, Periodic noise reduction using Frequency domain filtering, estimating the degradation function, inverse filtering, Minimum Least square error filtering, constrained least square filters. Wavelet and Multiresolution processing: Matrix-based transform, Walsh-Hadamard Transform, Slant transform Haar transform.

Unit – IV Image Compression and Segmentation

Image compression: Lossy and lossless compression schemes: Huffman coding, Run-length coding, Arithmetic coding, Block transform coding, JPEG Image Morphology: Fundamental operations, Morphological Algorithms.

Image segmentation: Point, Line and Edge detection, canny edge detection, Hough Transform, Edge linking, Thresholding, Region-based segmentation, Pixel-based segmentation.

Unit – V Feature Extraction and Video Processing

Feature Extraction: Boundary pre-processing, Boundary feature descriptor, Region feature descriptor, Principal components as feature descriptor, Whole image feature.

Video Processing: Video Formats, Video Enhancement and Restoration, Video Segmentation.

Text Books:

1. R.C. Gonzalez and R.E. Woods, “Digital Image Processing”, Pearson Education.

2. AL Bovik, “Handbook of Image and Video Processing”, Academic Press.

Reference Books:

1. B. Chanda and D. Dutta Mazumdar, “Digital Image Processing and Analysis”, PHI.

2. W.K. Pratt, “Digital Image Processing”, Wiley-Interscience.

3. A.K. Jain, “Fundamentals of Digital Image Processing”, Pearson India Education.

4. R.O. Duda and P.E. Hart, “Pattern Classification and Scene Analysis”, Wiley.

Course Code	Course Title	L	T	P	Credits
B0112PE	Advanced Databases (Professional Electives- I)	3	0	0	3

Course Description: This course contains Knowledge on concepts of Distributed Databases, Parallel Databases, Object-Based Databases and advanced database models.

Course Outcomes: After completion of this course, the student will be able to

C112.1 Understand Database system Architectures and parallel databases.
C112.2 Analyze transactions, Concurrency Control in Distributed Databases.
C112.3 Understand the importance of Data Warehousing and Mining.
C112.4 Compare different approaches of data warehousing and data mining with various technologies.
C112.5 Illustrate concepts of object-based databases.
C112.6 Understand the advance databases.

Unit – I

Database System Architectures: Centralized and Client–Server Architectures, Server System Architectures, Parallel Systems, Distributed Systems, Network Types.
Parallel Databases: Introduction, I/O Parallelism, Interquery Parallelism, Intra Query Parallelism, Intraoperation Parallelism, Interoperation Parallelism, Query Optimization, Design of Parallel Systems, Parallelism on Multicore Processors.

Unit – II

Distributed Databases: Homogeneous and Heterogeneous Databases, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control in Distributed Databases, Availability, Distributed Query Processing, Heterogeneous Distributed Databases, Cloud-Based Databases, Directory Systems.

Unit – III

Data Warehousing and Mining: Decision-Support Systems, Data Warehousing, Data Mining, Classification, Association Rules, Other Types of Associations, Clustering, Other Forms of Data Mining.

Unit – IV

Object-Based Databases: Introduction, Complex Data Types, Structured Types and Inheritance in SQL, Table Inheritance, Array and Multiset Types in SQL, Object-Identity and Reference Types in SQL, Implementing O-R Features, Persistent Programming Languages, Object-Relational Mapping, Object-Oriented versus Object-Relational.

Unit – V

XML: Motivation, Structure of XML Data, XML Document Schema, Querying and Transformation, Application Program Interfaces to XML, Storage of XML Data, XML Applications.
Advanced database models and applications: Active Database Concepts and Triggers, Temporal database concepts, spatial database concepts, Multimedia database concepts, Deductive databases.

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”, Sixth Edition.
2. Ramez Elmasri, Shamkant B. Navathe, “Database Systems - Models, Languages, Design and Application Programming”.

Course Code	Course Title	L	T	P	Credits
B0113PE	Data Wrangling and Visualization (Professional Electives- I)	3	0	0	3

Course Description: This Course contains knowledge on how to clean up the data with data wrangling techniques and to introduce visual perception and core skills for visual analysis.

Course Outcomes: After completion of this course, the student will be able to

C113.1 Create data from various data repositories.
C113.2 Perform data wrangling
C113.3 Explain principles of visual perception
C113.4 Apply core skills for visual analysis
C113.5 Apply visualization techniques for various data analysis tasks
C113.6 Evaluate visualization techniques

Unit – I

Data Wrangling: Need of data clean-up, data clean up basics – formatting, outliers, duplicates, Normalizing and standardizing data.

Unit – II

Visual Perception - Introduction of visual perception, visual representation of data, Gestalt principles, information overloads. Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Unit – III

Visualization - Classification of visualization systems, Interaction and visualization techniques, misleading Visualization of one, two and multi-dimensional data, text and text documents.

Unit – IV

Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization.

Unit – V

Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations.

Text Books:

1. Jacqueline Kazil and Katharine Jarmul, “Data Wrangling with Python: Tips and Tools to Make Your Life Easier”, O’Reilly.
2. Ward, Grinstein, Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, Natick A K Peters, Ltd.

Reference Book:

1. E. Tufte, “The Visual Display of Quantitative Information”, Graphics Press.

Course Code	Course Title	L	T	P	Credits
B0121PE	Data Stream Processing (Professional Electives- II)	3	0	0	3

Course Description: This course covers the Stream Processing Model, including fundamentals, transformations, aggregations, and time effects. It explains Streaming Architectures and Distributed Processing & Resilience, focusing on Spark's cluster management, fault tolerance, and delivery semantics. It also explores Structured Streaming and Spark Streaming, highlighting models, event-time processing, sources, sinks, checkpointing, and performance tuning.

Course Outcomes: After completion of this course, the student will be able to

C121.1 Explain stream processing fundamentals, models, and time effects.
C121.2 Describe streaming architectures and Spark as a processing engine.
C121.3 Demonstrate Spark's distributed model and cluster management.
C121.4 Analyze Spark's resilience, RDDs, and fault tolerance.
C121.5 Apply structured streaming with sources, sinks, and event time.
C121.6 Implement Spark Streaming with SQL, checkpointing, and tuning.

Unit – I Introduction to Stream Processing Model

Fundamentals of Stream Processing: What Is Stream Processing? Examples of Stream Processing - Scaling Up Data Processing - Distributed Stream Processing - Introducing Apache Spark. Stream-Processing Model: Sources and Sinks - Immutable Streams Defined from One Another, Transformations and Aggregations - Window Aggregations - Stateless and Stateful Processing - The Effect of Time.

Unit – II Streaming Architectures

Components of a Data Platform - Architectural Models - The Use of a Batch-Processing Component in a Streaming Application - Referential Streaming Architectures - Streaming Versus Batch Algorithms. Apache Spark as a Stream-Processing Engine: Spark's Memory Usage - Understanding Latency - Throughput Oriented Processing - Fast Implementation of Data Analysis.

Unit – III Distributed Processing and Resilience Model

Spark's Distributed Processing Model: Running Apache Spark with a Cluster Manager - Spark's Own Cluster Manager - Resilience and Fault Tolerance in a Distributed System - Data Delivery Semantics - Micro Batching and One-Element-at-a-Time - Bringing Micro batch and One-Record-at-a-Time Closer Together - Dynamic Batch Interval - Structured Streaming Processing Model. Spark's Resilience Model: Resilient Distributed Datasets in Spark - Spark Components - Spark's Fault-Tolerance Guarantees.

Unit – IV Structured Streaming

Introducing Structured Streaming - The Structured Streaming Programming Model - Structured Streaming in Action - Structured Streaming Sources - Structured Streaming Sinks - Event Time-Based Stream Processing.

Unit – V Spark Streaming

Introducing Spark Streaming - The Spark Streaming Programming Model - The Spark Streaming Execution Model - Spark Streaming Sources - Spark Streaming Sinks - Time-Based Stream Processing - Working with Spark SQL - Checkpointing - Monitoring Spark Streaming - Performance Tuning.

Text Books:

1. Gerard Maas and François Garillot, "Stream Processing with Apache Spark: Mastering Structured Streaming and Spark Streaming", O'Reilly, 2019.

Reference Books:

1. Henrique C. M. Andrade, Buğra Gedik and Deepak S. Turaga, "Fundamentals of Stream Processing: Application Design, Systems, and Analytics", Cambridge University Press, 2014.
2. Bryon Ellis, "Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data", Wiley, 1st edition, 2014.
3. Anindita Basak, Krishna Venkataraman, Ryan Murphy, Manpreet Singh, "Stream Analytics with Microsoft Azure", Packt Publishing, December 2017.

Course Code	Course Title	L	T	P	Credits
B0122PE	Social Media Analytics (Professional Electives- II)	3	0	0	3

Course Description: This course is designed to equip you with the knowledge and skills necessary to analyze and interpret data from various social media platforms effectively. Through a hands-on and practical approach, you will learn the techniques, tools, and methodologies to make informed decisions, develop successful social media strategies, and measure the impact of your efforts.

Course Outcomes: After completion of this course, the student will be able to

C122.1 Understanding characteristics and types of social media
C122.2 Knowledge on layers of social media analytics
C122.3 Apply text analysis tools on social media data
C122.4 Understand the significance of action analytics
C122.5 Detect viral topics on social media (YouTube)
C122.6 Analyze social media engagement and sentiment

Unit – I

Introduction to social media: World Wide Web, Web 1.0, Web 2.0, Web 3.0, social media, Core Characteristics of social media, Types of social media, Social Networking Sites, Using Facebook for Business Purposes, Content Communities.

Unit – II

Social Media Analytics Overview: Purpose of Social Media Analytics, social media Vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, social media Analytics Tools.
Case Study: The Underground Campaign That Scored Big.

Unit – III

Social Media Text Analytics: Types of social media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools.
Case Study: Tapping into Online Customer Opinions.

Unit – IV

Social Media Actions Analytics: Introduction to Actions Analytics, Common Social Media Actions, Actions Analytics Tools.
Case Study: Cover-More Group.

Unit – V

Social Media Hyperlink Analytics: Types of Hyperlinks, Hyperlink Analytics, Types of Hyperlink Analytics, Hyperlink Analytics Tools.
Case Study: Hyperlinks and Viral YouTube Videos.

Text Book:

1. Gohar F. Khan, “Seven Layers of Social Media Analytics: Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, And Location Data”, ISBN: 1507823207, ISBN-13: 9781507823200.

Reference Books:

1. Matthew Ganis, Avinash Kohirkar, “Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media”, Pearson Education.
2. Marshall Sponder, “Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics”, MGH.
3. Seema Acharya, Subhasini Chellappan, “Big Data and Analytics”, Wiley Publications.
4. Big Data, Black Book, Dreamtech Press, 2015 Edition.

Course Code	Course Title	L	T	P	Credits
B0123PE	Web and Database Security (Professional Electives- II)	3	0	0	3

Course Description: Web and database security are crucial aspects of modern technology and play a vital role in protecting sensitive information from unauthorized access, data breaches, and other security threats.

Course Outcomes: After completion of this course, the student will be able to

C123.1 Understand the Web architecture and applications
C123.2 Understand client side and server-side programming
C123.3 Understand the principles of database security.
C123.4 Understand the advances in access control models.
C123.5 Understand how common mistakes can be bypassed and exploit the application
C123.6 Identify common application vulnerabilities

Unit – I Web Security and Cryptography

The Web Security: The Web Security Problem, Risk Analysis and Best Practices. Cryptography and the Web: Cryptography and Web Security, Working Cryptographic Systems and Protocols, Legal Restrictions on Cryptography, Digital Identification.

Unit – II Web's War on Your Privacy

The Web's War on Your Privacy: Privacy-Protecting Techniques, Backups and Anti-theft, Web Server, Security, Physical Security for Servers, Host Security for Servers, Securing Web Applications.

Unit – III Database Security

Database Security: Recent Advances in Access Control, Access Control Models for XML, Database Issues in Trust Management and Trust Negotiation, Security in Data Warehouses and OLAP Systems.

Unit – IV Security Re-engineering for Databases

Security Re-engineering for Databases: Concepts and Techniques, Database Watermarking for Copyright Protection, Trustworthy Records Retention, Damage Quarantine and Recovery in Data Processing Systems, Hippocratic Databases: Current Capabilities.

Unit – V Future Trends Privacy

Future Trends Privacy in Database Publishing: A Bayesian Perspective, Privacy-enhanced Location-based Access Control, Efficiently Enforcing the Security and Privacy Policies in a Mobile Environment.

Text Books:

1. Simson Garfinkel, Gene Spafford, "Web Security, Privacy and Commerce", O'Reilly.
2. Michael Gertz, Sushil Jajodia, "Handbook on Database Security Applications and Trends".

Reference Books:

1. Andrew Hoffman, "Web Application Security: Exploitation and Countermeasures for Modern Web Applications", O'Reilly.
2. Jonathan LeBlanc, Tim Messerschmidt, "Identity and Data Security for Web Development – Best Practices", O'Reilly.
3. McDonald Malcolm, "Web Security for Developers", No Starch Press, US.

Course Code	Course Title	L	T	P	Credits
B0103PC	Advanced Data Structures Lab (using Python)	0	0	4	2

Course Description: This Lab course helps the students to explore various Data structures. This course also helps to develop python applications using all data structures and Object-Oriented Programming concepts.

Course Outcomes: After completion of this course, the student will be able to

C103.1 Examine all Python syntax and semantics and apply to implement all data structures.

C103.2 Develop Python Programs using basic data structures and Regular Expressions.

C103.3 Implement all linear data structures in python using linked list.

C103.4 Develop Python applications using non-linear data structures like trees and graphs.

List of Programs:

Cycle 1:

1. Write a Python program for class, Flower, that has three instance variables of type str, int, and float, that respectively represent the name of the flower, its number of petals, and its price. Your class must include a constructor method that initializes each variable to an appropriate value, and your class should include methods for setting the value of each type, and retrieving the value of each type.
2. Develop an inheritance hierarchy based upon a Polygon class that has abstract methods area() and perimeter(). Implement classes Triangle, Quadrilateral, Pentagon, that extend this base class, with the obvious meanings for the area() and perimeter() methods. Write a simple program that allows users to create polygons of the various types and input their geometric dimensions, and the program then outputs their area and perimeter.
3. Write a python program to implement Method Overloading and Method Overriding.
4. Write a Python program to illustrate the following comprehensions: a) List Comprehensions b) Dictionary Comprehensions c) Set Comprehensions d) Generator Comprehensions.
5. Write a Python program to generate the combinations of n distinct objects taken from the elements of a given list. Example: Original list: [1, 2, 3, 4, 5, 6, 7, 8, 9]; Combinations of 2 distinct objects: [1,2] [1,3] [1,4] [1,5] ... [7,8] [7,9] [8,9].
6. Write a python program for Linear Search and Binary search.

Cycle 2:

7. Write a python program to implement Bubble Sort and Selection Sort.
8. Write a python program to implement Merge sort and Quick sort.
9. Write a python program to implement Stacks and Queues.
10. Write a python program to implement a Singly Linked List.
11. Write a python program to implement a Doubly Linked list.
12. Write a python program to implement Binary Search Tree.

Text Books:

1. Michael T. Goodrich, “Data structures and algorithms in Python”.
2. Narasimha Karumanchi, “Data Structures and Algorithmic Thinking with Python”.

Reference Books:

1. Dr. Basant Agarwal, Benjamin Baka, “Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7”, 2nd Edition.
2. Kent D. Lee and Steve Hubbard, “Data Structures and Algorithms with Python”.
3. Bradley N Miller and David L. Ranum, “Problem Solving with Algorithms and Data Structures Using Python”.
4. R. Nageswara Rao, Dreamtech Press, “Core Python Programming”, Second Edition.

Course Code	Course Title	L	T	P	Credits
B0131PE	Image and Video Processing Lab (Professional Electives – I Lab)	0	0	4	2

Course Description: Hands-on exploration and research in advanced techniques and algorithms for enhancing, analyzing, and manipulating digital images and videos.

Course Outcomes: After completion of this course, the student will be able to

C131.1 Understand theory and models in Image and Video Processing.

C131.2 Explain the need of spatial and frequency domain techniques for image compression.

C131.3 Comprehend different methods for video processing, motion estimation, and quantitative models of image and video segmentation.

C131.4 Apply the process of image enhancement for optimal use of resources.

List of Programs:

Cycle 1:

1. Implement any four Image Enhancement Algorithms.
2. Frequency Domain Filtering Algorithms.
3. Image Restoration Algorithms.
4. Color Image Processing Algorithms.
5. Image compression techniques.
6. Morphological Image Processing Methods.

Cycle 2:

7. Image Segmentation Algorithms.
8. Spatial Filtering Algorithms for image enhancement and segmentation.
9. Object Recognition algorithms.
10. Video restoration techniques.
11. Video segmentation techniques.
12. Video compression techniques.

Text Books:

1. Gonzalez and Woods, “Digital Image Processing”, 3rd edition, Pearson.
2. Yao Wang, Joern Ostermann and Ya-Qin Zhang, “Video Processing and Communication”, 1st edition, PHI.

Reference Book:

1. M. Tekalp, “Digital Video Processing”, Prentice Hall International.

Course Code	Course Title	L	T	P	Credits
B0132PE	Advanced Databases Lab (Professional Electives – I Lab)	0	0	4	2

Course Description: This laboratory covers Knowledge on concepts of Distributed Databases, Object-Based Databases, advanced database models, SQL, DTD, and XML Schema.

Course Outcomes: After completion of this course, the student will be able to

C132.1 Understand Database system Architectures and parallel databases.
C132.2 Analyze transactions, Concurrency Control in Distributed Databases.
C132.3 Understand the importance of Data Warehousing and Mining.
C132.4 Illustrate concepts of object-based databases.

List of Programs:

Cycle 1:

1. Write a program to implement RDBMS - Cursors, Triggers.
2. Write a Program to implement Range Partitioning sort.
3. Write a program to implement parallel hash join.
4. Write a program to implement parallel nested join loop.
5. Write a program to implement parallelized duplicate elimination by partitioning the tuples.
6. Perform data fragmentation of distributed data (Horizontal, Vertical, Hybrid fragmentation).
7. Implement deadlock detection in distributed databases.
8. Implement Semi Join algorithm.

Cycle 2:

9. Data Cube Implementation – Aggregation.
10. Perform data Integration - Extraction, Transformation, Loading.
11. Implement any one classifier.
12. Implement vector space models for Text corpus.
13. Demonstrate type inheritance, table inheritance in object based databases.
14. Write queries in XQuery on DTD.
15. Write queries in SQL/XML to convert University data - XML Schema.

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”, Sixth Edition.
2. Ramez Elmasri, Shamkant B. Navathe, “Database Systems - Models, Languages, Design and Application Programming”.

Course Code	Course Title	L	T	P	Credits
B0133PE	Data Wrangling and Visualization Lab (Professional Electives – I Lab)	0	0	4	2

Course Description: This lab course contains topics related to learn data wrangling techniques and to introduce visual perception and core skills for visual analysis.

Course Outcomes: After completion of this course, the student will be able to

C133.1 Create data from various data repositories and perform data wrangling.

C133.2 Explain principles of visual perception.

C133.3 Apply core skills for visual analysis and visualization techniques for various data analysis tasks.

C133.4 Evaluate visualization techniques.

List of Programs:

Cycle 1:

1. Find missing values and perform data imputation.
2. Find outliers in a chosen dataset.
3. Methods to handle duplicate data.
4. Perform data normalization.

Cycle 2:

5. Explore 2-D charts: i. Clustered bar charts ii. Connected dot plots iii. Pictograms iv. Bubble charts v. Radar charts vi. Polar charts vii. Range chart viii. Box-and-whisker plots ix. Univariate scatter plots x. Histograms, word cloud xi. Pie chart xii. Waffle chart xiii. Stacked bar chart xiv. Treemap.
6. Multi-dimensional data visualization.
7. Graph data visualization – Home Automation.

Text Books:

1. Jacqueline Kazil and Katharine Jarmul, “Data Wrangling with Python: Tips and Tools to Make Your Life Easier”, O’Reilly.
2. Andy Kirk, “Data Visualization: A Handbook for Data Driven Design”, Sage Publications, 2016.
3. Philipp K. Janert, “Gnuplot in Action: Understanding Data with Graphs”, Manning Publications, 2010.

Course Code	Course Title	L	T	P	Credits
B0104PC	Research Methodology & IPR	2	0	0	2

Course Description: The course contains various approaches to identify research problem, sources and scope. This course explains about effective approaches for literature survey, plagiarism and publication ethics. It also deals with technical report writing and presentation skills. This course discusses about Intellectual property rights, their impact in research along with procedure to get grants of patents and administering patent system.

Course Outcomes: After completion of this course, the student will be able to

C104.1 Understand the characteristics and formulation of research problem.
C104.2 Analyze the approaches for literature survey and plagiarism.
C104.3 Apply the techniques for research proposal writing and presentation skills.
C104.4 Understand the effectiveness and importance of Intellectual Property Rights in research.
C104.5 Apply the steps to get grants of patents and patenting under PCT.
C104.6 Analyze the approaches of property rights and new developments to create new and better products.

Unit – I Research Problem

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit – II Literature Study and publication Ethics

Effective literature studies approaches, analysis, Plagiarism, Research ethics.

Unit – III Technical Report Writing and Presentation Skills

Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, presentation and assessment by a review committee.

Unit – IV Nature of Intellectual Property & Process of Patenting and Development

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT.

Unit – V Patent Rights and New Developments in IPR

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications. New Developments in IPR: Administration of Patent System, New developments in IPR, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”.
2. C.R. Kothari, “Research Methodology, methods & techniques”, 2nd edition, New Age International publishers.

Reference Books:

1. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step-by-Step Guide for Beginners”.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Asimov, “Introduction to Design”, Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
7. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.

I Year II Sem

Course Code	Course Title	L	T	P	Credits
B0201PC	Big Data Technologies	3	0	0	3

Course Description: This course begins with an Overview of Big Data, covering its evolution, elements, analytics, careers, and technologies like Hadoop, cloud, and in-memory computing. It explores the Hadoop Ecosystem, MapReduce, HBase, Hive, Pig, Oozie, and NoSQL Data Management, focusing on data storage, processing, and analysis. Finally, it covers ZooKeeper and Sqoop, emphasizing coordination, distributed services, data transfer, and integration for large-scale big data applications.

Course Outcomes: After completion of this course, the student will be able to

C201.1	Explain the fundamentals of Big Data, its evolution, elements, analytics, and supporting technologies.
C202.2	Demonstrate the working of the Hadoop ecosystem, HDFS, MapReduce, YARN, and HBase.
C202.3	Apply Hive for data definition, manipulation, queries, and analysis.
C203.4	Use Pig and Pig Latin for data analysis with operators and functions.
C203.5	Illustrate the role of Oozie in workflow management and explore NoSQL data management models.
C203.6	Utilize ZooKeeper for coordination and Sqoop for data import/export in Big Data applications.

Unit – I Overview of Big Data

Getting an Overview of Big Data: Big Data, History of Data Management – Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Careers in Big Data, Future of Big Data

Technologies for Handling Big Data: Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data.

Unit – II Hadoop Ecosystem, MapReduce and Hbase

Understanding Hadoop Ecosystem: Hadoop Ecosystem, Hadoop Distributed File System, MapReduce, Hadoop YARN, HBase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie

Understanding MapReduce Fundamentals and HBase: The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing

Unit – III Exploring Hive and Analyzing Data with Pig

Exploring Hive: Introducing Hive, Getting Started with Hive, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval Queries, Using JOINS in Hive

Analyzing Data with Pig: Introducing Pig, Running Pig, Getting Started with Pig Latin, Working with Operators in Pig, Working with Functions in Pig

Unit – IV Using Oozie and NoSQL Data Management

Using Oozie: Introducing Oozie, Installing and Configuring Oozie, Understanding the Oozie Workflow, Oozie Coordinator, Oozie Bundle, Oozie Parameterization with EL, Oozie Job Execution Model, Accessing Oozie, Oozie SLA.

NoSQL Data Management: Introduction to NoSQL, Aggregate Data Models, Key Value Data Model, Document Databases, Relationships, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations

Unit – V Zookeeper and Sqoop

Zookeeper: Installing and Running ZooKeeper, An Example, Group Membership in ZooKeeper, Creating the Group, Joining a Group, Listing Members in a Group, The ZooKeeper Service, Data Model, Operations, Implementation, Consistency, Sessions, Building Applications with ZooKeeper, A Configuration, Service, The Resilient ZooKeeper Application, A Lock Service, More Distributed Data Structures and Protocols, ZooKeeper in Production

Sqoop: Getting Sqoop, Sqoop Connectors, A Sample Import, Generated Code, Imports: A Deeper Look, Working with Imported Data, Importing Large Objects, Performing an Export, Exports: A Deeper Look

Text Books:

1. Big Data, Black Book, Dream Tech Press, 2015
2. Hadoop: The Definitive Guide, Tom White, 3rd Edition, O'Reilly Media, 2012.

References:

1. Big Data Analytics, Seema Acharya, Subhashini Chellappan, Wiley 2015.
2. Simon Walkowiak, Big Data Analytics with R, Packt Publishing, ISBN: 9781786466457
3. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business, Michael Minelli, Michehe Chambers, 1st Edition, Ambiga Dhiraj, Wiley CIO Series, 2013.
4. Big Data Analytics: Disruptive Technologies for Changing the Game, Arvind Sathi, 1st Edition, IBM Corporation, 2012.

Course Code	Course Title	L	T	P	Credits
B0202PC	Deep Learning	3	0	0	3

Course Description: This course is an elementary introduction to a machine learning technique called deep learning (also called deep neural nets), as well as its applications to a variety of domains, including image classification, speech recognition, and natural language processing.

Course Outcomes: After completion of this course, the student will be able to

C202.1	Implement deep learning algorithms, understand neural networks and traverse the layers of data.
C202.2	Learn topics such as convolutional neural networks, recurrent neural networks, training deep networks and high-level interfaces.
C202.3	Understand applications of Deep Learning to Computer Vision.
C202.4	Understand applications of Deep Learning to computer vision with LSTM and Attention Models.
C202.5	Understand and analyze Applications of Deep Learning to NLP.
C202.6	Understand and analyze classification using neural networks.

Unit – I

Introduction: Feed forward Neural networks, Gradient descent and the back-propagation algorithm, Unit saturation, the vanishing gradient problem, and ways to mitigate it, ReLU Heuristics for avoiding bad local minima, Heuristics for faster training, Nestors accelerated gradient descent, Regularization, Dropout.

Unit – II

Convolutional Neural Networks: Architectures, convolution/pooling layers, Recurrent Neural Networks: LSTM, GRU, Encoder Decoder architectures. Deep Unsupervised Learning: Auto encoders, Variational Auto-encoders, Adversarial Generative Networks, Auto-encoder and DBM Attention and memory models, Dynamic Memory Models.

Unit – III

Applications of Deep Learning to Computer Vision: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models, Attention Models for computer vision tasks.

Unit – IV

Applications of Deep Learning to NLP: Introduction to NLP and Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity.

Unit – V

Analogy reasoning: Named Entity Recognition, Opinion Mining using Recurrent Neural Networks: Parsing and Sentiment Analysis using Recursive Neural Networks: Sentence Classification using Convolutional Neural Networks, Dialogue Generation with LSTMs.

Text Books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press.
2. T. Hastie, R. Tibshirani, and J. Friedman, "The Elements of Statistical Learning", Springer.
3. Koller, and N. Friedman, "Probabilistic Graphical Models", MIT Press.

Reference Books:

1. Bishop, C, M., "Pattern Recognition and Machine Learning", Springer, 2006.
2. Yegnanarayana, B., "Artificial Neural Networks", PHI Learning Pvt. Ltd, 2009.
3. Golub, G., H., and Van Loan, C., F., "Matrix Computations", JHU Press, 2013.
4. Satish Kumar, "Neural Networks: A Classroom Approach", Tata McGraw-Hill Education, 2004.

Course Code	Course Title	L	T	P	Credits
B0211PE	Edge Analytics (Professional Elective – III)	3	0	2	4

Pre-Requisite: Python Programming

Course Description: The course gives an overview of the fundamentals of Edge Analytics, Architectures, Components, Communication Protocols and tools used for Edge Analytics.

Course Outcomes: After completion of this course, the student will be able to

C211.1 Understand the concepts of Edge Analytics, both in theory and in practical application.

C211.2 Comprehend concepts Edge Computing based on sensing and Internet connectivity.

C211.3 Demonstrate a comprehensive understanding of different tools used at edge analytics.

C211.4 Elaborate python programming with various interfacing devices using with Raspberry PI.

C211.5 Illustrate edge intelligence with microcontrollers, Azure Machine Learning designer, Azure IoT edge custom vision.

C211.6 Conceptualize applications implementing edge computing.

Unit – I

Introduction to Edge Analytics: What is edge analytics, Applying and comparing architectures, Key benefits of edge analytics, Edge analytics architectures, Using edge analytics in the real world.

Unit – II

Basic edge analytics components: connecting a sensor to the ESP-12F microcontroller, KOM-MICS smart factory platform, Communications protocols used in edge analytics, Wi-Fi communication for edge analytics, Bluetooth for edge analytics communication, Cellular technologies for edge analytics communication, Long-distance communication using LoRa and Signfox for edge analytics.

Unit – III

Working with Microsoft Azure IoT Hub: Cloud Service providers, Microsoft Azure, Exploring the Azure portal, Azure IoT Hub, Using the Raspberry Pi with Azure IoT edge, connecting our Raspberry Pi edge device, adding a simulated temperature sensor to our edge device.

Unit – IV

Using Micropython for Edge Analytics: Understanding Micropython, Exploring the hardware that runs MicroPython, Using MicroPython for an edge analytics application, using edge intelligence with microcontrollers, Azure Machine Learning designer, Azure IoT edge custom vision.

Unit – V

Designing a Smart Doorbell with Visual Recognition: setting up the environment, writing the edge code, creating the Node-RED dashboard, Types of attacks against our edge analytics applications, protecting our edge analytics applications.

Text Book:

1. Colin Dow, "Hands-On Edge Analytics with Azure IoT: Design and develop IoT applications with edge analytical solutions including Azure IoT Edge".

Reference Book:

1. Ashish Mahajan, "Learn Edge Analytics - Fundamentals of Edge Analytics: Automated analytics at source using Microsoft Azure".

Course Code	Course Title	L	T	P	Credits
B0212PE	Natural Language Processing (Professional Elective – III)	3	0	0	3

Course Description: This course introduces methods for finding the structure of words and documents, covering morphological models and document analysis techniques. It explores syntax analysis, including parsing, treebanks, syntactic representations, ambiguity resolution, and multilingual issues. The course further covers semantic parsing, predicate-argument structures, and meaning representation systems. It also addresses discourse processing and language modeling, including cohesion, reference resolution, n-gram models, evaluation, adaptation, and multilingual challenges.

Course Outcomes: After completion of this course, the student will be able to

C212.1 Identify and apply basic text processing methods such as tokenization and morphology.

C212.2 Analyze sentence structures using parsing algorithms and tree representations.

C212.3 Perform semantic interpretation for understanding word and sentence meaning.

C212.4 Implement word sense disambiguation and related semantic processing techniques.

C212.5 Design simple meaning representation systems using predicate-argument structures.

C212.6 Apply discourse analysis and statistical language modeling to develop NLP applications.

Unit – I

Finding the Structure of Words: Words and Their Components, Issues and Challenges, Morphological Models

Finding the Structure of Documents: Introduction, Methods, Complexity of the Approaches, Performances of the Approaches

Unit – II

Syntax Analysis: Parsing Natural Language, Treebanks: A Data-Driven Approach to Syntax, Representation of Syntactic Structure, Parsing Algorithms, Models for Ambiguity Resolution in Parsing, Multilingual Issues

Unit – III

Semantic Parsing: Introduction, Semantic Interpretation, System Paradigms, Word Sense Systems, Software.

Unit – IV

Predicate-Argument Structure, Meaning Representation Systems, Software.

Unit – V

Discourse Processing: Cohesion, Reference Resolution, Discourse Cohesion and Structure

Language Modeling: Introduction, N-Gram Models, Language Model Evaluation, Parameter Estimation, Language Model Adaptation, Types of Language Models, Language-Specific Modeling Problems, Multilingual and Cross Lingual Language Modeling

Text Books:

1. Daniel M. Bikel and Imed Zitouni, "Multilingual Natural Language Processing Applications: From Theory to Practice", Pearson Publication.
2. Tanvier Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, Inc.

Reference Book:

1. Daniel Jurafsky & James H Martin, "Speech and Natural Language Processing", Pearson Publications.

Course Code	Course Title	L	T	P	Credits
B0213PE	Enterprise Cloud Concepts (Professional Elective – III)	3	0	2	4

Course Description: The course is designed to provide a comprehensive understanding of cloud computing technologies and their application in the enterprise context. This course explores the fundamental concepts, principles, and best practices associated with the adoption and implementation of cloud computing solutions in large-scale organizations.

Course Outcomes: After completion of this course, the student will be able to

C213.1 Describe the fundamental concepts, roles, and boundaries in cloud computing.

C213.2 Analyze the impact of broadband networks and internet architecture on the reliability and performance of enterprise cloud solutions.

C213.3 Utilize virtualization technology to create and manage virtualized resources in enterprise cloud environments.

C213.4 Apply principles of cloud bursting architecture to dynamically scale resources in response to varying workload demands.

C213.5 Implement cloud technologies and services to enable the transition of an enterprise into a cloud-enabled organization.

C213.6 Analyze the benefits and challenges of transitioning to cloud-centric enterprises.

Unit – I Cloud Computing Concepts and Models

Understanding Cloud Computing: Origins and influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges.

Fundamental Concepts and Models: Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models.

Unit – II Cloud-Enabling Technology and Mechanisms

Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology, Cloud Computing Mechanisms.

Cloud Infrastructure Mechanisms: Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication.

Unit – III Fundamental Cloud Architectures

Cloud Management Mechanisms: Remote Administration System, Resource Management System, SLA Management System, Billing Management System, Case Study Example.

Fundamental Cloud Architectures: Cloud Computing Architecture, Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example.

Unit – IV Cloud-Enabled Smart Enterprises

Cloud-Enabled Smart Enterprises: Introduction, Revisiting the Enterprise Journey, Service-Oriented Enterprises, Cloud Enterprises, Smart Enterprises, The Enabling Mechanisms of Smart Enterprises.

Cloud-Inspired Enterprise Transformations: Introduction, the Cloud Scheme for Enterprise Success, Elucidating the Evolving Cloud Idea, Implications of the Cloud on Enterprise Strategy,

Establishing a Cloud-Incorporated Business Strategy.

Unit – V Transitioning to Cloud-Centric Enterprises

Transitioning to Cloud-Centric Enterprises: The Tuning Methodology, Contract Management in the Cloud, Cloud-Instigated IT Transformations.

Explaining Cloud Infrastructures, A Briefing on Next-Generation Services, Service Infrastructures, Cloud Infrastructures, Cloud Infrastructure Solutions, Clouds for Business Continuity, The Relevance of Private Clouds, The Emergence of Enterprise Clouds.

Text Books:

1. Erl Thomas, Puttini Ricardo, Mahmood Zaigham, "Cloud Computing: Concepts, Technology & Architecture", 1st Edition.
2. Pethuru Raj, "Cloud Enterprise Architecture", CRC Press.

Reference Book:

1. James Bond, "The Enterprise Cloud", O'Reilly Media, Inc.

Course Code	Course Title	L	T	P	Credits
B0221PE	Predictive Analytics (Professional Elective – IV)	3	0	0	3

Course Description: The course serves to advance and refine expertise on theories, approaches and techniques related to prediction and forecasting.

Course Outcomes: After completion of this course, the student will be able to

C221.1 Understand the theories, and approaches of classification and Regression.

C221.2 Analyze model assessment, selection and validation for model building.

C221.3 Illustrate various classification and Regression model & its statistical approaches.

C221.4 Comprehend Numerical Optimization for model building.

C221.5 Analyze supervised algorithms & its statistical approaches.

C221.6 Analyze supervised algorithms & its statistical approaches.

Unit – I Linear Methods for Regression and Classification

Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection, Ridge regression, Lasso regression, Linear Discriminant Analysis, Logistic regression, Perceptron learning algorithm.

Unit – II Model Assessment and Selection

Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross-validation, Bootstrap methods, conditional or expected test error.

Unit – III Additive Models, Trees, and Boosting

Generalized additive models, Regression and classification trees, Boosting methods – exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data).

Unit – IV Neural Networks

Neural Networks (NN), Support Vector Machines (SVM), and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest–Neighbor classifiers (Image Scene Classification).

Unit – V Unsupervised Learning and Random forests

Association rules, Cluster analysis, Principal Components, Random forests and analysis.

Text Book:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning – Data Mining, Inference, and Prediction", Second Edition, Springer Verlag, 2009.

Reference Books:

1. C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. L. Wasserman, "All of Statistics".
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R".

Course Code	Course Title	L	T	P	Credits
B0222PE	Mining Massive Datasets (Professional Elective – IV)	3	0	0	3

Course Description: This course introduces data mining concepts, MapReduce, and algorithms for large-scale processing. It covers similarity search and data stream mining, including shingling, distance measures, sampling, and filtering. The course explores link analysis, frequent itemsets, and clustering techniques for massive datasets and streams. It further examines online advertising, recommendation systems, and social-network graph mining, with applications in clustering, partitioning, and similarity analysis.

Course Outcomes: After completion of this course, the student will be able to

C222.1 Explain data mining basics, statistical limits, and MapReduce-based algorithms.

C222.2 Apply similarity search, shingling, distance measures, and stream mining methods.

C222.3 Analyze PageRank, link spam, and frequent itemset mining in large datasets.

C222.4 Implement clustering algorithms for streams and non-Euclidean spaces.

C222.5 Evaluate online advertising models and recommendation system approaches.

C222.6 Examine social-network graph mining techniques like SimRank and triangle counting.

Unit – I

Data Mining – Introduction: Definition of Data Mining, Statistical Limits on Data Mining.

MapReduce and the New Software Stack: Distributed File Systems, MapReduce, Algorithms Using MapReduce.

Unit – II

Similarity Search: Finding Similar Items – Applications of Near-Neighbor Search, Shingling of Documents, Similarity-Preserving Summaries of Sets, Distance Measures.

Streaming Data: Mining Data Streams – The Stream Data Model, Sampling Data in a Stream, Filtering Streams.

Unit – III

Link Analysis: PageRank, Efficient Computation of PageRank, Link Spam.

Frequent Itemsets: Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream.

Clustering: The CURE Algorithm, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism.

Unit – IV

Advertising on the Web: Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The Adwords Problem, Adwords Implementation.

Recommendation Systems: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction, The NetFlix Challenge.

Unit – V

Mining Social Networks as Graphs: Social Networks as Graphs, Clustering of Social-Network Graphs, Partitioning of Graphs, Simrank, Counting Triangles.

Text Book:

1. Jure Leskovec, Anand Rajaraman, Jeff Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge Univ. Press.

Reference Books:

1. Jiawei Han & Micheline Kamber, "Data Mining – Concepts and Techniques", 3rd Edition, Elsevier.
2. Margaret H Dunham, "Data Mining: Introductory and Advanced Topics", PEARSON Publishers.
3. Ian H. Witten, Eibe Frank, Mark A Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Elsevier.

Course Code	Course Title	L	T	P	Credits
B0223PE	Nature Inspired Computing (Professional Elective – IV)	3	0	0	3

Pre-Requisite: Data Structures and Algorithms, Machine Learning.

Course Description: This course enables to effectively apply nature-inspired algorithms to solve optimization problems and address data science challenges for advanced research and professional careers in the field of data science and computational optimization.

Course Outcomes: After completion of this course, the student will be able to

C223.1	Understand the principles and mechanisms behind bio-inspired models utilizing swarm models and hyper-heuristic functions to solve optimization problems.
C223.2	Apply the mathematical foundation of genetic algorithm to implement crossover and mutation operators.
C223.3	Analyze the influence of local information and pheromone trails on the decision-making process of ants.
C223.4	Analyze the principles and mechanisms of particle swarm algorithms behaviour with characteristics of artificial bee colony in various domains.
C223.5	Evaluate the effectiveness and efficiency of selected nature-inspired techniques in solving optimization problems with use cases.
C223.6	Evaluate the impact of nature inspired techniques through case studies.

Unit – I Models of Life and Intelligence

Fundamentals of bio-inspired models and bio-inspired computing, Evolutionary models and techniques, Swarm models and its self-organization, swarm and evolutionary algorithms, Optimisation problems – single and multi-objective optimisation, heuristic, meta-heuristic and hyper heuristic functions.

Unit – II Genetic Algorithms

Mathematical foundation, Genetic problem solving, crossover and mutation, genetic algorithms and Markov process, applications of genetic algorithms.

Unit – III Ant Colony Algorithms

Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO, case studies.

Unit – IV Particle Swarm Algorithms

Particle Swarm Algorithms: particles moves, particle swarm optimisation, variable length PSO, applications of PSO, case studies.

Artificial Bee Colony Algorithms: ABC basics, ABC in optimisation, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

Unit – V Selected Nature Inspired Techniques

Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firefly algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques – Social spider algorithm, Cultural algorithms, Harmony search algorithm, intelligent water drops algorithm, artificial immune system, Flower pollination algorithm, case studies.

Text Books:

1. Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.
2. Floreano, D. and C. Mattiussi, "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, 2008.

Reference Books:

1. Leandro Nunes de Castro, "Fundamentals of Natural Computing: Basic Concepts, Algorithms and Applications", Chapman & Hall/CRC, Taylor and Francis Group, 2007.
2. Marco Dorigo, Thomas Stutzle, "Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005.
3. Vinod Chandra SS, Anand HS, "Machine Learning: A Practitioner's Approach", Prentice Hall of India, New Delhi, 2020.

Course Code	Course Title	L	T	P	Credits
B0203PC	Big Data Technologies Lab	0	0	2	1

Course Description: The lab on the course Big Data Analytics provides a comprehensive exposure of various tools useful for big data analytics applications. This lab covers the tools like Hadoop, Pig, Cassandra and case study on analysis using programming language R. The Lab will have access to the necessary tools and resources to perform various tasks and exercises that align with the course objectives.

Course Outcomes: After completion of this course, the student will be able to

C203.1 Justify the importance of big data tools – HADOOP and MapReduce in data analytics.

C203.2 Determine the role of Pig and Cassandra tools in big data applications.

C203.3 Compare the use of MS Excel as an Analytical tool and a visualization tool.

C203.4 Examine the use of R programming in projects on statistical analysis and visualization of social media data.

List of Experiments:

Cycle 1:

1. Implement a simple map-reduce job that builds an inverted index on the set of input documents (Hadoop).
2. Process big data in HBase.
3. Store and retrieve data in Pig.
4. Perform Social media analysis using Cassandra.

Cycle 2:

5. Buyer event analytics using Cassandra on suitable product sales data.
6. Using PowerPivot (Excel), perform the following on any dataset:
   a. Big Data Analytics
   b. Big Data Charting
7. Use R-Project to carry out statistical analysis of big data.
8. Use R-Project for data visualization of social media data.

Text Books:

1. Seema Acharya, Subhashini Chellappan, "Big Data Analytics", Wiley, 2015.
2. Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", 1st Edition, Ambiga Dhiraj, Wiley CIO Series, 2013.
3. Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'Reilly Media, 2012.
4. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", 1st Edition, IBM Corporation, 2012.

Reference Books:

1. Jay Liebowitz, "Big Data and Business Analytics", Auerbach Publications, CRC Press, 2013.
2. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media, 2013, Oracle Press.

3. Kevin T. Smith, Alexey Yakubovich, Boris Lublinsky, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
4. Chris Eaton, Dirk deroos et al., "Understanding Big Data", McGraw Hill, 2012.
5. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
6. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.

Course Code	Course Title	L	T	P	Credits
B0231PE	Edge Analytics Lab (Professional Elective – III Lab)	0	0	4	2

Course Description: This lab will provide concept of edge computing, architectures along with implementation of edge computing in IoT, microservices in fog.

Course Outcomes: After completion of this course, the student will be able to

C231.1 Understand the benefits of edge computing, microservices.

C231.2 Conceptualize applications implementing services in the edge.

C231.3 Develop use cases in IoT with edge computing.

C231.4 Demonstrate a comprehensive understanding of implementation of services, use cases in MEC.

List of Programs:

Cycle 1:

1. Setup the Arduino IDE for ESP8266-12 module and program it to blink a LED light.
2. Installation tools to create and manage ECN's.
3. Deploy microservices and writing your own microservices.
4. Setup the Communication Parameters.
5. Implement any two Communications protocols.
6. Deploy modules to a Windows IoT Edge device.
7. Create an IoT hub.
8. Register an IoT Edge device to your IoT hub.

Cycle 2:

9. Install and start the IoT Edge for Linux on Windows runtime on your device.
10. Remotely deploy a module to an IoT Edge device and send telemetry.
11. Python based basic programs using Raspberry Pi.
12. Deploy a module to manage your Azure IoT Edge device from the cloud, to deploy a module that sends telemetry data to IoT Hub.
13. Publishing Data using HTTP.
14. Sensor Interfacing and Logging using MQTT.
15. File IO Example – example code to demonstrate writing and reading data to/from files.
16. Write code to turn on one of the LEDs on the board (Breadboard).

Additional Exercises on IoT Edge Analytics Applications:

1. Temperature Logger
2. Home Automation

Text Books:

1. Colin Dow, "Hands-On Edge Analytics with Azure IoT: Design and develop IoT applications with edge analytical solutions including Azure IoT Edge".
2. Charles Bell, "MicroPython for the Internet of Things: A Beginner's Guide to Programming with Python on Microcontrollers", Apress.

Reference Books:

1. Ashish Mahajan, "Learn Edge Analytics – Fundamentals of Edge Analytics: Automated Analytics at Source Using Microsoft Azure".
2. Peter Waher, "Mastering Internet of Things: Design and Create Your Own IoT Applications Using Raspberry Pi 3", First Edition, Packt Publishing, 2018.
3. John C. Shovic, "Raspberry Pi IoT Projects: Prototyping Experiments for Makers", Packt Publishing, 2016.
4. Donald Norris, "Python for Microcontrollers: Getting Started with MicroPython", McGraw-Hill Education TAB, 2016.
5. Nicholas H. Tollervey, "Programming with MicroPython: Embedded Programming with Microcontrollers and Python", O'Reilly.
6. R. Buyya, S.N. Srirama, "Fog and Edge Computing: Principles and Paradigms", Wiley-Blackwell, 2019.

Course Code	Course Title	L	T	P	Credits
B0232PE	Natural Language Processing Lab (Professional Elective – III Lab)	0	0	4	2

Course Description: This lab introduces fundamental Natural Language Processing (NLP) techniques such as tokenization, stemming, stop word removal, word analysis, and word generation. It further explores advanced methods, including part-of-speech tagging, morphology, chunking, and N-Gram models with smoothing.

Course Outcomes: After completion of this course, the student will be able to

C232.1	Perform basic text pre-processing using tokenization, stemming, stop word removal, and word generation.
C232.2	Apply POS tagging and morphology to understand the structure of words and sentences.
C232.3	Use chunking to identify meaningful groups of words in text.
C232.4	Build and analyze N-Gram models with smoothing for language processing tasks.

List of Programs:

Cycle 1:

1. Tokenization
2. Stemming
3. Stop word removal (a, the, are, ...)
4. Word Analysis
5. Word Generation

Cycle 2:

6. PoS Tagging
7. Morphology
8. Chunking
9. N-Grams
10. N-Grams Smoothing

Text Books:

1. Daniel M. Bikel and Imed Zitouni, "Multilingual Natural Language Processing Applications: From Theory to Practice", Pearson Publication.
2. Tanvier Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, Inc.

Course Code	Course Title	L	T	P	Credits
B0233PE	Enterprise Cloud Concepts Lab (Professional Elective – III Lab)	0	0	4	2

Course Description: This lab will provide a simulated enterprise cloud environment, utilizing cloud platforms such as Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform (GCP). The Lab will have access to the necessary tools and resources to perform various tasks and exercises that align with the course objectives.

Course Outcomes: After completion of this course, the student will be able to

C233.1	Understand the process of creating virtual machines using VirtualBox or VMware Workstation.
C233.2	Apply the knowledge of installing Google App Engine to set up the development environment for cloud-based web applications.
C233.3	Demonstrate the ability to configure network settings and establish connectivity between virtual machines to enable file transfer.
C233.4	Design a step-by-step procedure or guide for installing and configuring a single-node Hadoop cluster.

List of Experiments:

Cycle 1:

1. Install VirtualBox/VMware Workstation with different flavors of Linux or Windows OS on top of Windows 7 or 8.
2. Install a C compiler in the virtual machine created using VirtualBox and execute simple programs.
3. Install Google App Engine. Create a hello world app and other simple web applications using Python/Java.

Cycle 2:

4. Find a procedure to transfer the files from one virtual machine to another virtual machine.
5. Find a procedure to launch a virtual machine using TryStack (Online OpenStack Demo Version).
6. Install Hadoop single node cluster and run simple applications like word count.

E-Resources:

1. https://www.iitk.ac.in/nt/faq/vbox.htm
2. http://www.cs.columbia.edu/~sedwards/classes/2015/1102all/linuxvm.pdf
3. https://www.cloudsimtutorials.online/cloudsim/
4. https://edwardsamuel.wordpress.com/2014/10/25/tutorial-creating-openstack-instance-in-trystack/
5. https://www.edureka.co/blog/install-hadoop-single-node-hadoop-cluster

Course Code	Course Title	L	T	P	Credits
B0311PE	Digital Forensics (Professional Elective-V)	3	0	0	3

Course Description: Digital forensics, also known as computer forensics, is a specialized field within the broader discipline of forensic science that focuses on the investigation

n, analysis, and preservation of digital evidence. It involves the application of scientific and investigative techniques to collect, examine, and interpret data from digital devices and networks for legal purposes.

Course Outcomes: After completion of this course, the student will be able to

C311.1: Computer forensics and digital detective and various processes, policies and procedures.

C311.2: Understand relevant legislation and codes of ethics.

C311.3: E-discovery, guidelines and standards, E-evidence, tools and environment.

C311.4: Understand the workload of law enforcement.

C311.5: Email and web forensics and network forensics.

C311.6: Understand mobile forensics techniques and tools.

Unit–I

Digital Forensics Science: Forensics science, computer forensics, and digital forensics. Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber criminalistics area, holistic approach to cyber-forensics.

Unit–II

Cyber Crime Scene Analysis: Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.

Unit–III

Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.

Unit–IV

Computer Forensics: Prepare a case, begin an investigation, understand computer forensics workstations and software, conduct an investigation, and complete a case, Critique a case. Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data.

Unit–V

Mobile Forensics: Mobile forensics techniques, mobile forensics tools.

Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008. Recent trends in mobile forensic technique and methods to search and seizure electronic evidence.

Text Books:

1. John Sammons,“The Basics of Digital Forensics”, Elsevier.
2. John Vacca, “Computer Forensics: Computer Crime Scene Investigation”, Laxmi Publications.

Reference Books:

1. William Oettinger, “Learn Computer Forensics: A beginners guide to searching, analysing, and securing digital evidence”, Packt Publishing; 1st edition (30 April 2020), ISBN: 1838648178.
2. Thomas J.Holt, Adam M.Bossler, Kathryn C.Seigfried-Spellar,“Cyber crime and Digital Forensics: An Introduction”, Routledge.

Course Code	Course Title	L	T	P	Credits
B0312PE	Conversational AI (Professional Elective-V)	3	0	0	3

Course Description: This course provides a comprehensive introduction to conversational artificial intelligence (AI) and equips students with the knowledge and skills necessary to design and develop conversational agents and chatbots. Through a combination of theoretical concepts and practical hands-on projects, students will gain a solid foundation in the field of conversational AI and its applications.

Course Outcomes: After completion of this course, the student will be able to

C312.1: Describe the basic concepts, designing and Developing Dialogue Systems in AI.

C312.2: Analyze the rule based dialogue systems and Tools for Developing Dialogue Systems in AI.

C312.3: Utilize Statistical Data-Driven Dialogue Systems in the Statistical Data-Driven Approach for Reinforcement Learning.

C312.4: Apply principles of Dialogue State Tracking and Dialogue Policy of a Statistical Data-Driven Dialogue Systems.

C312.5: Evaluating Task-Oriented Dialogue Systems for evaluating the performance and effectiveness of conversational agents.

C312.6: Analyze the benefits and challenges of End-to-End Neural Dialogue Systems in conversational AI.

Unit–I

Introducing Dialogue Systems: What's a Dialogue System? A Brief History of Dialogue Systems, Present-Day Dialogue Systems, Modeling Conversation Dialogue Systems, Designing and Developing Dialogue Systems.

Unit–II

Rule-Based Dialogue Systems: Architecture, Methods, and Tools: A Typical Dialogue Systems Architecture, designing a Dialogue System, Tools for Developing Dialogue Systems, Rule-Based Techniques in Dialogue Systems Participating in the Alexa Prize.

Unit–III

Statistical Data-Driven Dialogue Systems: Motivating the Statistical Data-Driven Approach, Dialogue Components in the Statistical Data-Driven Approach, Reinforcement Learning (RL), Representing Dialogue as a Markov Decision Process, From MDPs to POMDPs, Dialogue State Tracking, Dialogue Policy, Problems and Issues with Reinforcement Learning in POMDPs.

Unit–IV

Evaluating Dialogue Systems: How to Conduct the Evaluation, Evaluating Task-Oriented Dialogue Systems, Evaluating Open-Domain Dialogue Systems, Evaluation Frameworks-PARADISE, Quality of Experience (QoE), Interaction Quality, Best Way to Evaluate Dialogue Systems.

Unit–V

End-to-End Neural Dialogue Systems: Neural Network Approaches to Dialogue Modeling, A Neural Conversational Model, Introduction to the Technology of Neural Dialogue, Retrieval-Based Response Generation, Task-Oriented Neural Dialogue Systems, Open-Domain Neural Dialogue Systems, Some Issues and Current Solutions, Dialogue Systems: Datasets, Competitions, Tasks, and Challenges.

Text Book:

1. 1.Michael McTear,"Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots", Second Edition, Moran and Claypool Publishers, 2020.

Reference Book:

1. 1.Cathy Pearl,"Designing Voice User Interfaces: Principles of Conversational Experiences", O'Reilly, 2016.

Course Code	Course Title	L	T	P	Credits
B0313PE	Video Analytics (Professional Elective-V)	3	0	0	3

Course Description: To establish essential coverage of service oriented architectural models and its underlying design paradigm, along with documentation of the methodology.

Course Outcomes: After completion of this course, the student will be able to

C313.1: Understand the basics of video- signals and systems.

C313.2: Able to estimate motion in a video.

C313.3: Able to detect the objects and track them.

C313.4: Recognize activity and analyze behavior.

C313.5: Evaluate face recognition technologies.

C313.6: Build real-time video analysis applications using advanced vision techniques.

Unit– I Introduction

Multi-dimensional signals and systems: signals, transforms, systems, sampling theorem. Digital Images and Video: human visual system and color, digital video,3Dvideo, digital-video applications, image and video quality.

Unit–II Motion Estimation

Introduction- Video Basics - Fundamentals for Video Surveillance- Scene Artifacts-Object Detection and Tracking: Adaptive Background Modelling and Subtraction-Pedestrian Detection and Tracking Vehicle Detection and Tracking- Articulated Human Motion Tracking in Low-Dimensional Latent Spaces.

Unit– III Video Analytics

Introduction-Video Basics-Fundamentals for Video Surveillance-Scene Artifacts-Object Detection and Tracking: Adaptive Background Modelling and Subtraction- Pedestrian Detection and Tracking Vehicle Detection and Tracking- Articulated Human Motion Tracking in Low-Dimensional Latent Spaces.

Unit–IV Behavioural Analysis & Activity Recognition

Event Modelling- Behavioural Analysis- Human Activity Recognition-Complex Activity Recognition Activity modelling using 3D shape, Video summarization, shape-based activity models- Suspicious Activity Detection.

Unit–V Human Face Recognition & Gait Analysis

Introduction: Overview of Recognition algorithms–Human Recognition using Face: Face Recognition from still images, Face Recognition from video, Evaluation of Face Recognition Technologies- Human Recognition using gait: HMM Framework for Gait Recognition, View Invariant Gait Recognition, Role of Shape and Dynamics in Gait Recognition.

Text Book:

1. A.Murat Tekalp,"Digital Video Processing", second edition, Pearson,2015.
2. Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S,"Recognition of Humans and their Activities using Video", Morgan & Claypool Publishers, 2005.
3. Yunqian Ma, Gang Qian,"Intelligent Video Surveillance: Systems and Technology", CRC Press (Taylor and Francis Group), 2009.

Reference Books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
2. Yao Wang, Jorn Ostermann and Ya-Qin Zhang,"Video Processing and Communications", Prentice Hall, 2001.
3. Thierry Bouwmans, Fatih Porikli, Benjamin Höferlin and Antoine Vacavant,"Background Modeling and Foreground Detection for Video Surveillance: Traditional and Recent Approaches, Implementations, Benchmarking and Evaluation", CRC Press, Taylor and Francis Group, 2014.
4. Md. Atiqur Rahman Ahad,"Computer Vision and Action Recognition-A Guide for Image Processing and Computer Vision Community for Action Understanding", Atlantis Press, 2011..

Course Code	Course Title	L	T	P	Credits
B0501AC	English for Research Paper Writing (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to Understand that how to improve your writing skills and level of readability. Learn about what to write in each section. Understand the skills needed when writing a Title Ensure the good quality of paper at very first time submission.

Course Outcomes: After Completion of this course, the student will be able to

C501.1: Apply correct style of referencing and use punctuation appropriately.

C501.2: Demonstrate writing meaningful sentences and coherent paragraphs.

C501.3: Show conciseness, clarity and avoid redundancy in writing.

C501.4: Summarize, evaluate literature, and write methodology, results and conclusion.

C501.5: Describe how to develop title, write abstract and introduction.

C501.6: Understand that how to improve your writing skills and level of readability.

Unit–I Planning and Preparation

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit– II Highlighting Your Findings

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Unit–III Review of the Literature

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

Unit–IV Key skills are needed when writing a Title

Key skills are needed when writing a Title, key skills are needed when writing an abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Unit–V Skills are needed when writing the Methods

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Text Books:

1. Goldbort R (2006),"Writing for Science", Yale University Press (available on Google Books).
2. Day R (2006),"How to Write and Publish a Scientific Paper", Cambridge University Press.

Reference Books:

1. Highman N (1998), "Handbook of Writing for the Mathematical Sciences", SIAM Highman's book.
2. Adrian Wallwork,"English for Writing Research Papers", Springer New York Dordrecht Heidelberg London, 2011.

Course Code	Course Title	L	T	P	Credits
B0502AC	Disaster Management (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. Evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

Course Outcomes: After Completion of this course, the student will be able to

C502.1: Understand the concept of Disaster Management Cycle and Framework

C502.2: Explain the Applications of Science and Technology for Disaster Management and mitigation.

C502.3: Impart knowledge of causes of various disasters.

C502.4: Understand the key concepts in disaster risk reduction and humanitarian response.

C502.5: Understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries.

C502.6: Enhance awareness of Disaster Risk Management institutional processes.

Unit–I Disaster Prone Areas in India

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. **Disaster Prone Areas in India:** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post- Disaster Diseases and Epidemics.

Unit– II Repercussions of Disasters and Hazards

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches.

Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Unit–III Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of **Risk:** Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Unit–IV Risk Assessment Disaster Risk

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation, Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies for Survival.

Unit– V Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation, Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Text Books:

1. R.Nishith, Singh AK,"Disaster Management in India: Perspectives, issues and strategies "New Royal book Company.
2. Sahni, Pardeep Et. Al.(Eds.),"Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.

Reference Book:

1. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Code	Course Title	L	T	P	Credits
B0503AC	Sanskrit for Technical Knowledge (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to knowledge in illustrious Sanskrit, the scientific language in the world. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Course Outcomes: After Completion of this course, the student will be able to

C503.1: Understand the basic Sanskrit language

C503.2: Ancient Sanskrit literature about science & technology can be understood

C503.3: Being a logical language will help to develop logic in students

C503.4: Understand the students to know the basic Sanskrit Grammar and Literature

C503.5: Understand the History of Epi graphical study in India

C503.6: Enhance the students to know the Knowledge of ontology and trends Indian Philosophy.

Unit– I

Alphabets in Sanskrit.

Unit– II

Past/Present/Future Tense, Simple Sentences.

Unit– III

Order, Introduction of roots.

Unit– IV

Technical information about Sanskrit Literature.

Unit– V

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

Text Books:

1. Dr. Vishwas,“Abhy asp usta kam”, Samskrita-Bharti Publication, New Delhi.
2. Pratham a Deeksha, Vempati Kutumb shastri, “Teach Yourself Sanskrit”, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

Reference Book:

1. Suresh Soni,“India’s Glorious Scientific Tradition”, Ocean books (P)Ltd.,New Delhi.

Course Code	Course Title	L	T	P	Credits
B0504AC	Value Education (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to understand value of education and self-development. Imbibe good values in students and let the students should know about the importance of character.

Course Outcomes: After Completion of this course, the student will be able to

C504.1: Knowledge of self-development.

C504.2: Learn the importance of Human values developing the overall personality.

C504.3: Understand the importance of value based living.

C504.4: Emerge as responsible citizens with clear conviction to practice values and ethics in life.

C504.5: Become value based professionals.

C504.6: Contribute in building a healthy nation.

Unit–I Values and self-development

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgements.

Unit–II Importance of cultivation of values

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline.

Unit–III Personality and Behavior Development

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness.

Unit–IV Avoid fault Thinking, Free from anger

Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature.

Unit– V Character and Competence

Character and Competence–Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.

Text Book:

1. 1.Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

Course Code	Course Title	L	T	P	Credits
B0505AC	Constitution of India (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Course Outcomes: After Completion of this course, the student will be able to

C505.1: Understand the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

C505.2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

C505.3: Understand the circumstances surrounding the foundation of the Congress Socialist Party.

C505.4: Enhance the passage of the Hindu Code Bill of 1956.

C505.5: Know the importance of Constitution and Government.

C505.6: Become Good Citizens and know their fundamental rights, duties and principles.

Unit–I History of Making of the Indian Constitution

History Drafting Committee, (Composition & Working), Philosophy of the Indian Constitution: Preamble, Salient Features.

Unit–II Contours of Constitutional Rights & Duties

Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit–III Organs of Governance

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

Unit– IV Local Administration

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Panchayat i raj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Unit– V Election Commission

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books:

1. The Constitution of India, 1950(Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, “Framing of Indian Constitution”, 1st Edition,2015.

Reference Books:

1. M.P.Jain,“Indian Constitution Law”,7th Edn.,LexisNexis,2014.
2. D.D.Basu,“Introduction to the Constitution of India”, LexisNexis,2015.

Course Code	Course Title	L	T	P	Credits
B0506AC	Pedagogy Studies (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to Review existing evidence on the review topic to in form programme design and policy making undertaken by the DfID, other agencies and researchers.

Course Outcomes: After Completion of this course, the student will be able to

C506.1: Develop a positive attitude towards life and teaching profession.

C506.2: Analyse the classroom teaching learning and the ability to observe classroom behaviour.

C506.3: Understand process of communication and use them in their classroom teaching and inculcate multi cult urism.

C506.4: Use of models of teaching by applying knowledge to make teaching effective.

C506.5: Use the collaborative learning into a course in away that aligns with students learning objectives and intended outcomes.

C506.6: Develop a positive attitude towards life and teaching profession.

Unit–I Introduction and Methodology

Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

Unit– II Thematic Overview

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Unit–III Evidence on the effectiveness of pedagogical practices

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers attitudes and beliefs and Pedagogic strategies.

Unit–IV Professional development

Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Unit– V Research gaps and future directions

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Text Books:

1. Ackers J, Hardman F (2001), "Classroom interaction in Kenya n primary schools", Compare, 31 (2): 245-261.
2. Agrawal M (2004), "Curricular reform in schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003),"Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1", London: DFID.

Reference Books:

1. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013), "Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development", 33 (3): 272–282.
2. Alexander RJ (2001), "Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell".
3. Chavan M (2003),"Read India: A mass scale, rapid,'learning to read' campaign".

Course Code	Course Title	L	T	P	Credits
B0507AC	Stress Management by Yoga (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to achieve overall Good Health of Body and Mind. To lower blood pressure and improve heart health to become non-violent and truthfulness. To increase the levels of happiness and to eliminate all types of body pains.

Course Outcomes: After Completion of this course, the student will be able to

C507.1: Develop healthy mind in a healthy body thus improving social health also improve efficiently.

C507.2: Develop body awareness. Learn how to use their bodies in a healthy way. Perform well in sports and academics.

C507.3: Will balance, flexibility, and stamina, strengthen muscles and connective tissues enabling good posture.

C507.4: Manage stress through breathing, awareness, meditation and healthy movement.

C507.5: Build concentration, confidence and positive self-image.

C507.6: Develop healthy mind in a healthy body thus improving social health.

Unit– I

Definitions of Eight parts of yoga.(Ashtanga)

Unit– II

Yamand Niyam.

Unit– III

Do`sand Don't'sinlife.

Ahinsa, satya, astheya, bramhacharya and aparigraha.

Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Unit– IV

As an and Pranayam.

Unit– V

Various yog poses and their benefits for mind & body.

Regularization of breathing techniques and its effects-Types of pranayam.

Text Books:

1. Janardan Swami,"Yogic Asanas for Group Tar in ing-Part-I":", Nagpur.
2. Swami Vivekananda,"Raja yoga or conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.

Course Code	Course Title	L	T	P	Credits
B0508AC	Personality Development through Life Enlightenment Skills (Audit Course-I & II)	2	0	0	0

Course Description: This course helps the students to learn to achieve the highest goal happily to become a person with stable mind, pleasing personality and determination, awaken wisdom in students Personality development of the patterns and attitude. It is the result of where we are born, the circle we interact with and our personal temperament. Every person is different.

Course Outcomes: After Completion of this course, the student will be able to

C508.1: Understand their Personality and achieve their highest Goals of Life.

C508.2: Learn to build Positive Attitude, Self-Motivation, enhancing Self-Esteem and Emotional Intelligence.

C508.3: Analyze and Develop Time management, Team management, Work ethics, good manners and personal and professional Etiquettes.

C508.4: Lead the nation and mankind to peace prosperity and practice emotional self-regulation.

C508.5: Learn to develop coping mechanism to manage Stress through Yoga and Meditation Techniques and develop a versatile personality.

C508.6: Study of Neetishatakam will help in developing versatile personality of students.

Unit– I

Neetisatakam-Holistic development of personality

Verses-19,20,21,22 (wisdom)

Verses-29,31,32(pride & heroism)

Verses-26,28,63,65 (virtue)

Unit– II

Neetisatakam-Holistic development of personality

Verses-52,53,59 (dont's)

Verses-71,73,75,78 (do's)

Unit– III

Approach today today work and duties

Shrimad Bhagwad Geeta: Chapter 2-Verses 41,47,48,

Chapter 3-Verses 13,21,27,35, Chapter 6-Verses 5,13,17,23, 35,

Chapter 18-Verses 45,46, 48.

Unit– IV

Statements of basic knowledge

Shrimad Bhagwad Geeta: Chapter 2-Verses 56,62,68

Chapter 12 -Verses 13, 14, 15, 16, 17, 18 Personality of Role model Shrimad Bhagwad Geeta:

Unit– V

Chapter 2-Verses 17, Chapter 3-Verses 36,37,42,

Chapter 4-Verses 18,38,39

Chapter 18–Verses 37,38, 63

Text Books:

1. Swami Swarupananda Advaita,"Sri mad Bhagavad Gita", Ashram (Publication Department), Kolkata.
2. P.Gopinath,"Bhartrihari's Three Satakam (Niti-sringar-vairagya)", Rashtriya Sanskrit Sansthanam, New Delhi.

Course Code	Course Title	L	T	P	Credits
B0300OE	Statistical Foundations for Data Science (Open Elective)	3	0	0	3

Course Description: The course Statistical Foundations for Data Science provides a rigorous introduction to probability, random variables, and statistical inference, essential for analyzing and interpreting data. The course explains regression models, estimation methods, hypothesis testing, and stochastic processes to build a strong foundation for data-driven decision-making. Emphasis is placed on applying mathematical concepts to real-world problems in data science, cryptography, and predictive analytics.

Course Outcomes: After completion of this course, the student will be able to

C300.1: Explain GCD, Euclidean algorithm, prime factorization, and congruences.

C300.2: Apply linear regression, correlation, and basic probability distributions.

C300.3: Use continuous distributions, sampling concepts, and central limit theorem.

C300.4: Perform parameter estimation and hypothesis testing.

C300.5: Apply maximum likelihood and interval estimation methods.

C300.6: Analyze stochastic processes and Markov chains.

Unit–I Greatest Common Divisors and Prime Factorization

Greatest Common Divisors and Prime Factorization: Greatest common divisors, The Euclidean algorithm, The fundamental theorem of arithmetic, Factorization of integers and the Fermat numbers Congruences: Introduction to congruences, Linear congruences, The Chinese remainder theorem, Systems of linear congruences

Unit–II Simple Linear Regression and Correlation

Simple Linear Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators, Inferences Concerning the Regression Coefficients, Prediction, Simple Linear Regression Case Study Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Statistical Independence. Discrete Probability Distributions: Binomial Distribution, Poisson distribution.

Unit–III Continuous Probability Distributions

Continuous Probability Distributions: Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Fundamental Sampling Distributions: Random Sampling, Sampling Distributions, Sampling, Distribution of Means and the Central Limit Theorem, Sampling Distribution of S2, t–Distribution, F Distribution.

Unit–IV Estimation & Tests of Hypotheses

Estimation & Tests of Hypotheses: Introduction, Statistical Inference, Classical Methods of Estimation. Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples and Maximum Likelihood Estimation.

Unit–V Stochastic Processes and Markov Chains

Stochastic Processes and Markov Chains: Introduction to Stochastic processes-Markov process. Transition Probability, Transition Probability Matrix, First order and Higher order Markov process, n step transition probabilities, Markov chain, Steady state condition, Markov analysis.

Text Book:

1. Kenneth H.Rosen, Elementary number theory & its applications, sixth edition, Addison Wesley, ISBN 978 0-321-50031-1
2. Ronald E.Walpole, Raymond H.Myers, Sharon L.Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Ed. Pearson Publishers.
3. S.D.Sharma, Operations Research, Kedarnath and Ramnath Publishers, Meerut, Delhi David A. Bader, “Massive Graph Analytics”, CRC Press.

Reference Books:

1. S C Gupta and V K Kapoor, “Fundamentals of Mathematical statistics”, Khanna publications
2. T.T.Soong,“Fundamentals of Probability And Statistics For Engineers”, John Wiley & Sons Ltd, 2004.
3. Sheldon M Ross, “Probability and statistics for Engineers and scientist”, Academic Press. Stanley Wasserman, Katherine Faust,"Social Network Analysis: Methods and Applications”, (Structural Analysis in the Social Sciences), Cambridge University Press, 1995.

Course Code	Course Title	L	T	P	Credits
B0301OE	Big Data Technologies (Open Elective)	3	0	0	3

Course Description: The course Big Data Technologies introduces students to the principles, techniques, and tools of big data analytics. It covers Hadoop ecosystem components such as HDFS, MapReduce, Hive, Pig, and HBase, along with NoSQL databases and Zookeeper coordination. Students will gain hands-on experience in managing, processing, and analyzing large-scale datasets while understanding the role of big data in busi ness, cloud computing, and social media applications.

Course Outcomes: After completion of this course, the student will be able to

C301.1: Understand Big Data concepts and challenges.

C301.2: Apply Hadoop ecosystem tools for data processing.

C301.3: Design storage solutions using HBase and NoSQL.

C301.4: Analyze large datasets with efficient querying.

C301.5: Use Zookeeper for distributed application management.

C301.6: Evaluate Big Data applications in business, social media, and cloud.

Unit–I Getting an Overview of Big Data

Getting an Overview of Big Data Big Data, History of Data Management – Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Careers in Big Data, Future of Big Data

Technologies for Handling Big Data Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data

Unit–II Understanding Hadoop Ecosystem

Understanding Hadoop Ecosystem Hadoop Ecosystem, Hadoop Distributed File System, MapReduce, Hadoop YARN, Hbase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie **Understanding MapReduce Fundamentals and HBase** The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing

Unit–III Exploring Hive

Exploring Hive Introducing Hive, Getting Started with Hive, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval Queries, Using JOINS in Hive

Analyzing Data with Pig Introducing Pig, Running Pig, Getting Started with Pig Latin, Working with Operators in Pig, Working with Functions in Pig

Unit–IV Using Oozie Using Oozie

Introducing Oozie, Installing and Configuring Oozie, Understanding the Oozie Work flow, Oozie Coordinator, Oozie Bundle, Oozie Parameterization with EL, Oozie Job Execution Model, Accessing Oozie, Oozie SLA

NoSQL Data Management

Introduction to NoSQL, Aggregate Data Models, Key Value Data Model, Document Databases, Relationships, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations

Unit– V Zookeeper

Zookeeper: Installing and Running ZooKeeper, An Example, Group Membership in ZooKeeper, Creating the Group, Joining a Group, Listing Members in a Group, The ZooKeeper Service, Data Model, Operations, Implementation, Consistency, Sessions, Building Applications with oo Keeper, A Configuration, Service, The Resilient ZooKeeper Application, A Lock Service, More Distributed Data Structures and Protocols, ZooKeeper in Production

Sqoop: Getting Sqoop, Sqoop Connectors, A Sample Import, Generated Code, Imports: A Deeper Look, Working with Imported Data, Importing Large Objects, Performing an Export, Exports: A Deeper Look

Text Books:

1. Blackbook,"Bigdata", DreamTechPress,2015.
2. Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'Reilly Media, 2012.

References:

1. Seem a Acharya, Subhashini Chellappan,"Big Data Analytics", Wiley 2015.
2. Simon Walkowiak,"Big Data Analytics with R", Packt Publishing, ISBN:9781786466457
3. Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Busi ness Intelligence and Analytic Trends for Today's Busi ness",1st Edition, Am big a Dhiraj, Wiley CIO Series, 2013.
4. A rvind Sathi,"Big Data Analytics: Disruptive Technologies for Changing the Game",1st Edition, IBM Corporation, 2012.

Course Code	Course Title	L	T	P	Credits
B0302OE	Predictive Analytics (Open Elective)	3	0	0	3

Course Description: The course Predictive Analytics focuses on statistical and machine learning techniques used for prediction and forecasting. It covers regression models, model assessment, and advanced methods such as boosting, neural networks, support vector machines, and random forests. Students will gain practical knowledge of supervised and unsupervised learning techniques for analyzing data and making accurate predictions. Emphasis is placed on applying predictive models to real-world case studies across busi ness and scientific domains.

Course Outcomes: After completion of this course, the student will be able to

C302.1: Apply regression and classification techniques for prediction.

C302.2: Evaluate models using bias-variance and validation methods.

C302.3: Implement boosting, bagging, and ensemble methods.

C302.4: Use NN, SVM, and k-NN for predictive tasks.

C302.5: Apply clustering, association rules, and random forests.

C302.6: Analyze real-world datasets for forecasting and decision-making

Unit–I

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection , Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression , Perce ptr on learning algorithm.

Unit– II

Model Assessment and Selection: Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation, Bootstrap methods, conditional or expected test error.

Unit–III

Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees , Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data)

Unit–IV

Neural Networks (NN), Support Vector Machines (SVM), and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour class if i ers (Image Scene Classification)

Unit– V

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis.

Text Book:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The Elements of Statistical Learning Data Mining, Inference, and Prediction”, Second Edition, Springer Verlag, 2009.

Reference Books:

1. C.M.Bishop,“Pattern Recognition and Machine Learning”, Springer,2006
2. L.Wasserman,“All of statistics”.
3. Gareth James, Daniela Witten . Trevor Hastie Robert Tibshirani. An Introduction to Statistical Learning with Applications in R

Duplicate entry for course code B0303OE also appears later in this document with revised outcomes and content — final version to be confirmed by BOS.

Course Code	Course Title	L	T	P	Credits
B0303OE	**Generative AI (Open Elective)**	**3**	**0**	**0**	**3**

Course Description: This course introduces the foundations, principles, and evolution of AI, ML, DL, NLP, and Generative AI. It provides in-depth knowledge of advanced neural architectures such as GANs, VAEs, and Transformers, along with large language models and prompt engineering. Students will explore multi modal applications in text, image, and video generation while addressing ethical, legal, and societal implications. The course emphasizes practical applications, fine-tuning models, and responsible deployment of Generative AI in real-world scenarios.

Course Outcomes: After Completion of this course, the student will be able to

C303.1: Demonstrate knowledge of AI foundations, generative models, and neural architectures.

C303.2: Apply generative AI techniques to solve problems in text, image, and multimedia domains.

C303.3: Design and fine-tune large language models for specialized tasks.

C303.4: Utilize frameworks and tools for implementing generative AI applications.

C303.5: Evaluate ethical, legal, and social implications of generative AI deployment.

C303.6: Propose innovative solutions using generative AI for real-world challenges.

Unit–I

Foundations of AI and Generative Models Introduction and historical evolution to Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP)and Deep Learning (DL), Structure of Artificial Neural Networks (ANNs), Mathematical and computational foundations of generative modeling, Overview of generative models and their applications across various domains; Importance of Generative AI in modern applications, Transfer learning and in advancing Generative AI

Unit–II

Advanced Neural Architectures for Generative AI Variation al Auto encoders (VAEs): principles and applications, Generative Adversarial Networks (GANs): architecture and working principles; Transformer architecture and attention mechanisms (in detail); Long Short-Term Memory Networks (LSTMs)and the limitations of traditional RNNs/LSTMs, Advanced Transformer architectures and techniques, Pre-training and transfer learning strategies for generative models

Unit–III

Large Language Models and Prompt Engineering Overview of Large Language Models (LLMs), GPT architecture, variants, and working principles, Prétraining and fine-tuning GPT models for applications (e.g., chatbots, text generation), Case study: GPT-based customer support chatbot, BERT architecture, pre-training objectives, and fine-tuning, Prompt Engineering: Designing effective prompts, controlling model behavior, and improving output quality, Fine-tuning language models for creative writing and chatbot development

Unit–IV

Multi-Agent Systems and Generative AI Applications Introduction to Multi-Agent Systems (MAS), Types of agents: reactive, deliberative, hybrid, and learning agents, Multi-agent collaboration and orchestration for generative tasks, Use cases: autonomous research assistants, cooperative creative generation, distributed problem-solving, Frameworks and tools: AutoGen, CrewAI, Hugging GPT for LLM-powered multi-agent systems, Generative AI applications: Art, Creativity, Image/Video generation, Music composition, Healthcare, Finance, Real-world case studies and deployment challenges

Unit–V

Frameworks, Multi modal Applications, and Ethics LangChain framework: components and LLM application development, Retrieval-Augmented Generation (RAG), Embeddings, Indexing networks, and Vector databases, Generative AI across modalities: Text, Code, Image, and Video generation, Image and Video generation using GANs and VAEs, Multi modal Generative AI: integration and training strategies, Ethical considerations: bias, fairness, trust, and responsible AI deployment, Social and legal implications of Generative AI, Risk mitigation strategies and real-world ethical case studies

Text Book:

1. Altaf Rehmani, Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology.
2. Charu C.Aggarwal, Neural Networks and Deep Learning: A Textbook. Joseph Babcock, Rag hav Bali, Generative AI with Python and TensorFlow 2, 2024

Reference Books:

1. Josh Kalin,“Generative Adversarial Networks Cookbook”.
2. Jesse Sprinter,“Generative AI in Software Development: Beyond the Limitations of Traditional Coding”, 2024.

Online References:

1. Fabian Gloeckle et al.,“Better & Faster Large Language Models via Multi-token Prediction”, arXiv:2404.19737v1, 2024.Vaswani et al., Attention Is All You Need, Neur IPS 2017.

Course Code	Course Title	L	T	P	Credits
B0311PE	Digital Forensics (Professional Elective-V)	3	0	0	3

Pre-Requisite Computer Networks

Course Description: This course provides an in-depth study of the rapidly changing and fascinating field of computer forensics. Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.

Course Outcomes: After completion of this course, the student will be able to

C311.1: Understand relevant legislation and ethical codes to ensure legal compliance in digital investigations.

C311.2: Illustrate the holistic investigative process and detective procedures for various categories of computer crime.

C311.3: Execute standard protocols for the search, seizure, and documentation of electronic evidence for court proceedings.

C311.4: Implement evidence management strategies and forensic mindsets to maintain the integrity of the chain of custody.

C311.5: Summarize specialized computer and network forensic investigations using industry-standard workstations and open-source tools.

C311.6: Discover mobile forensic techniques and recent trends to retrieve data from contemporary digital devices.

Unit–I

Digital Forensics Science: Forensics science, computer forensics, and digital forensics. **Computer Crime:** Criminalistics as it relates to the investigative process, analysis of cyber criminalistics area, holistic approach to cyber-forensics, NIST Incident Response Lifecycle, NIST Digital Forensics**,** Framework (NIST SP 800-86).

Unit–II

Cyber Crime Scene Analysis: Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved andun-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation, Forensic Imaging Techniques, FTK Imager and Autopsy.

Unit–III

Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause, Forensic Report Writing standards.

Unit–IV

Computer Forensics: Prepare a case, begin an investigation, understand computer forensics workstations and software, conduct an investigation, complete a case, Critique a case. **Memory Forensics:** Volatility Framework, Ransom ware Investigations. **Network Forensics:** Open-source

security tools for network forensic analysis, requirements for preservation of network data.

Unit–V

Mobile Forensics: mobile forensics techniques, mobile forensics tools, Recent trends in mobile forensic technique and methods to search and seizure electronic evidence. **Legal Aspects of Digital Forensics**: IT Act 2000, amendment of IT Act 2008, Introduction to Digital Personal Data Protection (DPDP) Act.

Text Books:

1. John Sammons, The Basics of Digital Forensics, Elsevier.
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications.

Reference Books:

1. William Oettinger, Learn Computer Forensics: A beginner's guide to searching, analyzing, and securing digital evidence, 1st Edition, 2020, Packt Publishing.
2. Thomas J.Holt, Adam M.Bossler, Kathryn C.Seigfried-Spellar, Cyber crime and Digital Forensics: An Introduction, Routledge
3. Kenneth C.Brancik, Insider Computer Fraud,2008, Auerbach Publications Taylor & Francis Group.
4. Bill Nelson, Amelia Phillips, Christopher Steuart, Guide to Computer Forensics and Investigations, 4th Edition, Cengage Learning.
5. NISTSP800-86Guide to Integrating Forensic Techniques into Incident Response,2006.
6. Michael Ligh, Andrew Case, Jamie, Walters, The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory, 2014, Wiley.
7. Gerard Johansen, Digital Forensics and Incident Response,3rd Edition,2022O'Reilly.
8. https://dpdpa.com/index.html

Course Code	Course Title	L	T	P	Credits
B0312PE	Conversational AI (Professional Elective-V)	3	0	0	3

Course Description: This course provides a comprehensive introduction to conversational artificial intelligence (AI) and equips students with the knowledge and skills necessary to design and develop conversational agents and Chatbots through a combination of theoretical concepts and practical hands- on projects, students will gain a solid foundation in the field of conversational AI and its applications.

Course Outcomes: At the end of the course, the student will be able to

C312.1: Describe the basic concepts, Designing and Developing Dialogue Systems in AI.

C312.2: Analyze the rule based dialogue systems and Tools for Developing Dialogue Systems in AI.

C312.3: Utilize Statistical Data-Driven Dialogue Systems in the Statistical Data-Driven Approach for Reinforcement Learning.

C312.4: Apply principles of Dialogue State Tracking and Dialogue Policy of a Statistical Data-Driven Dialogue Systems.

C312.5: Evaluating Task-Oriented Dialogue Systems for evaluating the performance and effectiveness of conversational agents.

C312.6: Analyze the benefits and challenges of End-to-End Neural Dialogue Systems in conversational AI.

Unit–I

Introducing Dialogue Systems: What's a Dialogue System? A Brief History of Dialogue Systems, Present-Day Dialogue Systems, Modeling Conversation Dialogue Systems, Designing and Developing Dialogue Systems.

Unit–II

Rule-Based Dialogue Systems: Architecture, Methods, and Tools: A Typical Dialogue Systems Architecture, designing a Dialogue System, Tools for Developing Dialogue Systems, Rule-Based Techniques in Dialogue Systems Participating in the Alexa Prize, Microsoft Bot Frameworks, Introduction to Google Dialog flow.

Unit–III

Data-Driven Dialogue Systems: Motivating a dialogue-based approach, Reinforcement Learning (RL), Representing Dialogue as a Markov Decision Process, From MDPs to POMDPs, Dialogue State Tracking, Dialogue Policy, Problems and Issues with Reinforcement Learning in POMDPs, Few-shot and Zero-shot learning, Retrieval Augmented Generation (RAG), Fine-Tuning vs Prompt Engineering.

Unit–IV

Evaluating Dialogue Systems: How to Conduct the Evaluation, Evaluating Task-Oriented Dialogue Systems, Evaluating Open-Domain Dialogue Systems, Evaluation Frameworks-PARADISE, Quality of Experience (QoE), Interaction Quality, Best Way to Evaluate Dialogue

Systems, LLM Evaluation Metrics-Hallucination, Bias. LLMS ecurity Risks-Mitigating LLM Risks-Prompt injection attacks.

Unit–V

End-to-End Neural Dialogue Systems: Neural Network Approaches to Dialogue Modeling, A Neural Conversational Model, Introduction to the Technology of Neural Dialogue, Retrieval-Based Response Generation, Task-Oriented Neural Dialogue Systems, Open-Domain Neural Dialogue Systems, Some Issues and Current Solutions, Dialogue Systems: Datasets, Competitions, Tasks, and Challenges, Building a Voice AI fora Virtual Assistant Like the Google Assistant, Building a Multi-Language Agent, Fine-Tuning the Text to Speech Output of Voice Bots with SSML.

Text Books:

1. Michael McTear, Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots, 2nd Edition, 2020, Moran and Claypool Publishers.
2. Building LLMs with Transformer Architecture: A Practical Guide to Developing and Fine-tuning NLP Models with Real-World Examples, Kindle Edition.
3. McTear, M, Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Synthesis Lectures on Human Language Technologies), Science and Busi ness Media LLC, 2020, Springer.

Reference Books:

1. Cathy Pearl, Designing Voice User Interfaces: Principles of Conversational Experiences, 2016, O'REILLY.
2. Srini Janarthanam, Building Chatbots and Conversational AI Solutions,1st Edition, Packt Publishing.
3. Abhishek Singh, Kart hik Ramasubramanian and Shrey Shivam, Building an Enterprise Chatbot: Work with Protected Enterprise Data Using Open Source Frameworks, Apress Media.
4. Vaibhav Malik, Ken Huangand Ads Dawson, AI-Native LLM Security: Threats, defenses, and best practices for building safe and trustworthy AI, Packt Publishing.
5. Uday Kamath, Kevin Keenan, Garrett Somers, Large Language Models: A Deep Dive: Bridging Theory and Practice, Springer.
6. Lee Boonstra, The Definitive Guide to Conversational AI with Dialog flow and Google Cloud, Apress Berkeley, CA.

Course Code	Course Title	L	T	P	Credits
B0313PE	Video Analytics (Professional Elective-V)	3	0	0	3

Course Description: This course explores Advanced Video Analytics and Surveillance Intelligence, focusing on the transformation of raw multi-dimensional signals into actionable insights. It integrates computer vision models with edge deployment strategies to automate the detection, tracking, and recognition of complex human behaviors.

Course Outcomes: At the end of the course, the student will be able to

C313.1: Understand the basics of video-signals and systems.

C313.2: Estimate motion in avideo.

C313.3: Detect the objects and track them.

C313.4: Recognize activity and analyze behavior.

C313.5: Evaluate face recognition technologies.

C313.6: Build real-time video analysis applications using advanced vision techniques.

Unit– I

Multi-dimensional signals and systems: signals, transforms, systems, sampling theorem. Digital Images and Video: human visual system and color, digital video,3Dvideo, digital-video applications, image and video quality, Video Streaming Basics-Real-Time Streaming Protocol (RTSP)Streams, CCTV pipelines.

Unit– II

Motion Estimation: Image formation, motion models, 2D apparent motion estimation, Differential methods, matching methods, non-linear optimization methods, transform domain methods,3Dmotion and structure estimation, Introduction to Edge AI Architecture, Edge Device Deployment Work flows.

Unit– III

Video Basics: Introduction**,** Fundamentals for Video Surveillance-Scene Artifacts, Anomaly Detection in Surveillance: Introduction-Video Anomaly Concepts and Detection Techniques**,** Adaptive Background Modelling and Subtraction-Pedestrian Detection and Tracking Vehicle Detection and Tracking- Articulated Human Motion Tracking in Low-Dimensional Latent Spaces.

Unit– IV

Event Modelling: Behavioral Analysis-Human Activity Recognition-Complex Activity Recognition Activity modelling using 3D shape, Video summarization, shape-based activity models- Suspicious Activity Detection. Introduction to Fall Detection Monitoring and Health Monitoring.(Healthcare use case).

Unit– V

Recognition algorithms: Introduction**,** Human Recognition using Face: Face Recognition from still images, Face Recognition from video, Evaluation of Face Recognition Technologies- Human Recognition using gait: HMM Framework for Gait Recognition, View Invariant Gait Recognition,

Role of Shape and Dynamics in Gait Recognition, Introduction to Data Privacy: GDPR Fundamentals, Data Privacy vs Data Security.

Text Books:

1. A.Murat Tekalp, Digital Video Processing,2nd Edition,2015, Pearson.
2. Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S, Recognition of Humans and their Activities using Video, 2005, Morgan & Claypool Publishers.
3. Yunqian Ma, Gang Qian, Intelligent Video Surveillance: Systems and Technology, 2009, CRC Press (Taylor and Francis Group).

Reference Books:

1. Yao Wang, Jorn Ostermann and Ya-Qin Zhang, Video Processing and Communications, 2001, Prentice Hall.
2. Md. Atiqur Rahman Ahad, Computer Vision and Action Recognition-A Guide for Image Processing and Computer Vision Community for Action Understanding, 2011, Atlantis Press.
3. K.S.Thyagarajan, Computer Vision and Image Processing: Fundamentals and Applications,1st Edition, CRC Press (Taylor & Francis).
4. Fred Halsall, Multimedia Communications: Applications, Networks, Protocols and Standards, 3rd Edition, 2013, Pearson Education.
5. Xiao chun Wang, Anomaly Detection in Video Surveillance, 1st Edition, Springer.
6. Supa rna Biswas, Machine Learning and Deep Learning in Human Activity Recognition and Fall Detection: Algorithms, Frameworks, and Applications for Sustainable Healthcare, Kindle Edition, 2026, Springer.
7. Ravi Rajput, CDO Privacy Handbook: ISO 27701 in Action GDPR & DPDP Act-2023 Compliance Simplified privacy information management system PIMS GDPR data protection officer resources Privacy Best Practices, Kindle Edition.

Course Code	Course Title	L	T	P	Credits
B0300OE	Statistical Foundations for Data Science (Open Elective)	3	0	0	3

Pre-Requisite Mathematics courses of first year of study

Course Description: This course provides a comprehensive foundation in Number Theory, Statistical Analysis, and Stochastic Modeling. It integrates discrete mathematical structures with probabilistic frameworks, offering the essential tools to analyze complex data patterns and secure digital systems.

Course Outcomes: At the end of the course, the student will be able to

C300.1: Examine various theorems, algorithms in arithmetic for GCD and factorization.

C300.2: Analyze the techniques of regression and correlation.

C300.3: Justify the importance of discrete probability distributions in data science.

C300.4: Compare various continuous probability distribution techniques.

C300.5: Inspect the methods of Estimation and tests of hypotheses.

C300.6: Distinguish between Stochastic Processes and Markov Chains in data analysis.

Unit–I

Greatest Common Divisors and Prime Factorization: Greatest common divisors, The Euclidean algorithm, The fundamental theorem of arithmetic, Factorization of integers and the Fermat numbers Congruences: Introduction to congruences, Linear congruences, The Chinese remainder theorem, Systems of linear congruences.

Unit–II

Simple Liner Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators, Inferences Concerning the Regression Coefficients, Prediction, Simple Linear Regression Case Study Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Binomial Distribution, Continuous Probability Distributions, Exponential Distribution, Poisson distribution, Statistical Independence.

Unit–III

Continuous Probability Distributions: Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Fundamental Sampling Distributions: Random Sampling, Sampling Distributions, Sampling, Distribution of Means and the Central Limit Theorem, Sampling Distribution of S2, t–Distribution, F Distribution.

Unit–IV

Estimation & Tests of Hypotheses: Introduction, Statistical Inference, Classical Methods of Estimation, Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples, Chi-Square Test, Probability Foundations-Conditional probability, Bayes'Theorem, Maximum Likelihood Estimation,

Stochastic Processes and Markov Chains: Introduction to Stochastic processes- Markov process. Transition Probability, Transition Probability Matrix, First order and Higher order Markov process, n step transition probabilities, Markov chain, Steady state condition, Markov analysis, Overview of Hidden Markov Models.

Text Books:

1. Kenneth H.Rosen, Elementary number theory & its applications, 6th Edition, Addison Wesley.
2. Ronald E.Walpole, Raymond H.Myers, Sharon L.Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Edition, Pearson Publishers.
3. S.D.Sharma, Operations Research, Kedarnath and Ramnath Publishers, Meerut, Delhi.

Reference Books:

1. SC Gupta and VK Kapoor, Fundamentals of Mathematical statistics, Khanna publications.
2. T.T.Soong, Fundamentals of Probability and Statistics for Engineers,2004, John Wiley & Sons Ltd.
3. Sheldon M Ross, Probability and statistics for Engineers and scientists, Academic Press.
4. Larry Wasserman, All of Statistics: A Concise Course in Statistical Inference,1st Edition, Springer.
5. S.C.Gupta & V.K.Kapoor, Fundamentals of Applied Statistics, Latest Revised Edition, Sultan Chand & Sons.

Course Code	Course Title	L	T	P	Credits
B0301OE	Big Data Technologies (Open Elective)	3	0	0	3

Course Description: This course begins with an Overview of Big Data, covering its evolution, elements, analytics, careers, and technologies like Hadoop, cloud, and in-memory computing. It explores the Hadoop Ecosystem, MapReduce, HBase, Hive, Pig, Oozie, and NoSQL Data Management, focusing on data storage, processing, and analysis. Finally, it covers ZooKeeper and Sqoop, emphasizing coordination, distributed services, data transfer, and integration for large-scale big data applications.

Course Outcomes: At the end of the course, the student will be able to

C301.1: Explain the fundamentals of Big Data, its evolution, elements, analytics, and supporting technologies.

C301.2: Demonstrate the working of the Hadoop ecosystem, HDFS, MapReduce, YARN and HBase.

C301.3: Apply Hive for data definition, manipulation, queries, and analysis.

C301.4: Use Pig and Pig Latin for data analysis with operators and functions.

C301.5: Illustrate the role of Oozie in work flow management and explore NoSQL data management models.

C301.6: Utilize ZooKeeper for coordination and Sqoop for data import/export in Big Data applications.

Unit–I

Getting an Overview of Big Data: Big Data, History of Data Management – Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Careers in Big Data, Future of Big Data. **Technologies for Handling Big Data:** Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data, Introduction to data lakes, Architecture.

Unit–II

Understanding Hadoop Ecosystem: Hadoop Ecosystem, Hadoop Distributed File System, MapReduce, Hadoop YARN, Hbase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie. **Understanding MapReduce Fundamentals and HBase:** The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing, Apache Spark-Distributed Processing with Spark.

Unit–III

Exploring Hive: Introducing Hive, Getting Started with Hive, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval Queries, Using JOIN Sin Hive. **Analyzing Data with Pig:** Introducing Pig, Running Pig, Getting Started with Pig Latin, Working with Operators in Pig, Working with Functions in Pig, Columnar Storage Formats-Parquet, ORC, Avro.

Unit–IV

Using Oozie: Introducing Oozie, Installing and Configuring Oozie, Understanding the Oozie Work flow, Oozie Coordinator, Oozie Bundle, Oozie Parameterization with EL, Oozie Job Execution Model, Accessing Oozie, Oozie SLA, Basic concepts of Data Pipelines & ETL/ELT- Flume, Sqoop**.** **NoSQL Data Management:** Introduction to NoSQL, Aggregate Data Models, Key Value Data Model, Document Databases, Relationships, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations, The Birth of NoSQL, Relational versus Document Databases, Graph-like Data Models.

Unit–V

Zookeeper: Installing and Running ZooKeeper, An Example, Group Membership in ZooKeeper, Creating the Group, joining a Group, Listing Members in a Group, The ZooKeeper Service, Data Model, Operations, Implementation, Consistency, Sessions, Building Applications with ZooKeeper, A Configuration, Service, The Resilient ZooKeeper Application, A Lock Service, More Distributed Data Structures and Protocols, ZooKeeper in Production. **Sqoop:** Getting Sqoop, Sqoop Connectors, A Sample Import, Generated Code, Imports: A Deeper Look, Working with Imported Data, Importing Large Objects, Performing an Export, Exports: A Deeper Look.

Text Books:

1. DT Editorial Services, Bigdata, blackbook,2015, DreamTechPress.
2. Tom White, Hadoop: The Definitive Guide,3rd Edition,2012, O'Reilly Media.

Reference Books:

1. Seem a Acharya, Subhashini Chellappan, Big Data Analytics,2015, Wiley.
2. Simon Walkowiak, Big Data Analytics with R, Packt Publishing.
3. Michael Minelli, Michehe Chambers, Am big a Dhiraj, Big Data, Big Analytics: Emerging Busi ness Intelligence and Analytic Trends for Today's Busi ness, 1st Edition, 2013, Wiley CIO Series.
4. Big Data Analytics: Disruptive Technologies for Changing the Game, A rvind Sathi, 1st Edition, 2012, IBM Corporation.
5. Martin Kleppmann, Designing Data-Intensive Applications,1st Edition, O'Reilly Media.
6. Anne Laurent, Cédrine Madera, Dominique Laurent, Data Lake, Volume 2,2020, John Wiley & Sons.

Course Code	Course Title	L	T	P	Credits
B0302OE	Predictive Analytics (Open Elective)	3	0	0	3

Course Description: This course delivers a rigorous foundation in Statistical Learning and Predictive Modeling, spanning the transition from classical linear methods to complex ensemble and neural architectures. It emphasizes the critical balance between model complexity and generalization through robust evaluation frameworks.

Course Outcomes: At the end of the course, the student will be able to

C302.1: Understand the theories, and approaches of classification and Regression.

C302.2: Evaluate and validate the model assessment, selection and validation for model building.

C302.3: Illustrate various classification and Regression model & its statistical approaches.

C302.4: Comprehend Numerical Optimization for model building.

C302.5: Analyze supervised algorithms & its statistical approaches.

C302.6: Implement unsupervised frameworks to extract patterns, reduce dimensionality, and detect anomalies.

Unit– I

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection, Ridge regression, Lasso regression, Linear Discriminant Analysis, Logistic regression, Perce ptr on learning algorithm, Emphasize on Feature Engineering-The Effects of Feature Scaling, Encoding categorical variables.

Unit– II

Model Assessment and Selection: Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross-validation, Bootstrap methods, conditional or expected test error, Evaluation Metrics-Accuracy vs Precision vs Recall-F1-score, Confusion Matrix, ROC- AUC, Over fitting, Fine-Tune Your Model (N).

Unit– III

Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees, Random forests and analysis. Gradient Boosting methods-exponential loss, AdaBoost, XG boost and LightGBM, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data)**.**

Unit– IV

Neural Networks (NN), Support Vector Machines (SVM), and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest–Neighbor class if i ers (Image Scene Classification).

Unit– V

Unsupervised Learning: Association rules, Cluster analysis- Partitioning based methods, Hierarchical based methods, Density-based methods, Grid based methods, Dimensionality Reduction-PCA for visualization, Anomaly Detection-Isolation Forest (conceptual).

Text Book:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning-Data Mining, Inference, and Prediction, 2nd Edition, 2009, Springer Verlag.

Reference Books:

1. C.M.Bishop, Pattern Recognition and Machine Learning,2006, Springer.
2. L.Wasserman, All of statistics,2004, Springer.
3. Gareth James. Daniela Witten. Trevor Hastie Robert Tibshirani, An Introduction to Statistical Learning with Applications in R.
4. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning (with Applications in Python), 2nd Edition, Springer.
5. Arun K.Pujari, Data Mining: Concepts and Techniques,3rd Edition, Universities Press (India).
6. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow,3rd Edition 2022, O'Reilly Media.
7. Alice Zheng,& Amend a Casari, Feature Engineering for Machine Learning-Principle and Techniques for Data Scientists, O'Reilly Media.

Course Code	Course Title	L	T	P	Credits
B0303OE	Generative AI (Open Elective)	3	0	0	3

Course Description: This course introduces the foundations, principles, and evolution of AI, ML, DL, NLP, and Generative AI. It provides in-depth knowledge of advanced neural architectures such as GANs, VAEs, and Transformers, along with large language models and prompt engineering. Emphasizes practical applications, fine-tuning models, and responsible deployment of Generative AI in real-world scenarios.

Course Outcomes: At the end of the course, the student will be able to

C301.1: Explain the foundations of AI, generative models, and advanced neural architectures.

C301.2: Apply generative AI techniques for text, image, video, and multi modal applications.

C301.3: Design and fine-tune large language models for domain-specific use cases.

C301.4: Analyze ethical, social, and legal implications of generative AI systems.

C301.5: Develop multi-agent and framework-based generative AI applications using LLM ecosystems

C301.6: Evaluate multi modal generative AI systems and propose responsible AI deployment strategies.

Unit– I

Foundations of AI and Generative Models Introduction and historical evolution to Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP) and Deep Learning (DL)**,** Structure of Artificial Neural Networks (ANNs), Mathematical and computational foundations of generative modeling, Overview of generative models and their applications across various domains; Importance of Generative AI in modern applications, Transfer learning and in advancing Generative AI

Unit– II

Advanced Neural Architectures for Generative AI: principles and applications, Generative Adversarial Networks (GANs): architecture and working principles; Transformer architecture and attention mechanisms (in detail); Long Short-Term Memory Networks (LSTMs) and the limitations of traditional RNNs/LSTMs, Advanced Transformer architectures and techniques, Pre-training and transfer learning strategies for generative models, Parameter-Efficient Fine-Tuning (PEFT), Low Rank Adaptation (LoRA).

Unit– III

Large Language Models and Prompt Engineering: Overview of Large Language Models (LLMs), GPT architecture, variants, and working principles, Pré-training and fine-tuning GPT models for applications (e.g., chatbots, text generation), Case study: GPT-based customer support Chabot, BERT architecture, pre-training objectives, and fine-tuning, RAG vs Fine-tuning comparison, Prompt Engineering: Designing effective prompts, controlling model behavior, and improving output quality, Fine-tuning language models for creative writing and Chabot development, Concept of Function Calling.

Unit– IV

Multi-Agent Systems and Generative AI Applications Introduction to Multi-Agent Systems (MAS), Types of agents: reactive, deliberative, hybrid, and learning agents, Multi-agent collaboration and orchestration for generative tasks, Planning and Task Decomposition, Reasoning in Agentic Systems, Use cases: autonomous research assistants, cooperative creative generation, Frameworks and tools: AutoGen, CrewAI, Hugging GPT for LLM-powered multi-agent systems, Generative AI applications: Art, Creativity, Image/Video generation, Music composition, Healthcare, Finance, Real-world case studies and deployment challenges.

Unit– V

GEN AI Ethics and LangChain Framework: components and LLM application development, Retrieval-Augmented Generation (RAG), Embeddings, Indexing networks, and Vector databases, Generative AI across modalities: Text, Code, Image, and Video generation, Image and Video generation using GANs and VAEs, Multi modal Transformers, Multi modal Generative AI: integration and training strategies, Ethical considerations: bias, fairness, trust, and responsible AI deployment, Social and legal implications of Generative AI, Risk mitigation strategies and real-world ethical case studies.

Text Books:

1. Altaf Rehmani, Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology.
2. Charu C.Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer.
3. Joseph Babcock, Rag hav Bali, Generative AI with Python and TensorFlow 2,2024, Packt Publishing Limited.
4. Generative Deep Learning: Teaching Machines to Paint, Write, Compose and Play, 2019, O'Reilly Media, Inc.

Reference Books:

1. Josh Kalin, Generative Adversarial Networks Cookbook,2021, Packt Publishing Limited.
2. Jesse Sprinter, Generative AI in Software Development: Beyond the Limitations of Traditional Coding, 2024
3. Richard Steeve, Efficient Fine-Tuning of LLMs: Practical Techniques Using LoRA, QLoRA, and PEFT for Scalable and Cost-Effective NLP Model, 2025.
4. Maarten Balliauw, Daniel Cazzulino, Programming Large Language Models with Azure Open AI, 2024, Pearson.
5. Sinan Ozdemir, Building Agentic AI Systems, 2024, Pearson.
6. Akansha Singh, Krishna Kant Singh, Multimodal Generative AI, 2024, Springer Nature.